

St. Louis Regional Hazard Mitigation Plan  
Update for 2015-20

Prepared for Franklin, Jefferson, St. Charles, St. Louis Counties  
and the City of St. Louis

Prepared By

East-West Gateway Council of Governments

June 23, 2015

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Chapter 1 of 4 Chapters

## The Planning Process

Approved July 13, 2015

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## **Preface**

The Hazard Mitigation plan for the St. Louis, Missouri Metropolitan Region is updated every five years to comply with Federal rules. This plan covers five Missouri counties and the 135 municipalities and 50 school districts, which are located within those counties. The 2015 plan describes the process used in developing this new plan, provides an updated overview of the region, including conditions, capacity and risks of natural disaster, and includes a new action plan for the jurisdictions within the region. In a separate file, East-West Gateway Council of Governments (East-West Gateway) will maintain and update a list of participating communities and school districts that have adopted this plan and submitted signed resolutions to East-West Gateway.

## **1. The Planning Process**

### **A. Introduction: The St. Louis Metropolitan Region addressed in this plan**

The five counties in eastern Missouri (Franklin, Jefferson, St. Charles and St. Louis Counties and the independent City of St. Louis) making up the Missouri portion of the St. Louis region, share common geographic, climatic and related risk factors that make them similarly susceptible to certain natural hazards. These five counties and the 135 municipalities within them are also members of the East-West Gateway Council of Governments (EWG) and are represented in regional transportation plans, (both the Long Range Transportation Plan and the Transportation Improvement Programs); in the 208 Water Quality plan for the region; in Homeland Security Planning through the St. Louis Area Regional Response System (STARRS), and in OneSTL, the regional plan for sustainable development. (See map at end of chapter)

In 2004 and again in 2009, these five counties were part of a collaborative planning process to develop the All Hazard Mitigation Plan. Because of shared geography and shared collaboration in governance and planning, the region can be addressed as one entity for the purposes of developing an update to the regional hazard mitigation plan. This plan is designed to help protect public safety and prevent loss of life or injury in the event of a natural disaster. It is also designed to reduce risk to existing and future development and to prevent damage to each community's unique economic, cultural and environmental assets. The plan will also help to improve the operational effectiveness of local governments and school districts following any natural disaster, by providing recommendations for advance preparation. Advance planning should prepare first responders as well as local government leaders and thus serve to reduce costs and improve efficiency of disaster response and recovery. By identifying a regional Action Plan, this document also encourages collaboration, cooperation and a shared approach to disaster mitigation efforts.

In this first section, EWG addresses the planning process. In Section 2 the plan discusses the major hazards that all counties and communities share in common. In Section 3, the plan addresses risk assessments and vulnerabilities. In chapter 4, the plan outlines up updated plan of action with a series of action steps reviewed by our Working Group, the county emergency managers, and all of the community representatives who attended the workshops that were part of the planning process. In an effort to facilitate coordination and regional collaboration, this plan focuses more on the regional priorities. Many of the individual community issues were

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addressed in the previous plans. For a more detailed county by county description of hazards, one can consult the previous plan, adopted in March 2010, which is available on the EWG website.<sup>1</sup>

#### **A1. Documenting the Planning Process (Requirement §201.6(c)(1))**

This is the third-five year plan for All-Hazard Mitigation in the St. Louis region. Because the plan is based on the work of the two previous approved plans, in 2004 and 2009, EWG has sought to enhance the planning process and the public involvement, and to focus the elements that have evolved in the last five years. Previous plans focused on the specific details that might be different from one community or one county to another, while in this plan we seek to focus on the elements all of the five counties share. In building a common framework for action, EWG expects to be able coordinate a more effective plan. Note also for this plan as an update on two previous plans, EWG revised the organizational structure to enable a more streamlined approach. As a result, the new plan does not seek to identify changes from previous plans, because the entire approach has been changed. This plan stands alone, but it also stands upon the work in the previous two iterations of the plan. Those wanting more detail about risks, hazards, and local community conditions should review the document produced in 2009 for the 2010-2015 period.

To initiate the planning, EWG created a Working Group to oversee the plan development and give guidance to the EWG staff. The Working Group consists of the following:

- 1) one emergency management representative from each county (5 people)
- 2) one representative of municipalities (Municipal League) from each county (4 people) - EWG contacted the President of each county municipal league and asked them to serve or delegate this role to a specific individual.
- 3) one representative of school districts in the region who is a staff member at EducationPlus, formerly the Cooperating School Districts in the five counties.
- 4) one representative of the St. Louis Area Regional Coalition of Community Organizations Active in Disaster<sup>2</sup> (SLARCC) Steering Committee.

Working Group members met with EWG staff in June 2014 to discuss the overall plan, provide advice on the survey that was sent to local governments in July, and to plan for workshops in each county in September. As an outgrowth of that meeting, EWG staff presented information on the plan update to the SLARCC executive committee and the full regional SLARCC Steering Committee in July. Staff also presented to the St. Charles County Municipal League in July. The Working Group members provided advice and helped to organize the time and location for the county based workshops to address the plan. They also assisted in making invitations to the workshops and attended the workshops.

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<sup>1</sup> [http://www.ewgateway.org/ProgProj/Emergency\\_Response/HazMit/hazmit.htm](http://www.ewgateway.org/ProgProj/Emergency_Response/HazMit/hazmit.htm)

<sup>2</sup> Community Organizations Active in Disaster (COAD) include a wide variety of community organizations, businesses, nonprofits and individuals working together to plan community responses to a variety of emergency and disaster situations.

The Working Group also concurred with the staff recommendation that the Mission for the All Hazard Mitigation Plan should be in alignment with OneSTL, the regional plan that was adopted by EWG's board of directors in December 2013. OneSTL has nine Themes, and the Prepared Theme states the vision: *Equip the region's communities with the infrastructure, knowledge, communications and partnerships necessary to be safe and resilient.* This statement was thus adopted as the general mission of the Hazard Mitigation Plan. (See section A4 below)

**Contacting Affected Municipalities:** In June 2014, EWG staff sent a detailed letter to the municipal clerks for each municipality in the five counties and described the time frame for the Hazard plan update and also asked the municipality to identify who would be the contact person for the planning process if the contact person would be someone other than the clerk. It also requested that the municipality put the hazard plan on the municipal governing body agenda in July or August as a discussion item, and it described the importance of adopting the updated plan by a resolution of the governing body, once the plan is complete.<sup>3</sup>

In July, EWG sent a survey to each city clerk or to the designated municipal contact person. The survey further asked the municipality to identify their representative to the planning process. It also asked about the natural hazard incidents experienced by the community during the past five years, so that EWG has an updated summary of hazard experiences.

**A2. Involving neighboring communities and local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process.** (Requirement §201.6(b)(2)).

To broaden participation in the All-Hazard Mitigation Plan. EWG planning staff met with the staff of STARRS and arranged a presentation to the STARRS Board of Directors for the eight county region. STARRS is a regional grants management organization created to coordinate planning for response to large-scale critical incidents in the bi-state metropolitan region. STARRS' mission is to help local governments, businesses, and citizens plan for, prevent, protect against, respond to, and recover from critical incidents in the St. Louis region. In addition, STARRS, through the EWG, provides administration services for homeland security and healthcare disaster preparedness grants.<sup>4</sup>

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<sup>3</sup> A copy of the letter is in Appendix J where public involvement documents are listed.

<sup>4</sup> STARRS was formed as a result of the Urban Area Security Initiative (UASI) Grant Program for Homeland Security. When the UASI program was announced in June 2003, the St. Louis Metropolitan Medical Response System (SLMMRS) was operating as a nonprofit 501 (c)(3) Missouri Corporation authorized to conduct affairs in Illinois. Incorporated in 2002, SLMMRS was built upon efforts by volunteers from the medical community, EMS, fire, police, public health and government over several years to coordinate multi-disciplinary, multi-jurisdictional responses to large-scale medical emergencies in the greater St. Louis Metropolitan region. In February 2004 SLMMRS entered into a Memorandum of Understanding (MOU) with EWG, whereby EWG recognized SLMMRS as the metropolitan agency for planning and implementation of emergency medical response in the bi-state metropolitan region. In 2003, after the UASI Grant Program directed a regional approach to Homeland Security funding, SLMMRS adopted the name STARRS to encompass a growing role in regional planning.

STARRS also manages the Hospital Preparedness Program grant from the U.S. Department of Health and Human Services Assistant Secretary of Preparedness and Response (ASPR). The ASPR contracts are intended to help hospitals within the Missouri Region Counties to prepare for mass casualty incidents through improved communication in the health care community, sharing of resources and participation in regional training and exercises. Since some natural disasters, especially a major earth quake or tornado, could require participation from all of these various services, STARRS is a critical partner.

STARRS has established the STARRS Board of Directors as the urban area work group required by the UASI grant guidance. The Board is comprised of appointed representation from the eight county elected leaders, the emergency managers from each of the eight counties, and operational subject matter experts from key disciplines including, EMS, fire and police agencies, hospitals and public health. In addition, several technical committees have been established to determine the best application of grant funding and implement the important work of developing and maintaining regional plans and response capabilities. The various governments and agencies within the St. Louis Urban Area are better prepared to work together during disaster events as a result of the planning that takes place in these groups.

A presentation on the All-Hazard Mitigation Plan update process to the STARRS board was made in May 2014, and has provided an important link to emergency management staff, police, fire and departments of health, as well as to similar agencies in neighboring counties in Illinois. It also served to inform and enlist the support of the county emergency managers to serve on the Working Group that helped to guide the plan. Staff then presented information to the EWG Board of Directors, which includes both the leadership of the five counties involved in the plan and the three counties in Illinois.

As a result of presenting to the STARRS Board, EWG staff also received an invitation to meet with the executive committee of SLARCC (July 11)), and then to provide a presentation to the entire SLARCC board on July 31. Each of the five counties was represented at the SLARCC board meeting, and there was strong interest among their partners in being involved in the plan and informing others about the plan and the planning process. The Co-Chair of the SLARCC committee also volunteered to be a member of the Working Group, so EWG has developed ongoing access to input from this significant volunteer focused effort. As will be referenced later in the report, the formation of the SLARCC is one of the most important actions that has taken

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STARRS is cooperating with the eight governments that make up the St. Louis Urban Area; these are Franklin, Jefferson St. Charles and St. Louis Counties and the City of St. Louis in Missouri and the governments of St. Clair, Madison and Monroe Counties in Illinois. STARRS has a formal relationship with these governmental agencies through the MOU with EWG, which also serves as its fiscal agent. Over the past ten years, STARRS has distributed more than \$100 million dollars in grant funds to the entire St. Louis Urban Area in accordance with the Department of Homeland Security and the Department of Health and Human Services grant guidance.

place in the last five years, and EWG Staff expects that the SLARCC will continue to play a significant role in public education, awareness and preparedness.

Through these initiatives, neighboring communities are aware of the Hazard Mitigation Plan and have a tremendous opportunity to collaborate in both planning and implementation. EWG staff also spoke with the executive director of the Boonslick Regional Planning Commission on two separate occasions (May and July) to review the fact that the planning process for the five counties is beginning. This provided an opportunity for staff to learn that Boonslick is updating its plan on a county-by-county basis and will be working on the Montgomery County plan this year.

### **A3. How the public was involved in the planning process during the drafting stage**

(Requirement §201.6(b)(1))

The SLARCC and its working groups provide access to a wide range of citizen organizations including, non-profit service organizations, churches and government agencies. The SLARCC has become important structures for reaching the interested public. In addition, EWG asked all municipalities included in the study to add the Hazard Mitigation Plan to the municipal council agenda as a discussion item in the months of June, July, August or September. This action placed the All-Hazard Mitigation Plan in the public domain, and served to increase public awareness of the plan. It also informed elected official about the plan before the September county-by-county workshops six months before they were asked to adopt the plan. Local governments and the public were also informed of the Workshops held in each county in September that provide an overview of the elements in the plan and sought comment and recommendation to the plan.

EWG staff worked with the County Emergency Management offices to plan the workshops in each county. This coordination is essential to providing the information necessary and to identifying the attendees for the workshops. The workshops were held in later September and early October. Two workshops were planned for each site, one during business hours for professional staff to attend and one beginning at 5 pm for citizens or elected persons to be able to attend following the work day. In all 14 workshops were planned at seven sites in the five county region (a flyer listing the workshops, plus other related publicity is in Appendix J):

City of St. Louis & South St. Louis County, Carondelet Rec Center, September 23

Franklin County – Union, September 24, 2014

St. Louis County – EducationPlus office, Creve Coeur, September 25

Jefferson County – Hillsboro, September 29, 2014

St. Louis County – North County Recreation Complex, September 30

St. Louis County – Brentwood Recreation Center, October 1

St. Charles County – County Administration Building, October 6

A list of 27 cities and four counties attended the meetings; along with representatives from 8 school districts and two organizations. General comments from the meetings are found in the Appendix J, and a number of key comments were integrated into the plan.

## *St. Louis Regional Hazard Mitigation Plan*

At the workshops representatives were asked to identify priorities for their communities and rate the various action steps in the All Hazard Mitigation Plan. The spreadsheet in Chapter 4 indicates the individual community priorities.

Communities that did not attend the workshop were invited to fill out a worksheet to identify their priorities. Many communities preferred to designate their county emergency manager who serves on the Working Group to act on their behalf. A number of the smaller communities in the region contract for emergency management services through their county emergency management office. Those communities have been represented in the planning process by the county emergency managers on the Working Group. Especially for the many small municipalities in St. Louis County, the assistance of emergency management staff is critical.

The school districts in the region were represented by the representative of the EducationPlus who served on the Working Group and has represented all of the school districts in the planning process.

In November 2014, EWG also presented information on the Hazard Mitigation Plan to the American Planning Association for the metropolitan region, thus regional urban planners have had a chance to weigh in on the plan and process. EWG also provided an update in November to the SLARCC. A copy of the presentation and the publicity is in Appendix J.

Upon completion of the draft plan in December 2014, EWG provided it to the Working Group members at the same time it provided the plan to SEMA and FEMA. The Working Group members provided feedback through separate communications.

The final stage of the planning process is the adoption of the plan by the local governing boards of municipalities, school districts and counties. That adoption process will provide the final stage of public information on the plan, as each entity brings the resolution to the floor for discussion and action. As jurisdictions adopt the plan, they send a copy of the resolution to East-West Gateway, which keeps track of participating jurisdictions.

### **A4. Review and incorporation of existing plans, studies, reports, and technical information (Requirement §201.6(b)(3))**

In December 2013, EWG Board of Directors approved *OneSTL: Many Communities, One Future*, a regional plan for sustainable development. This plan was the result of a three-year planning grant from US Department of Housing and Urban Development through the Sustainable Communities Initiative. OneSTL is a guide for future planning undertaken by EWG. The Hazard Mitigation plan is referenced in this regional plan, as is the Long Range Transportation Plan and regional security planning. Moreover, OneSTL establishes a framework for planning that EWG will encourage local governments to follow as they update their comprehensive plans. OneSTL can be found at [www.onestl.org](http://www.onestl.org). Reference to the Hazard Mitigation Plan is under the *Prepared* theme. The two relevant Goals and Objectives under the Prepared Theme in OneSTL include the following:

*Goal 1: Protect communities from known risks of natural disaster by focusing on prevention.*

*Objectives*

- 1: Reduce exposure to risks and hazards through improved disaster planning actions.*
- 2: Increase understanding of risks and take appropriate actions to minimize risks of flooding.*
- 3: Reduce the severity of future events through mitigation and adaptation efforts.*

*Goal 2: Strengthen capabilities for shared disaster response.*

*Objectives*

- 1: Increase cooperation among first responders.*
- 2: Promote community involvement in preparedness efforts.<sup>5</sup>*

In addition to the Themes, Goals, Objectives and Strategies laid out in the OneSTL plan, EWG and the more than fifty partner organizations that were involved in that three year planning process have created a *Sustainable Solutions Toolkit* (<http://www.onestl.org/toolkit>) that seeks to provide practical solutions to challenges of local government in a variety of areas. Some of the toolkit elements focus on disaster mitigation practices. Finally, the OneSTL network has grown in size during 2014 to more than 100 organizations, and the Network will be promoting work on all of the goals in coming years. This OneSTL network becomes a place for more comprehensive and integrated planning to continue to grow.

Through this Hazard Mitigation planning process, EWG is encouraging local communities to include hazard mitigation planning as well as disaster response planning in their local comprehensive plans, if they do not already do so. After the Plan is approved by SEMA and FEMA, then EWG will also present the regional plan to the members of professional organizations including the City Managers Association, the Municipal League, and the St. Louis area Section of the American Planning Association. The professional planners are in position to bring the elements of the plan into alignment with the city and county comprehensive plans of local communities.

#### **A5. How the communities will continue public participation in the plan maintenance process** (Requirement §201.6(c)(4)(iii))

County Emergency managers and their agencies already play a key role in planning and plan maintenance. EWG planning staff also works closely with municipalities throughout the region on development and planning issues, and EWG will stay current on issues with FEMA and SEMA as well as the local communities. The SLARCC and the network through STARRS both provide for on-going public participation in a wide range of related planning, and this plan will serve as one more element to track.

For example, STARRS along with the SLARCC, which has representatives from the American Red Cross and local social services agencies across the St. Louis region, have undertaken a

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<sup>5</sup> The OneSTL website lists all of the goals, objectives and strategies, many of which are consistent with - and anticipatory of - this plan update. See <http://www.onestl.org/plan/plan-implementation-goals/themes-goals-objectives-strategies>

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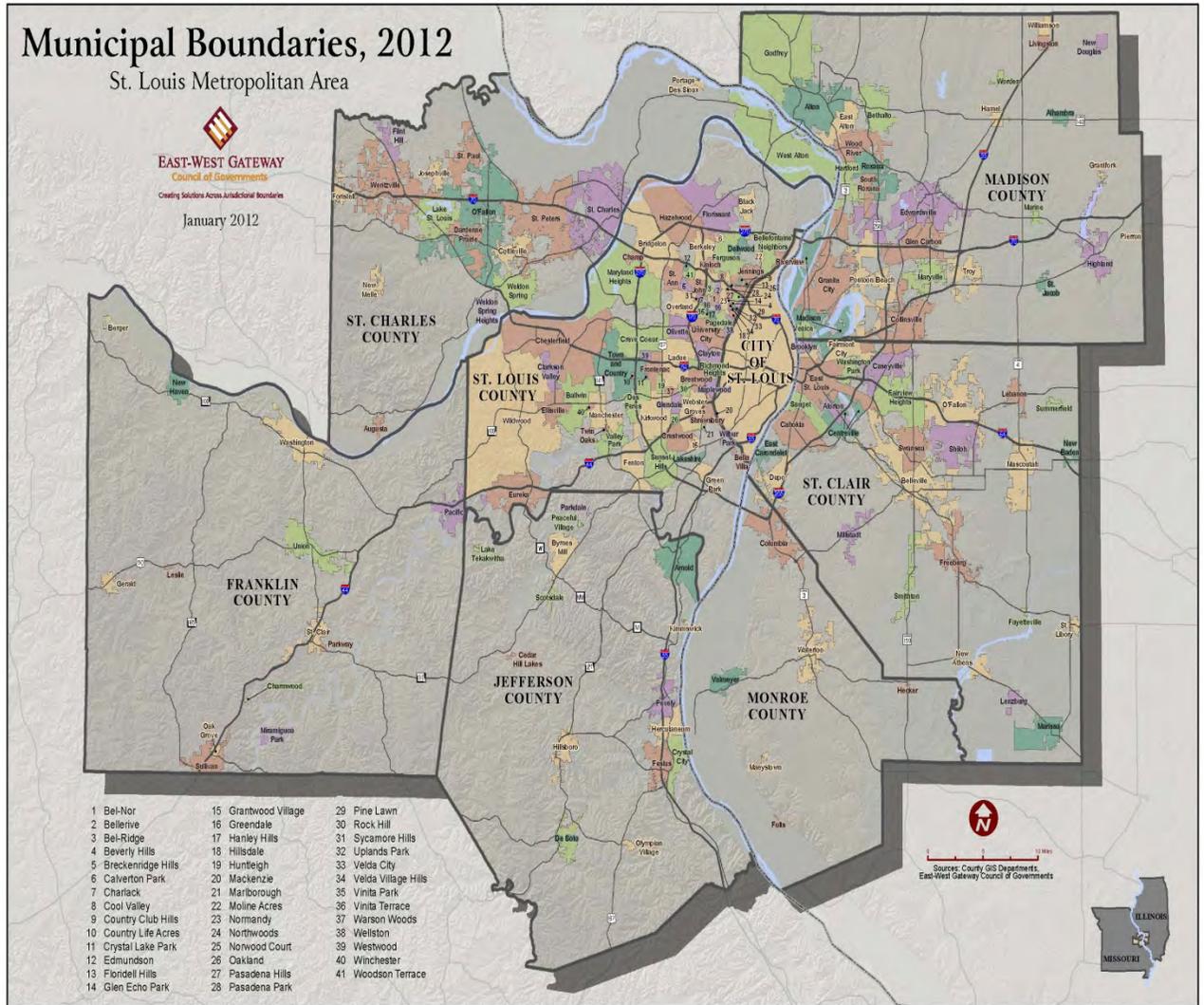
comprehensive public awareness campaign called "All Ready?" that was developed to help foster a culture of emergency preparedness in the region. The All Ready? Campaign will use surveys to determine how aware and prepared the public is to face unexpected events. Through STARRS, EWG will continue to be a part of the All Ready Campaign during the next five years. The Hazard Mitigation Plan workshops already served to introduce some of municipal and school district officials to the All Ready campaign, to the SLARCC to the potential to connect with a local Community Organization Active in Disaster (COAD) group, and to the availability of volunteer training.

As a regional plan, this all hazard mitigation plan update will provide the necessary framework for continued collaboration and cooperation to maintain the plan and the growing regional collaboration will ensure that it is addressed as circumstances change. The COAD member organizations also provide an important link to individual citizens, making involvement and comment on the plan and its implementation more accessible to all.

**A6. The method and schedule for keeping the plan current** (Includes monitoring, evaluating and updating the mitigation plan) (Requirement §201.6(c)(4)(i))

Through the STARRS board, EWG has regular meetings with the relevant emergency response agencies in the region. STARRS provides a valuable structure for making a regional plan effective, since cooperating jurisdictions are already sharing information and resources through STARRS. EWG planning department staff will report to the STARRS board annually on the All Hazard plan, and will invite the county emergency managers to provide regular updates of hazard related activities in their jurisdictions. Additionally, EWG will coordinate with the STARRS board and the SLARCC as major sources of information about various hazards and local and county hazard plans. The All Hazard Mitigation Plan should provide an important context for involving partner municipalities in the COADs. The COADs will also be informed by the SLARCC about these presentations and will share information through each of the county COAD organizations. EWG will also pass on information from SEMA and FEMA to the STARRS board and the SLARCC.

St. Louis Regional Hazard Mitigation Plan



Metropolitan St. Louis Region, Missouri and Illinois. This plan is focused only on the five Missouri Counties, including 135 cities and 50 school districts.

**St. Louis Regional Hazard Mitigation Plan  
Update for 2015-20  
Final Plan**

**Prepared for Franklin, Jefferson, St. Charles, St. Louis Counties and the City  
of St. Louis**

**Prepared By**

**East-West Gateway Council of Governments**

**Chapter 2 of 4 chapters**

**Regional Profile and Community Capabilities**

**Approved July 13, 2015**

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## **Chapter 2 Regional Profile and Community Capabilities**

This preface highlights the areas where this plan has made changes from the previous plan, completed in 2009-2010. In previous plans, the information on the topics addressed in this chapter was presented for each county separately. In this effort, information and data has been consolidated and edited to provide a more regional analysis. Below is a list of the major changes in the new plan.

Geography and Topography – Pages 2-1 – 2-12

Geography, Geology, Soils and Climate

Waterways and Water Resources

*In previous plans information on these topics was presented separately for each county. In this effort, information and data has been consolidated.*

Demographic Information - Pages 2-12 – 2-15

*Tables 2-1 – 2-8 updated*

*Table 2-9 is new*

Significant Cultural and Social Issues – Pages 2-15 – 2-20

This is a new section

Tables 2-9 & 2-10 new

Form of Government – Pages 2-21 – 2-25

This is a new section

Since 2009-2010 Plan, Charmwood, Peaceful Village and Lake Tekawitha have been incorporated. In November 2011 residents voted to disincorporate St. George and become part of unincorporated St. Louis County.

Tables 2-12 to 2-16 are new

Critical Assets and Essential Facilities – Pages 2-25 – 2-38

Schools – Pages 2-27 – 2-29

Section and Tables Updated

Figure 2-12 new, unified map replaces 5 individual county maps

Development Trends Pages 2-38 – 2-39

Updated section

Economy, Employment and Industry, Labor Force – Pages 2-40 – 2-44

Updated Table 2-25 and Tables 2-27 to 2-33

Table 2-26 is new

Regional and Local Capabilities – Pages 2-44 – 2-55

Updated Community Partnerships with new discussion of COADS and CERT

New sub-section on School Capabilities, Tables 2-33 – 2-34

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### Changes

Codes, Regulations for Buildings, Fire, Zoning – Pages 2-55 – 2-56

Section Updated

Updated Table 2-35

Existing Community Plans – Pages 2-56 – 2-63

Section Updated

Updated Table 2-36

Tables 2-37 to 2-40 new

Flood Mitigation Efforts – Pages 2-63

New information

National Flood Insurance Program – Pages 2-63 – 2-68

Tables 2-41, 2-43 and 2-44 updated to identify all incorporated units participating in the NFIP

Media Relations – Pages 2-69

In previous plans information on this topic was presented separately for each county. In this effort, information and data has been consolidated and edited.

County Capability Assessment – Pages 2-69 – 2-75

In previous plans information on these topics was presented in a stand-alone chapter for each county. In this new plan, information and data has been updated, consolidated and edited. The section on funding sources was deleted.

County Capabilities (Organization, Staffing, Training)

No change

Vulnerability Assessment of County Policies and Development Trends

No change

Capability Assessment Worksheets

No change (Only updated year of most recent building code)

## *St. Louis Regional Hazard Mitigation Plan*

Natural hazards impact not only the citizens of the EWG planning region, but also their property, the environment and the economy. Natural hazards here are defined as floods, tornadoes, severe winter storm, earthquake, heat wave, drought, dam failure, and wildfire. These hazards have exposed the region's residents and businesses to the financial and emotional costs of recovering after disasters. The risk associated with hazards increases as more people move to areas affected by hazards. The inevitability of hazards along with a growing population and increased economic activity within the five counties of the St. Louis, Missouri region create an urgent need to develop strategies, coordinate resources and increase public awareness to reduce risk and prevent loss from future hazard events. Identifying risks posed by hazards, and developing strategies to reduce the impact of a hazard event can protect life and property. Local governments can work together with local residents and businesses, emergency managers, non-profit organizations and East-West Gateway to implement this Hazard Mitigation Plan that addresses and reduces the potential impact of hazard events.

### **Regional Profiles**

#### **A. Geography and Topography**

Although the region shares a variety of geographic features, in this section of the plan addresses the variations by county.

Franklin County is located in the east-central part of Missouri on the northern edge of the Ozark region within the Salem Plateau. It has an area of 595,226 acres (922 square miles), of which 5,203 acres are water. It is the fourth largest county (area) in Missouri. (DEM MAP) The physiographic features of Franklin County include four major landforms, the Salem Plateau, the River Hills, the St. Louis Highlands and the flood plains along the Missouri River, Meramec River and other streams in the county. Elevations range from 427 feet above sea level (near the Meramec River) to 1,050 feet near Sullivan. The topographic relief in Franklin County is varied. Steeper slopes are found in the southern and western portions of the county.

Jefferson County is located in east-central Missouri, just west of the Mississippi River. The county has an area of about 425,280 acres that includes about 2,176 acres of water in the Meramec, Mississippi and Big Rivers and other large impoundments. (DEM Map) The County is divided into seven distinct physiographic regions. From the northeast to the south these regions include: a small area of Dissected Till Plains, the River Hills, the Zell

Figure 2-1 Franklin County Elevation

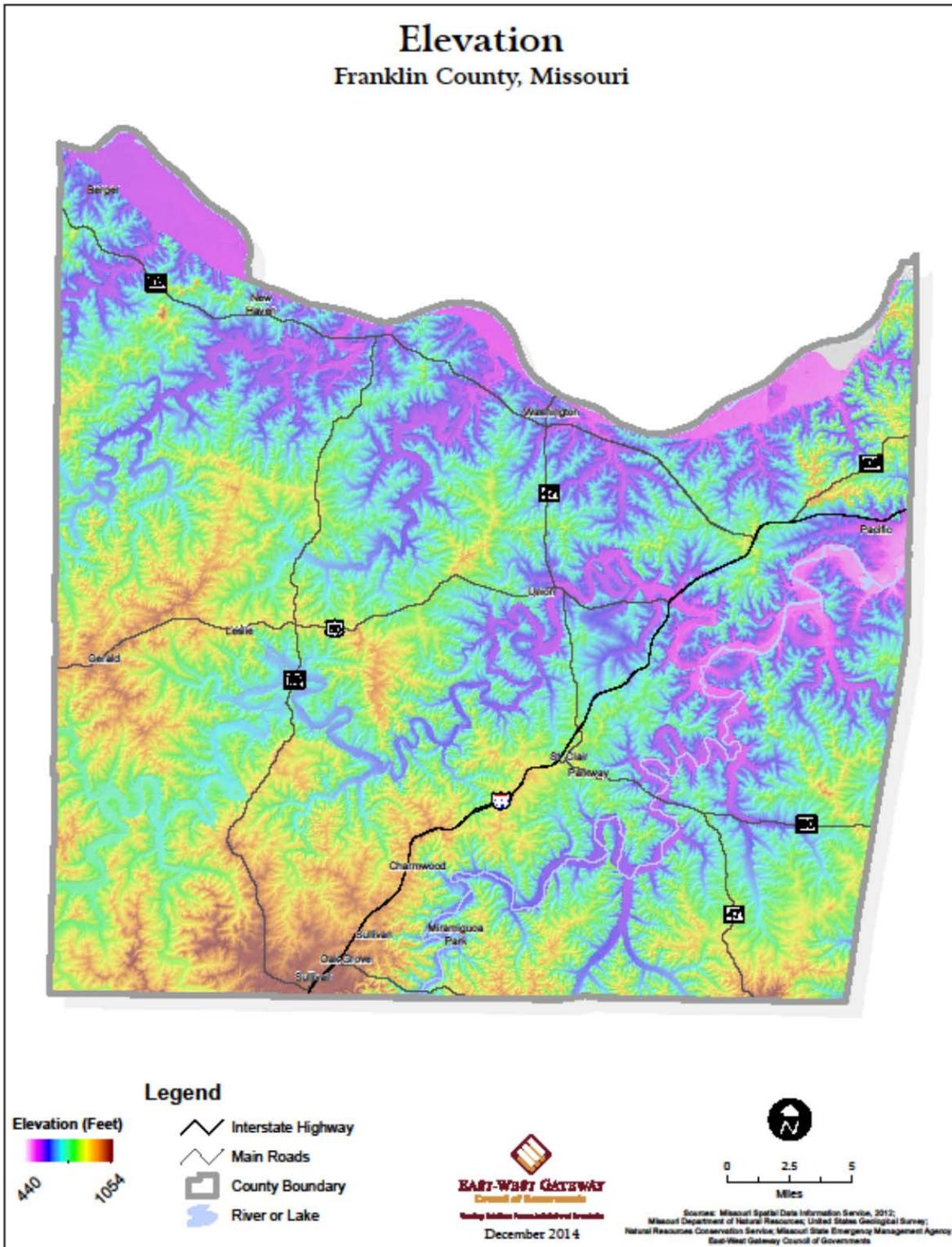
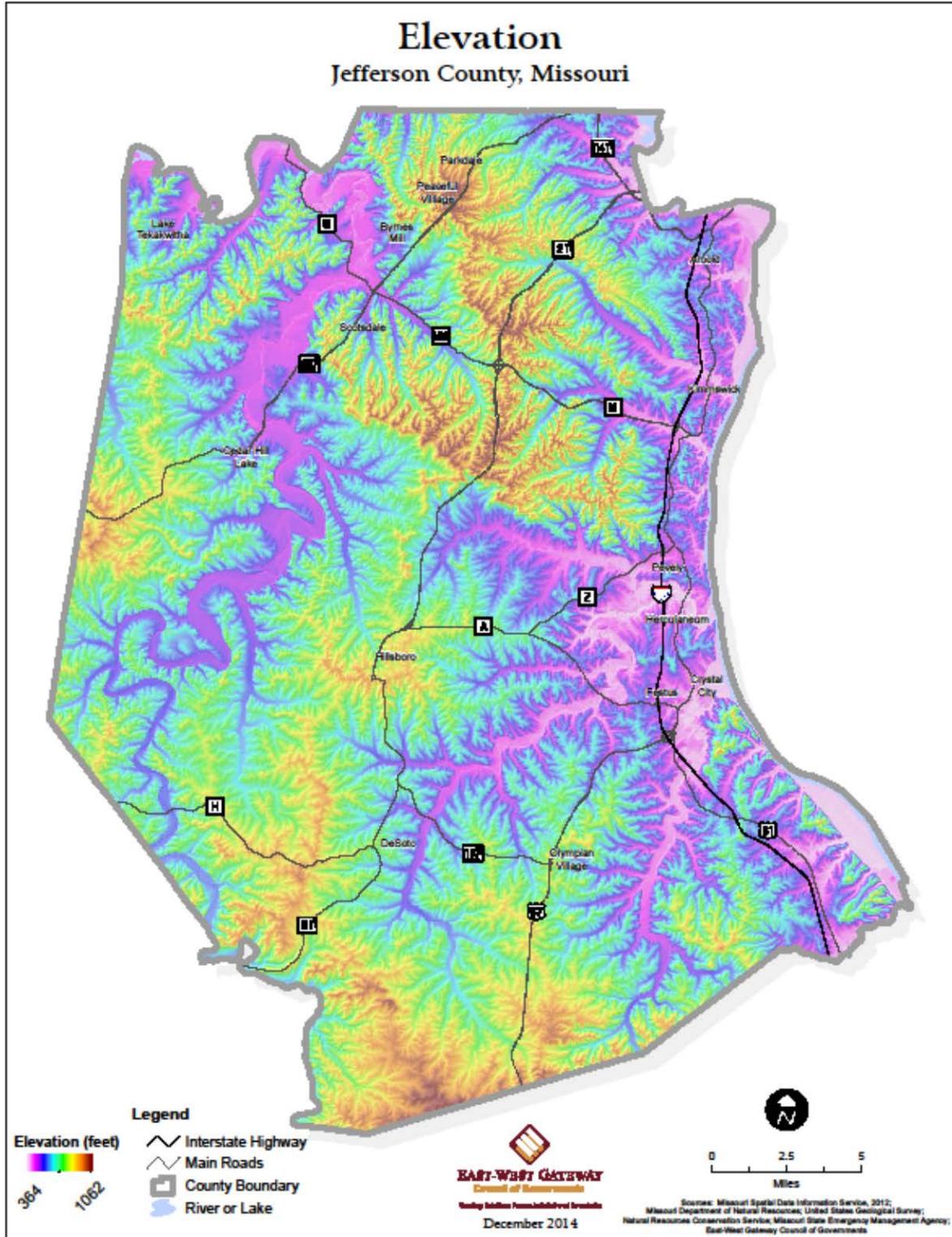


Figure 2-2 Jefferson County Elevation



## *St. Louis Regional Hazard Mitigation Plan*

Platform, the Burlington Escarpment, the Crystal Escarpment, the Salem Plateau, the Avon Escarpment and the floodplains of the Big, Meramec and Mississippi Rivers. The highest point in Jefferson County is Vinegar Hill about 1,060 feet above sea level in the southern part of the county. The lowest point is about 385 feet above sea level in the Mississippi River bottoms.

St. Charles County is located in the east-central part of Missouri. Neighboring Missouri counties include Lincoln, Warren, Franklin, and St. Louis. (DEM map) St. Charles County is approximately 18 miles northwest of the City of St. Louis and is included in the St. Louis Standard Metropolitan Statistical Area. St. Charles County has an area of 561 square miles of land area and 25 square miles of water area. Business and industry are rapidly increasing, along with home building. The strategic location of St. Charles County at the confluence of the Mississippi and Missouri Rivers has greatly enriched its history. Dominant in the County are the alluvial flood plains of the Mississippi and Missouri Rivers located in the northeast and southern portion of the county. A band of loess-covered hills of varying thickness borders the river plains. The northwest portion of the county has a prairie region of loess and glacial till (Dissected Till Plains physiographic region). Elevations range from about 397 feet above sea level at the confluence of the Missouri and the Mississippi Rivers to about 902 feet above sea level in the south-central part of the county.

St. Louis County is located on the eastern border of Missouri. It is bordered on the east by the City of St. Louis, on the north by the Missouri River, on the south by Jefferson County and the Meramec River and on the west by Franklin County. St. Louis County covers 517 square miles. The topographic elevation ranges between 380 feet (at the mouth of the Meramec River at Mississippi River and 900 feet (Rockwoods Range in Wildwood) above mean sea level. There are four physiographic regions in St. Louis County: the alluvial plain along the rivers, the hilly upland located in the southern portion of the county, low hills located along the Missouri River bluffs near Chesterfield, Missouri and the rolling upland located in the central and northern portions of the county. St. Louis County lies at the northeast tip of the Ozark Uplift and is bordered on the north and east by areas that were altered by glaciers.

The independent City of St. Louis also functions as a county and is an urbanized area covering 66 square miles. It is located in east-central Missouri. It is bordered by the Mississippi River to the east and by St. Louis County. The elevation of the city ranges between 413 feet and 616 feet above mean sea level. The City of St. Louis is part of the Dissected Till Plains physiographic region. Topography varies from river bottoms/floodplains along the Mississippi River and River Des Peres to rolling upland terrain in the northern and western portions of the city. St. Louis was founded in 1764. In 1876,

City residents voted to separate from St. Louis County and become an independent city which has county functions and responsibilities.

Figure 2-3 St. Charles County Elevation

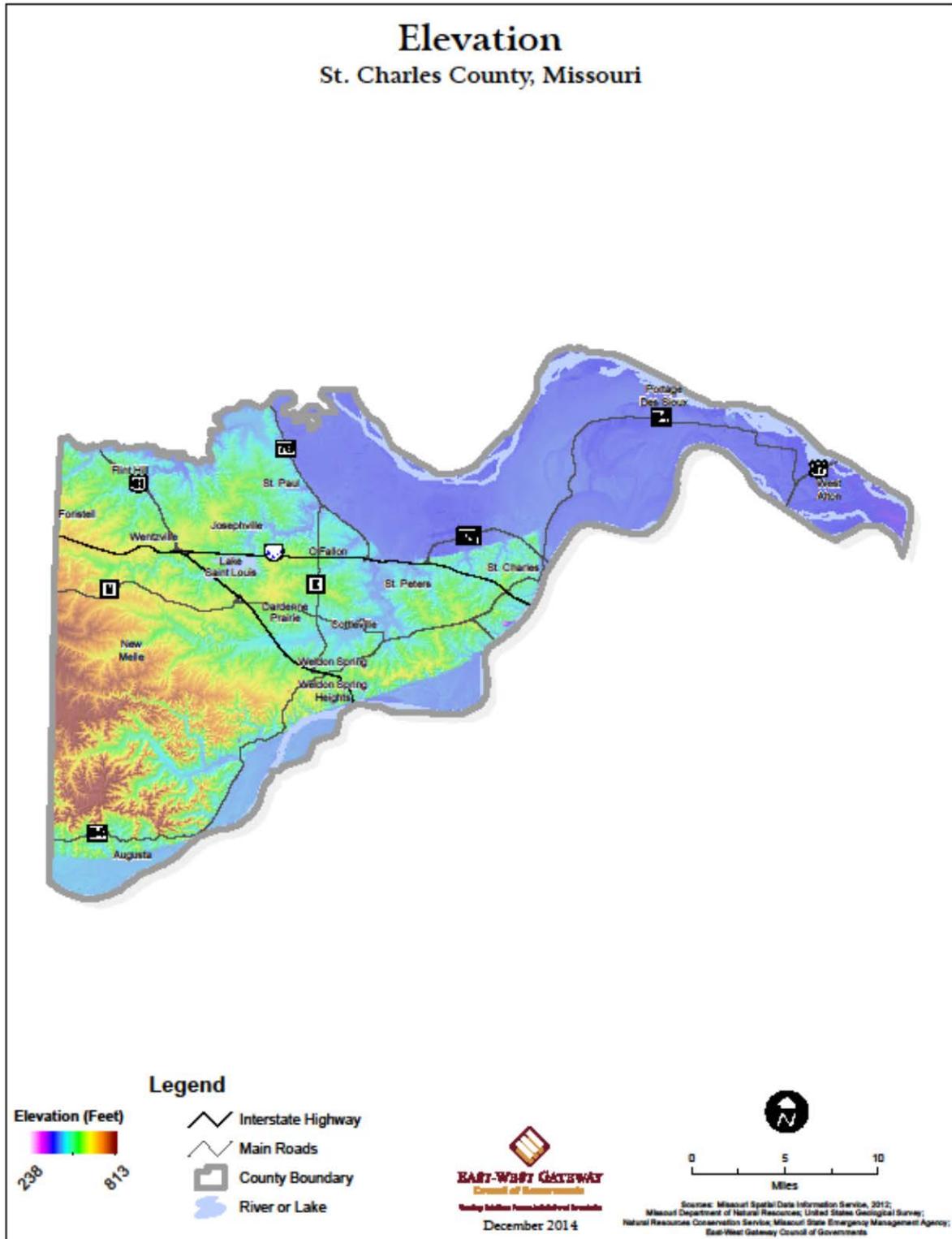


Figure 2- 4 St. Louis County Elevation

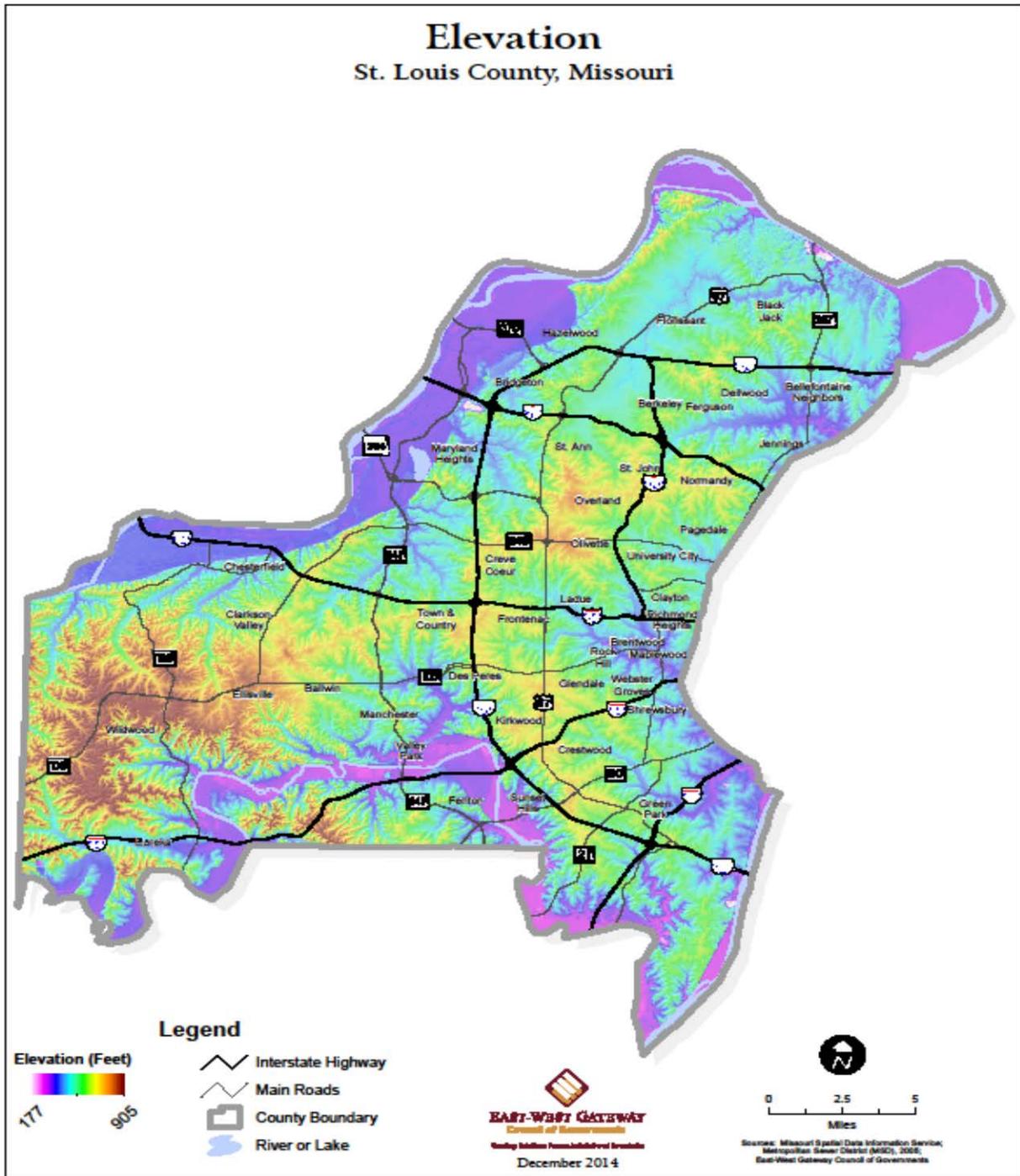
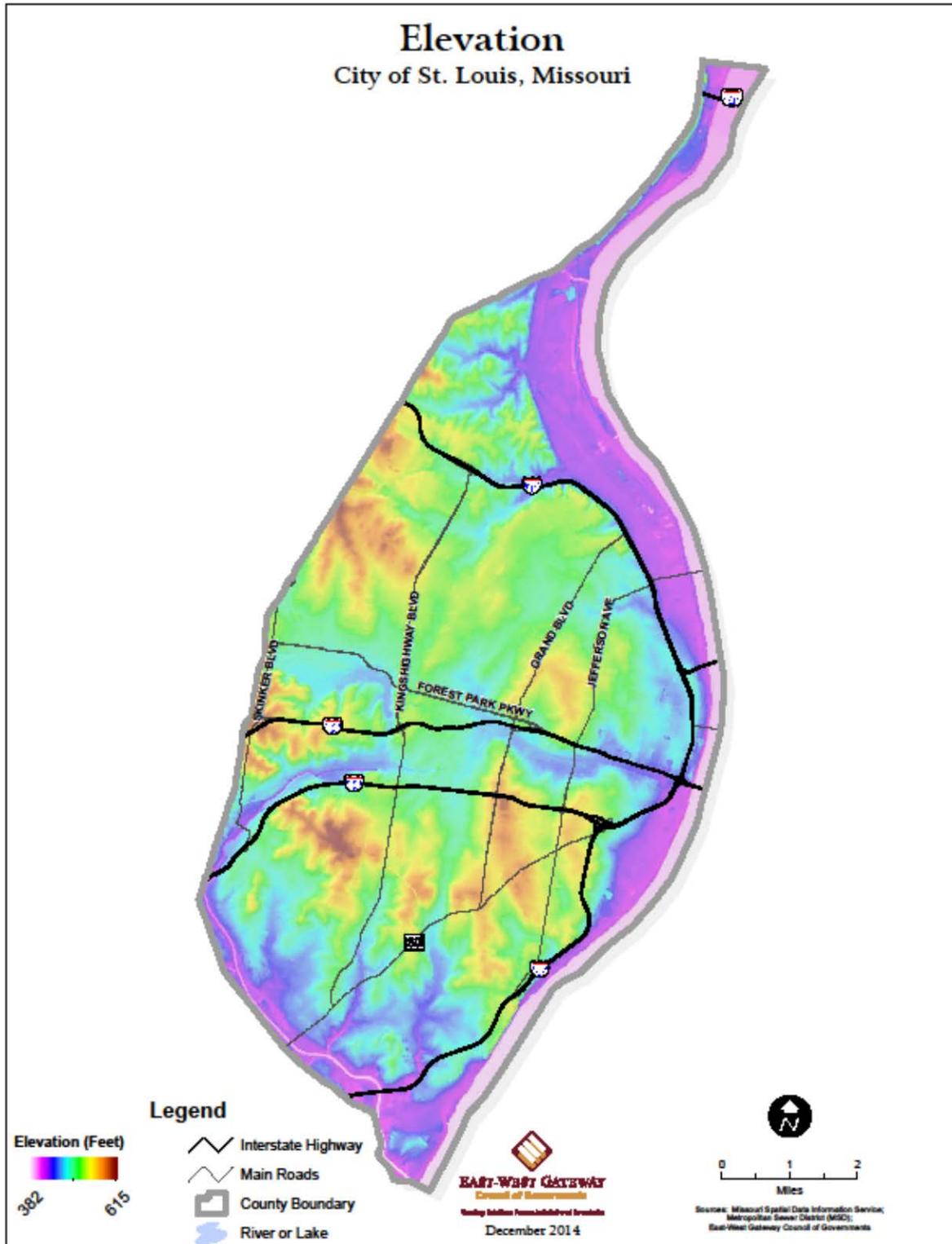


Figure 2-5 City of St. Louis Elevation



## **B. Geography, Geology, Soils, Climate and Waterways**

The physiographic features of Franklin County include four major landforms. The major landforms are the Salem Plateau, the River Hills, the St. Louis Highlands and the flood plains along the Missouri River and along other streams. The Salem Plateau is the most extensive landform in the county. It is located in a high area that is dissected by streams and hollows, mainly in the southern part of the county along the flanks of the Ozark dome. Cherty red clays and cherty dolomite bedrock are common here. The Salem Plateau is bounded on the northeast by the Crystal escarpment, which separates the Salem Plateau from a small area of highlands extending from St. Louis County. This area is characterized by narrow, loess-capped ridgetops and steep side slopes. The River Hills consist of loess-covered uplands in a band one to three miles wide. The River Hills are bounded on the north by the Missouri River flood plains. The southern boundary is less distinct because the loess gradually decreases. The major flood plains in the county are along the Missouri, Meramec, and Bourbeuse Rivers and their tributaries. The Appendix-Map Sets contains a land use/land cover map for the five county area.

Jefferson County is divided into seven distinct physiographic regions. Much of the county can be classified as rugged. Large areas, with greater than 20 percent slopes are common throughout northern and southern portions of the county. The central one-third of the county consists of wider and flatter crests and shallower valleys. From the northeast to the south these regions include: a small area of Dissected Till Plains, the River Hills, the Zell Platform, the Burlington Escarpment, the Crystal Escarpment, the Salem Plateau and the Avon Escarpment. The Dissected Till Plains consist of rolling and partially dissected basin with low hills and broad ridges adjacent to the lower Meramec and Mississippi Rivers. Thick layers of alluvium and loess have covered glacial till and outwash materials. The River Hills consist of a narrow band of uplands bounded on the east by the Mississippi River and on the west by the Burlington Escarpment. The Glaize, Joachim, Plattin, Pomme and Rock Creeks dissect this area. Ridges and north and east slopes are covered with loess. West and south slopes consist of upper cherty red clays and limestone outcrops on the lower slopes. The Zell Platform is a small valley with rolling topography east of Selma south to Ste. Genevieve County.

The River Hills are on the east and the Crystal Escarpment is on the west. The Burlington Escarpment is a band that borders the River Hills and the Crystal Escarpment. The Salem Plateau is the largest area in the county and borders the Crystal Escarpment to the north and east and the Avon Escarpment to the south. The Avon Escarpment is the highest area in the county located in the southwest corner. The Salem Plateau is on the north. Major soils in this area are Goss and Wrengart. Floodplains of the Big, Meramec and Mississippi Rivers and their tributaries are the most fertile of the county. Topography varies considerably throughout Jefferson County. A land use/land cover map for the five county area can be found in the Appendix – Map Sets.

## *St. Louis Regional Hazard Mitigation Plan*

St. Charles County has a number of major physiographic regions. The alluvial flood plains of the Mississippi and Missouri Rivers are dominant and are located in the northeast and southern portion of the county. A band of loess-covered hills of varying thickness borders the river plains. The northwest portion of the county has a prairie region of loess and glacial till (Dissected Till Plains physiographic region). The southern limit of the glaciation runs in an east west line through the southwestern corner of the county and extends northward through the center of the county. The topographic relief in St. Charles County is varied. Slopes ranging from 0-5.9 percent are found in the river bottomland around major drainage areas. Steeper slopes ranging from 6-13.0 percent are found in the central and western portions of the county. The greatest relief (14 percent) or greater is found in the southwestern portion of the county. Approximately 43 percent of St. Charles County lies within the floodplain. The Appendix – Map Sets contains a land use/land cover map for the five county area.

There are four physiographic regions in St. Louis County: the alluvial plain along the rivers, the hilly upland located in the southern portion of the county, low hills located along the Missouri River bluffs near Chesterfield, Missouri and the rolling upland located in the central and northern portions of the county. The northern and eastern portions of St. Louis County are included in the Dissected Till Plains physiographic region. St. Louis County lies at the northeast tip of the Ozark Uplift and is bordered on the north and east by areas that were altered by glaciers (the Missouri River is the approximate southern extent of the glacial movement). The area ranges from urbanized, nearly level to moderately sloping lands to relatively non-urbanized moderately sloping to steep. A land use/land cover map for the five county area can be found in the Appendix – Map Sets.

The City of St. Louis is located on the eastern border of Missouri, centered between the north and south state lines. It is bordered on the east by the Mississippi River, on the north by the Missouri River, on the south by Jefferson County and the Meramec River and on the west by St. Louis County. The elevation of the city ranges between 413 feet and 616 feet above mean sea level. The City of St. Louis is part of the Dissected Till Plains physiographic region. Topography varies from river bottoms/floodplains along the Mississippi River and River Des Peres to rolling upland terrain in the northern and western portions of the city. The City consists of urbanized, nearly level to moderately sloping lands. All of the land drains into the Mississippi either through direct runoff or into creeks and small rivers (Des Peres River) that then drain east into the Mississippi River. The Appendix – Map Sets contains a land/use land cover map for the five county area.

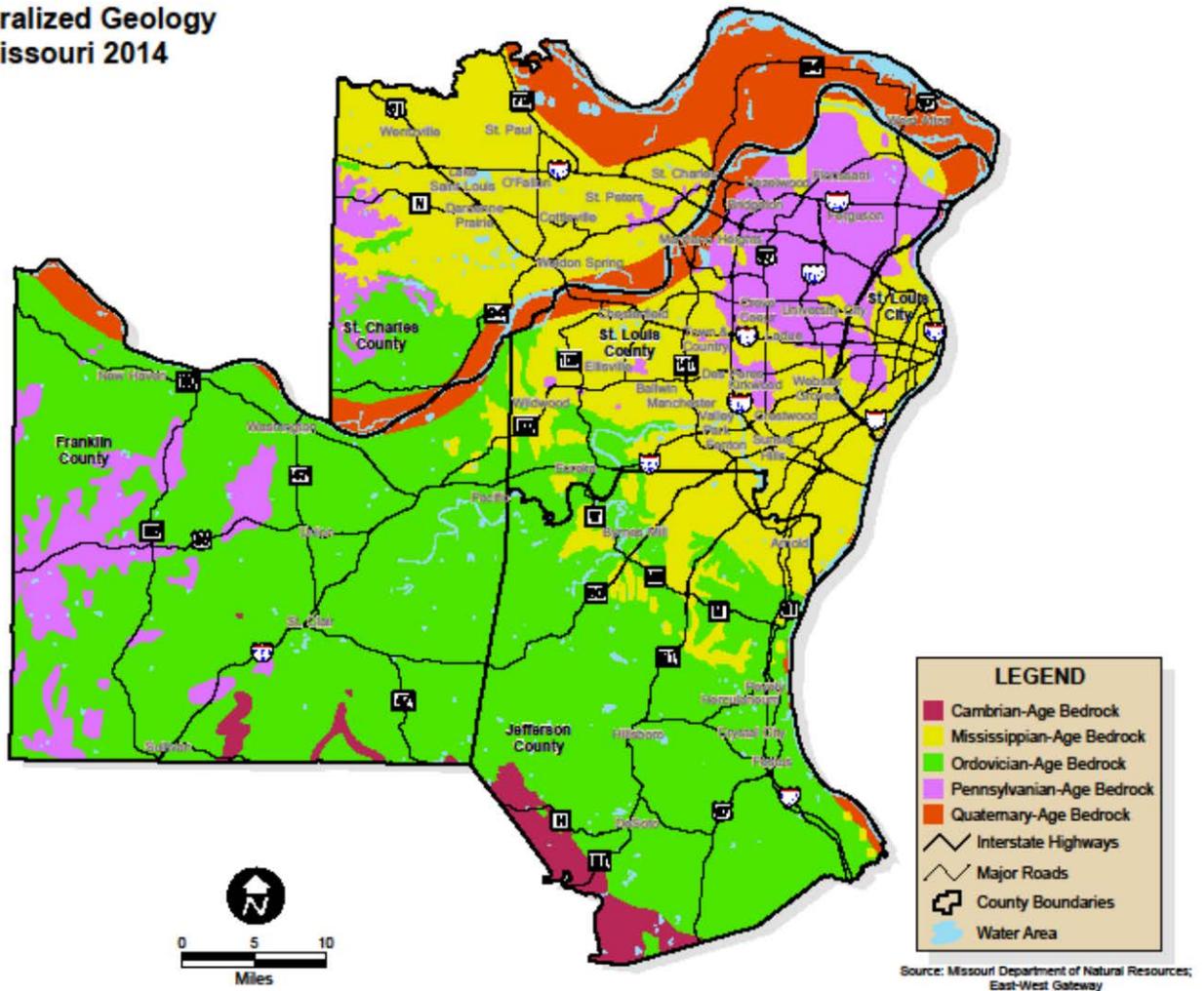
**Climate** - The climate in the four counties and the City of St. Louis consists of cold winters and hot summers. Heavy rains occur mainly in spring and early summer when moist air from the Gulf of Mexico interacts with drier continental air. In winter, the average temperature is 33°F; the average daily minimum temperature is 24°F. The lowest temperature, -22 °F, was recorded on January 5, 1884. In summer, the average temperature is 77°F and the average daily maximum temperature is 87°F. The highest

## St. Louis Regional Hazard Mitigation Plan

recorded temperature at Lambert Airport was 115°F. The total annual precipitation is 37.68 inches. Of this amount, 60 percent falls in April through September. The heaviest 1-day rainfall during the period of record was 6.85 inches on August 20, 1915. Thunderstorms occur on about 40 to 50 days primarily in the spring and summer months. For this area, the average growing season is 208 days.

FIGURE 2-6 St. Louis Region Generalized Geology

### Generalized Geology Missouri 2014



Missouri's mid-continental location makes it subject to airflows from a variety of source regions with markedly different properties. The state is close enough to the Gulf of Mexico that warm air with high humidity can flow into the state from a southerly direction at almost any time of the year. This warm, moist air is the principal source of spring,

## *St. Louis Regional Hazard Mitigation Plan*

summer and fall precipitation. In contrast, air arriving over Missouri from semi-arid to arid regions to the southwest is warm or hot and usually dry. Air that has moved from the Rocky Mountains arrives warm and dry. Such air may arrive over Missouri with surface winds from southwest through west to northwest.

Abnormally cold air in the winter and cold summer air with only very small moisture content arrives over Missouri from the northwest or north. These cold air masses originate in Canada and the northern plains. Normally, the flow from one of the principal source regions (warm or cold) will last for two or three days before switching to a different direction and source region and produce a variety of weather conditions. In some instances, however, a particular flow pattern may be very persistent or dominant for a period of weeks or even months. These periods can lead to wet, dry, hot or cold spells that place stress on normal agricultural processes and/or activities.

**Waterways and Water Resources** - The Missouri, Mississippi and Meramec Rivers are the dominant waterways and resources in the five county area. All three provide drinking water to substantial portions of the population. The Missouri and Mississippi are also major transportation corridors.

There are three major drainage basins in Franklin County: Missouri, Bourbeuse and Meramec. About 60 percent of the county drains eastward into the Mississippi River through the Meramec and Bourbeuse Rivers and their tributaries. This drainage area is south of a major drainage divide that spans the county from west to northeast. The Boeuf, Berger, St. Johns and Dubois Creeks drain areas north of this divide into the Missouri River. Approximately 14 percent of Franklin County lies within the floodplain. Floodplains located within the unincorporated areas of Franklin County are managed and regulated by Planning and Zoning Department. Floodplains located within municipal boundaries are managed and regulated by the respective communities.

The three largest rivers in Jefferson County are the Mississippi River, Meramec River and Big River. These waterways offer commercial and recreational opportunities, but a significant portion of the county is subject to flooding. Due to the amount of waterways, as well as fluctuations in water levels the Big River drains about 37 percent of the county; the Meramec River drains approximately 15 percent of the county. Smaller streams draining directly into the Mississippi River make up about 48 percent of the county. Big River flows into Meramec River, which then flows into Mississippi River. Both Joachim and Plattin Creeks flow into the Mississippi River.

There are six major drainage basins in St. Charles County. Two of these, the Femme Osage Creek and the Missouri River Basin drain south into the Missouri River. The Cuivre River Basin, Peruque Creek Basin, Dardenne Creek Basin and the Mississippi River Basin drain into the Mississippi Drainage network. Approximately 70 percent of northern St. Charles

## *St. Louis Regional Hazard Mitigation Plan*

County drains north and east into the Mississippi River. These watersheds are an integral component of the natural hydrologic cycle of the county.

St. Louis County is divided into three major watersheds including the Meramec River, Missouri River, and Mississippi River. A small area of the northeastern portion of the St. Louis County drains into the Mississippi River. There is a divide in the central and northern sections of the County separating the area into two drainage systems. The northern part drains into the Missouri River and the southern part drains into the River des Peres and Meramec River which enter the Mississippi River.

All of the City of St. Louis drains into the Mississippi River on its eastern boundary. The City is protected by a levee/floodwall with gates. The use of the land along the Mississippi riverfront is for commercial and industrial purposes including barges and barge load-out facilities). All of the land drains into the Mississippi either through direct runoff or into creeks and the 9.3 mile River Des Peres on the southern boundary of the City. The River des Peres and its tributaries drain a portion of St. Louis County and the City of St. Louis.

### **C. Demographic Information**

Approximately 1.9 million people reside in the five county area. Of this total, 24 percent are 17 years or younger and 13 percent are 65 years and older. (See Table 2-1). Appendix A contains information on the total population and population by age groups for the incorporated jurisdictions within the five county area.

Table 2-1 Population by Age in Five County Area

County	Total Population	Age 0 – 17 Years	Percent Share of Total	Age 18 – 64 Years	Percent Share of Total	65 Years and Older	Percent Share of Total
Franklin	101,492	25,104	24.7	62,388	61.5	14,000	13.8
Jefferson	218,733	54,988	25.1	139,351	63.7	24,394	11.2
St. Charles	360,485	92,860	25.8	227,247	63.0	40,378	11.2
St. Louis	998,954	234,174	23.4	615,287	61.6	149,493	15.0
City of St. Louis	319,294	67,539	21.2	216,580	67.8	35,175	11.0
Total	1,998,958	474,665	23.7	1,260,853	63.1	263,440	13.2

Source - 2010 U.S. Census

The following tables contain county level information on population by: racial groups; income; families living below the poverty level; and individuals with a disability.

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Table 2-2 Franklin County Population by Race

Race	Population	Percent Share of Total
White	97,390	96.0
Black/African American	847	0.8
American Indian and Alaskan Native	290	0.3
Asian	410	0.4
Hawaiian and Pacific Islander	30	0.0
Hispanic	1,397	1.4
Other Race	63	0.1
Two or More Races	1,065	1.0
Total	101,492	100

Source - 2010 U.S. Census

Table 2-3 Jefferson County Population by Race

Race	Population	Percent Share of Total
White	208,742	95.4
Black/African American	1,776	0.8
American Indian and Alaskan Native	608	0.3
Asian	1,403	0.6
Hawaiian and Pacific Islander	48	0.0
Hispanic	3,408	1.6
Other Race	120	0.1
Two or More Races	2,628	1.2
Total	218,733	100

Source - 2010 U.S. Census

Table 2-4 St. Charles County Population by Race

Race	Population	Percent Share of Total
White	321,078	89.1
Black/African American	14,827	4.1
American Indian and Alaskan Native	692	0.2
Asian	7,789	2.2
Hawaiian and Pacific Islander	153	0.0
Hispanic	9,983	2.8
Other Race	427	0.1
Two or More Races	5,536	1.5
Total	360,485	100

Source - 2010 U.S. Census

Table 2-5 St. Louis County Population by Race

Race	Population	Percent Share of Total
White	687,984	68.8
Black/African American	231,801	23.2
American Indian and Alaskan Native	1,632	0.2

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Race	Population	Percent Share of Total
Asian	34,466	3.5
Hawaiian and Pacific Islander	273	0.0
Hispanic	25,024	2.5
Other Race	1,187	0.1
Two or More Races	16,587	1.7
Total	998,954	100

Source - 2010 U.S. Census

Table 2-6 City of St. Louis Population by Race

Race	Population	Percent Share of Total
White	134,702	42.2
Black/African American	156,389	49.0
American Indian and Alaskan Native	684	0.2
Asian	9,233	2.9
Hawaiian and Pacific Islander	62	0.0
Hispanic	11,130	3.5
Other Race	478	0.1
Two or More Races	6,616	2.1
Total	319,294	100

Source - 2010 U.S. Census

Table 2-7 Population by Income

County	Median Household Income
Franklin	\$45,951
Jefferson	\$50,491
St. Charles	\$66,374
St. Louis	\$54,830
City of St. Louis	\$32,570

Source - 2011 American Community Survey

Table 2-8 Families Living Below the Poverty Level

County	Number of Families	Families Below Poverty Level	Percent Share of Total
Franklin	26,129	2,889	11.1
Jefferson	59,423	5,305	8.9
St. Charles	100,741	6,361	6.3
St. Louis	257,478	23,159	8.9
City of St. Louis	65,142	15,028	23.1
Total	508,913	52,742	10.4

Source - 2012 5-Year American Community Survey

*St. Louis Regional Hazard Mitigation Plan*

Table 2-9 Individuals with a Disability

County	Population Evaluated	Number Disabled	Percent Disabled of Population Evaluated
Franklin	101,066	13,138	13.0
Jefferson	217,904	29,424	13.5
St. Charles	363,601	35,355	9.7
St. Louis	986,854	110,921	11.2
City of St. Louis	313,387	44,125	14.1
<b>Total</b>	<b>1,982,812</b>	<b>232,963</b>	<b>11.7</b>

Source - 2011 American Community Survey

Appendix A contains information on the above demographic breakdowns for the incorporated jurisdictions within the five county area.

### **D. Significant Cultural and Social Issues**

As part of the hazard mitigation planning process, it is important to be aware of needs and circumstances of certain population groups like the elderly, disabled, people living below the poverty level and those with limited English speaking ability. These groups may be more susceptible to effects of natural hazards like extreme heat or experience challenges in general.

#### **Population Over 65**

According to the 2010 U.S. Census, approximately 13 percent of the five county population is aged 65 and over. The greatest percentage of elderly residents can be found in St. Louis County and Franklin County and the remaining counties have around 11 percent. Figure 2-7 shows the St. Louis metropolitan area’s distribution of elderly population.

Table 2-10 Population over 65

County	Elderly (65 years and older)	Percent of Total Population
Franklin	14,000	13.8
Jefferson	24,394	11.2
St. Charles	40,378	11.2
St. Louis	149,493	15.0
City of St. Louis	35,175	11.0

Source - 2010 U.S. Census

### **Long Term Care Facilities**

Although most elderly live independently, there are a number of long-term facilities in the area. They fulfill a range of needs, including retirement housing, assisted living, and intermediate care and continuing care. Residents may have mobility and/or cognition issues that present special problems. In the five county area there are 24,058 licensed long term

*St. Louis Regional Hazard Mitigation Plan*

care beds in 241 facilities. The majority of facilities and licensed beds are in St. Louis County. Long-term care facilities are likely to be more impacted in a disaster. (See Table 2-11 and Figure 2-7)

Figure 2-7 Population over 65

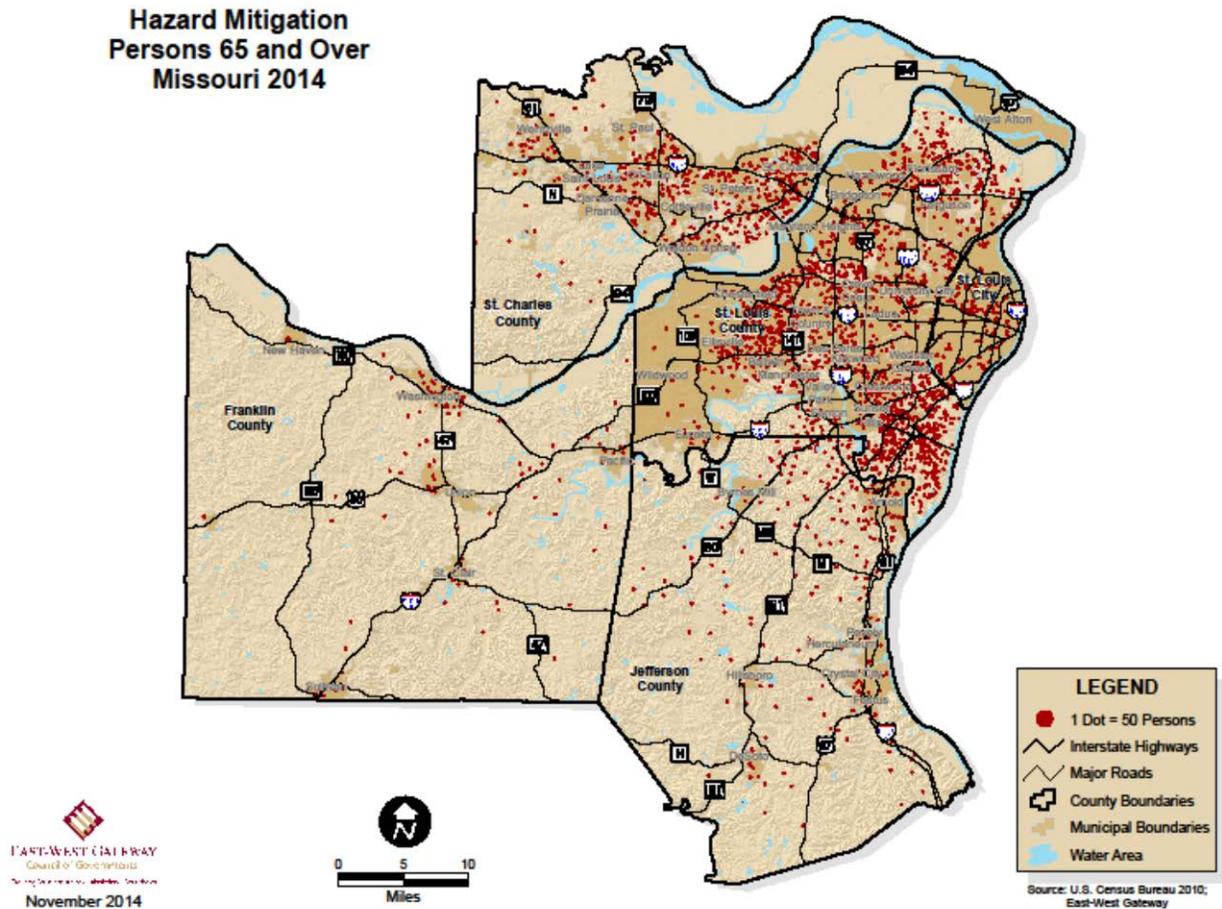
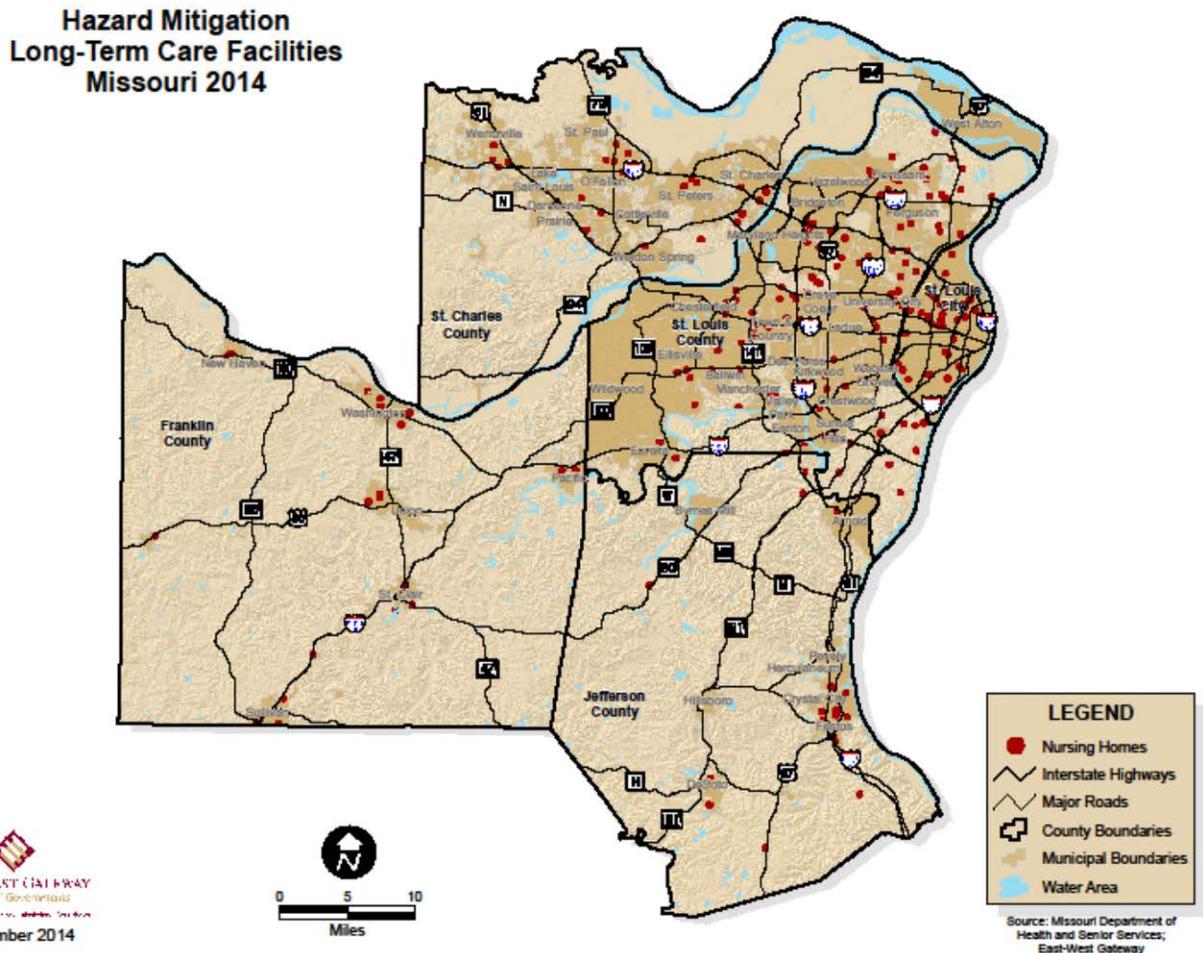


Table 2-11 Long Term Care Facilities

County	Facilities	Percent Share	Licensed Beds	Percent Share
Franklin	23	9.5	1,394	5.8
Jefferson	23	9.5	2,075	8.6
St. Charles	26	10.9	2,523	10.5
St. Louis	122	50.6	14,558	60.5
City of St. Louis	47	19.5	3,508	14.6
<b>Total</b>	<b>241</b>	<b>100</b>	<b>24,058</b>	<b>100</b>

Source - Missouri Long Term Care Facilities Directory, Missouri Department of Health and Senior Services, June 9, 2014

Figure 2-8 Long Term Care Facilities

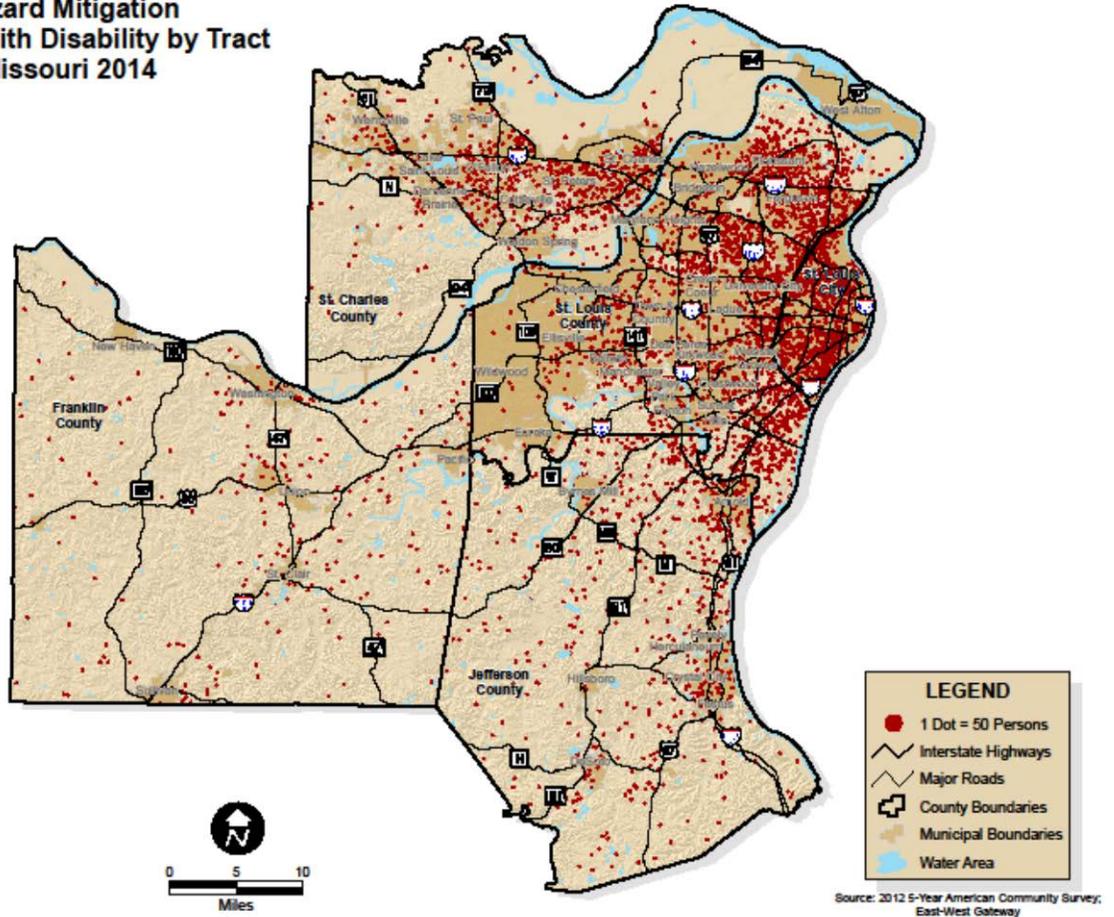


### Physically Disabled Population

Persons with physical disabilities may require special services or can have challenges if hazardous conditions or emergency actions require special response. According to the 2011 American Community Survey, there are 232,963 persons with disabilities in the five county St. Louis area (11.7 percent of the total population). The figure below depicts the distribution of people with disability.

Figure 2-9 Persons with Disability by Census Tract

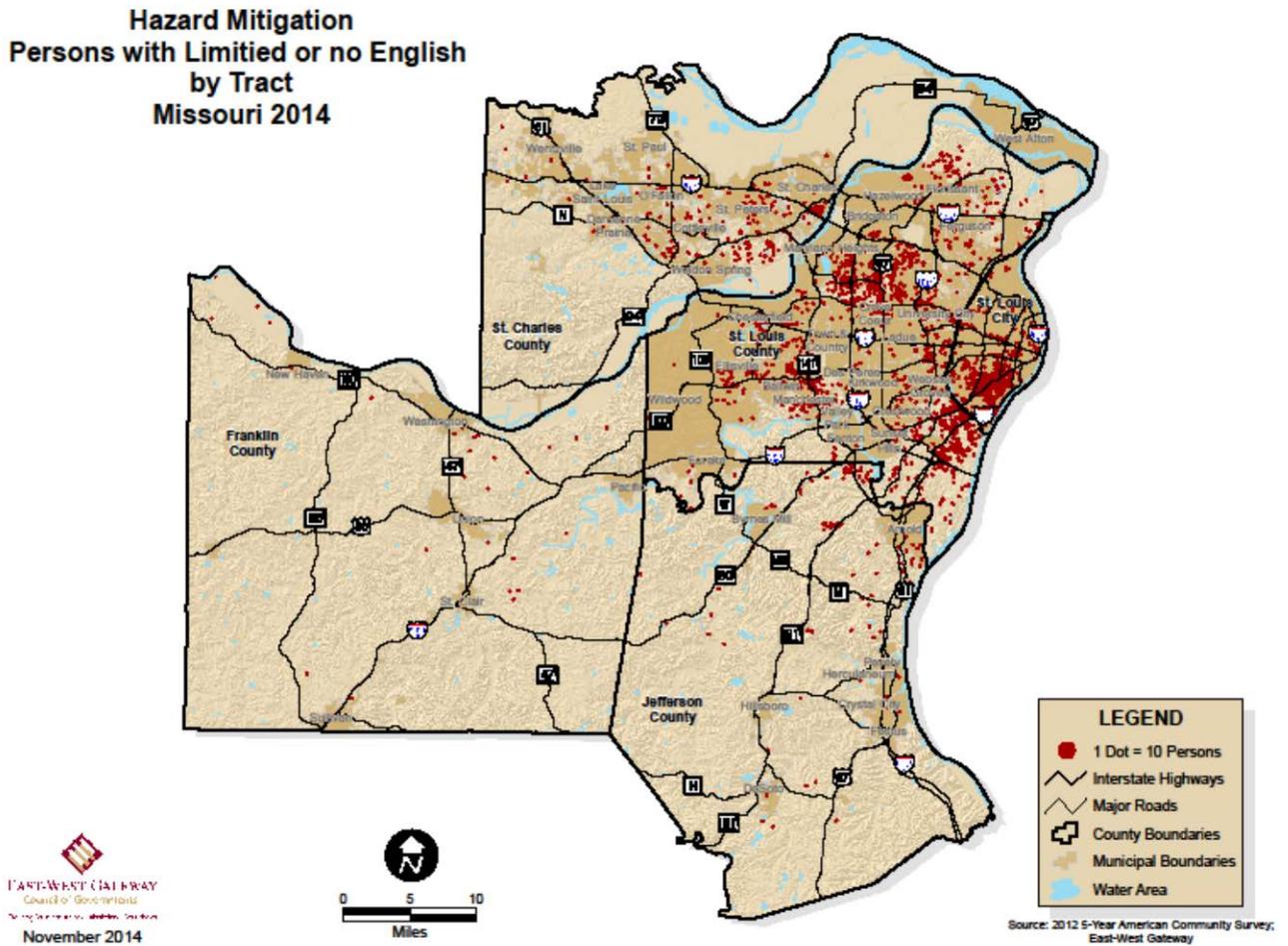
**Hazard Mitigation  
Persons with Disability by Tract  
Missouri 2014**



**Non/Limited English Speaking Population**

There are groups of people in the five county St. Louis area who do not speak English as their primary language and have a limited ability to read, speak, write or understand English. These groups may require special considerations to communicate with them about natural hazards and to provide emergency assistance. Approximately 19,549 people over the age of five do not speak English well. Figure 2-10 presents the distribution of persons with limited or non-English speaking ability.

Figure 2-10 Persons with Limited or No English by Census Tract

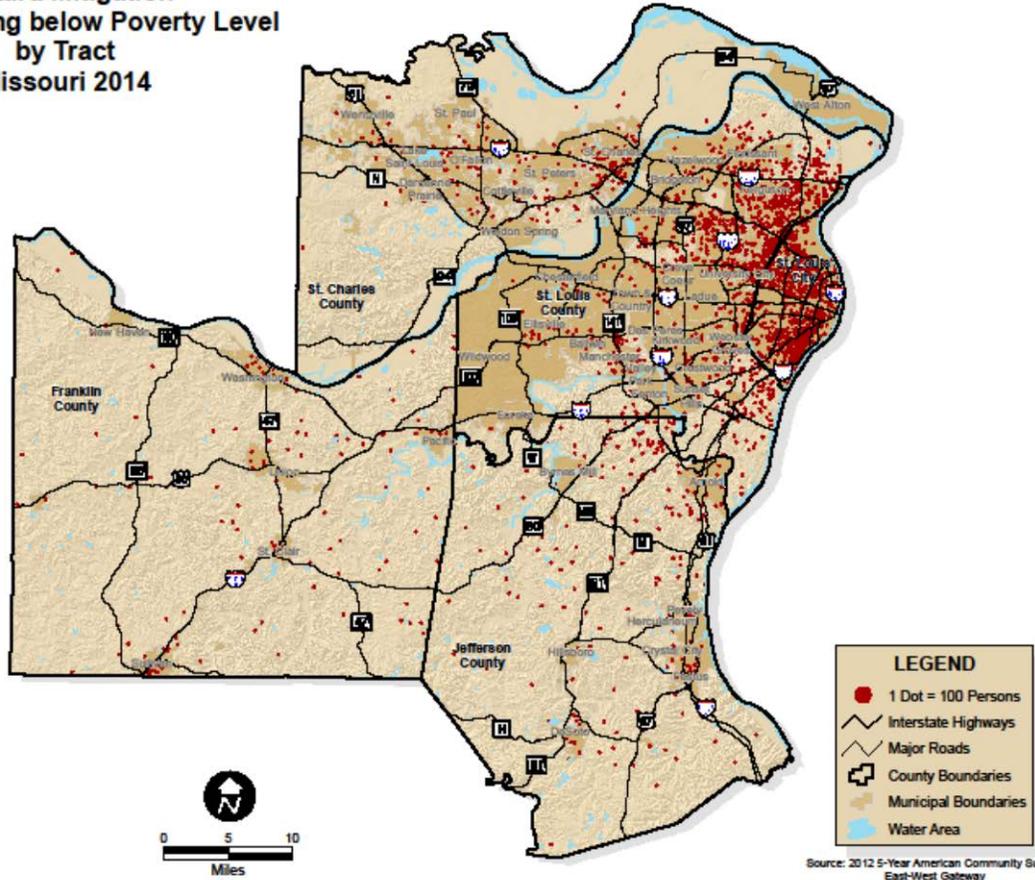


### Population Living Below the Poverty Level

Of the 513,550 families residing in the five county St. Louis area, 49,909 families (or 9.7 percent) live below the federal poverty level. Approximately 23 percent of these families live in the City of St. Louis.

Figure 2-11 Persons Living below the Poverty Level by Census Tract

**Hazard Mitigation  
Persons living below Poverty Level  
by Tract  
Missouri 2014**



  
EAST-WEST GATEWAY  
Council of Governments  
For the people and places of the St. Louis region  
November 2014

Source: 2012 5-Year American Community Survey;  
East-West Gateway

*St. Louis Regional Hazard Mitigation Plan*

**E. Form of Government**

This plan covers five counties, 134 municipalities and 50 school districts. The City of St. Louis is an independent city with county responsibilities.

Table 2-12 County Governments

County	County Seat	Classification	2010 Population	Assessed Valuation
Franklin	Union	First	101,492	\$1,827,956,631
Jefferson	Hillsboro	First – Charter	218,733	\$2,967,327,339
St. Charles	St. Charles	First – Charter	360,485	\$7,110,075,775
St. Louis	Clayton	First – Charter	998,954	\$23,424,242,056
City of St. Louis	St. Louis	First – Charter Independent City	319,294	\$4,679,603,247

Source - Official Manual State of Missouri 2013-2014 (Blue Book), Secretary of State

Franklin County is a first class county and is governed by a three-member County Commission led by the Presiding Commissioner. This commission governs the unincorporated area and 13 municipalities. The County government primarily consists of the following organizations: Treasurer, Sheriff, Recorder of Deeds, Public Administrator, Prosecuting Attorney, Public Defender, Assessor, Auditor, Building Department, Court, County Counselor, Collector, County Clerk, Emergency Management, Health Department, Highway, Information Technology, Juvenile, and Planning and Zoning.

Table 2-13 Incorporated Units in Franklin County

Community	Date Incorporated	Classification	2010 Population
Berger	1928	City – Fourth Class	221
Charmwood	2010	Village	31
Gerald	1907	City – Fourth Class	1,345
Leslie	1912	Village	171
Miramiguoia Park	1997	Village	120
New Haven	1858	City – Fourth Class	2,089
Oak Grove Village	1955	Village	509
Pacific	1859	City – Fourth Class	7,002
Parkway	1943	Village	439
St. Clair	1882	City – Fourth Class	4,724
Sullivan	1883	City – Fourth Class	7,081
Union	1851	City – Fourth Class	10,204
Washington	1841	City – Third Class	13,982

Source - Official Manual State of Missouri 2013-2014 (Blue Book), Secretary of State  
2010 U.S. Census

Jefferson County is classified as a first class county and has its county seat in Hillsboro. November 2008 citizens of Jefferson County approved a Home Rule Charter. An elected

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County Executive and a seven-member County Council governs the county and 15 municipalities. The county government is divided into the following departments and divisions: Assessors office, Auditor’s office, Circuit Court Clerk, Collector of Revenue, County Clerk, County Commission, Data Processing, Department of Administration, Economic Development, Jefferson County Health Center, Juvenile Office, Land Use Development and Code Enforcement, Parks and Recreation, Public Administrator’s Office, Public Works, Recorder of Deeds, and the Sheriff’s Department.

Table 2-14 Incorporated Units in Jefferson County

Community	Date Incorporated	Classification	2010 Population
Arnold	1972	City – Third Class	20,808
Byrnes Mill	1986	City – Fourth Class	2,781
Cedar Hill Lakes	1973	Village	237
Crystal City	1911	City – Third Class	4,855
DeSoto	1869	City – Third Class	6,400
Festus	1887	City – Third Class	11,602
Herculaneum	1972	City – Fourth Class	3,468
Hillsboro	1839	City – Fourth Class	2,821
Kimmswick	1871	City – Fourth Class	157
Lake Tekakwitha	2009	Village	254
Olympian Village	1965	City – Fourth Class	774
Parkdale	1959	Village	170
Peaceful Village	2008	Village	9
Pevely	1953	City – Fourth Class	5,484
Scottsdale	-	Town	222

Source - Official Manual State of Missouri 2013-2014 (Blue Book), Secretary of State 2010 U.S. Census

An elected County Executive and an elected seven member County Council govern St. Charles County. St. Charles County is a county with a charter form of government. There are 17 municipalities in the County. The County Executive and Council members are elected to four-year terms, with the terms of the members of the Council being staggered. Other elected county officials are the Sheriff, Recorder of Deeds, Collector, Assessor, Prosecuting Attorney and the Director of Elections. St. Charles County government is organized into several different departments and divisions to support carrying out the directives of the governing body and other elected officials and provide governmental services to the citizens in the unincorporated and incorporated areas of the county. Other county governmental services are supplied by: airport, auditor, building inspection, circuit court circuit clerk, health and environment, corrections, county counselor, courts/judge, dispatch/alarm, election authority, maintenance, family arena, finance, governmental communication, highways, information systems, juvenile justice, parks and recreation, human resources, planning/zoning, police, public administrator, transportation, and workforce.

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Table 2-15 Incorporated Units in St. Charles County

Community	Date Incorporated	Classification	2010 Population
Augusta	1855	Village	253
Cottleville	1853	City – Fourth Class	3,075
Dardenne Prairie	1981	Town	11,494
Flint Hill	1976	City – Fourth Class	525
Foristell	1980	City – Fourth Class	505
Josephville		Village	376
Lake Saint Louis	1975	City – Fourth Class	14,545
New Melle	1978	Village	475
O’Fallon	1912	City – Fourth Class	79,329
Portage des Sioux	1854	City – Fourth Class	328
St. Charles	1809	Home Rule	65,794
St. Paul	1976	City – Fourth Class	1,829
St. Peters	1910	City – Fourth Class	52,575
Weldon Spring	1984	City – Fourth Class	5,443
Weldon Spring Heights	1950	Village	91
Wentzville	1872	City – Fourth Class	29,070
West Alton		City – Fourth Class	522

Source - Official Manual State of Missouri 2013-2014 (Blue Book), Secretary of State 2010 U.S. Census

St. Louis County is governed by a County Executive and a seven member County Council. The first St. Louis County home rule charter, adopted in 1950, created the position of County Supervisor as a full time paid executive, established a seven member County Council with members elected from districts, created eleven County departments and left 16 positions to be elected. The St. Louis County Police Department was established and master zoning ordinance and modern building codes were adopted. Subsequent amendments to the 1950 Charter reduced the number of elective offices and authorized a merit system for county employees. The 1968 Charter provided for the following to be elected officials: County Supervisor (now County Executive), the seven County Council Members and the Prosecuting Attorney and County Assessor. Government department heads are appointed by the County Executive with approval from the Council. The county provides county-wide services (e.g. courts, health codes/inspections, assessments/collections) to all geographic areas and also acts as a type of municipal government to unincorporated areas. Some municipalities contract the county for various services. The most recent version of the County Charter was adopted by the residents of St. Louis County in 1979. There are currently 90 municipalities in St. Louis County.

Table 2-16 Incorporated Units in St. Louis County

Community	Date Incorporated	Classification	2010 Population
Ballwin	1950	City – Fourth Class	30,404
Bel-Nor	1937	Village	1,499
Bel-Ridge	1947	Village	2,737
Bella Villa	1947	City – Fourth Class	729
Bellefontaine Neighbors	1950	City – Fourth Class	10,860
Bellerive Acres	1939	Village	188

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Community	Date Incorporated	Classification	2010 Population
Berkeley	1937	Home Rule	8,978
Beverly Hills	1935	City – Fourth Class	574
Black Jack	1970	City – Third Class	6,929
Breckenridge Hills	1950	City – Third Class	4,746
Brentwood	1919	City – Fourth Class	8,055
Bridgeton	1843	Home Rule	11,550
Calverton Park	1940	Village	1,293
Champ	1959	Village	13
Charlack	1945	City – Fourth Class	1,363
Chesterfield	1988	City – Third Class	47,484
Clarkson Valley	1989	City – Fourth Class	2,632
Clayton	1913	Home Rule	15,939
Cool Valley	1951	City – Fourth Class	1,196
Country Club Hills	1943	City – Fourth Class	1,274
Country Life Acres	1946	Village	74
Crestwood	1949	Home Rule	11,912
Creve Coeur	1949	Home Rule	17,833
Crystal Lake Park	1957	City – Fourth Class	470
Dellwood	1951	City – Fourth Class	5,025
Des Peres	1934	City – Fourth Class	8,373
Edmundson	1948	City – Fourth Class	834
Ellisville	1932	Home Rule	9,133
Eureka	1954	City – Fourth Class	10,189
Fenton	1837	City – Fourth Class	4,022
Ferguson	1894	Home Rule	21,203
Flordell Hills	1946	City – Fourth Class	822
Florissant	1786	Home Rule	52,158
Frontenac	1947	City – Fourth Class	3,482
Glen Echo Park	1938	Village	160
Glendale	1912	City – Fourth Class	5,925
Grantwood Village	1937	Village	863
Green Park	1995	City – Fourth Class	2,622
Greendale	1950	City – Fourth Class	651
Hanley Hills	1948	Village	2,101
Hazelwood	1949	Home Rule	25,703
Hillsdale	1947	Village	1,478
Huntleigh	1929	City – Fourth Class	334
Jennings	1946	City – Third Class	14,712
Kinloch	1948	City – Fourth Class	298
Kirkwood	1865	Home Rule	27,540
Ladue	1936	City – Fourth Class	8,521
Lakeshire	1951	City – Fourth Class	1,432
Mackenzie	1946	Village	134
Manchester	1959	City – Fourth Class	18,094
Maplewood	1908	Home Rule	8,046
Marlborough	1944	Village	2,179
Maryland Heights	1985	City – Third Class	27,472
Moline Acres	1949	City – Fourth Class	2,442
Normandy	1945	City – Third Class	5,008

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Community	Date Incorporated	Classification	2010 Population
Northwoods	1940	City – Fourth Class	4,227
Norwood Court	1949	Village	959
Oakland	1920	City – Fourth Class	1,381
Olivette	1930	Home Rule	7,737
Overland	1939	City – Third Class	16,062
Pagedale	1950	City – Fourth Class	3,304
Pasadena Hills	1935	City – Fourth Class	930
Pasadena Park	1935	Village	470
Pine Lawn	1947	City – Fourth Class	3,275
Richmond Heights	1913	Home Rule	8,603
Riverview	1950	Village	2,856
Rock Hill	1929	City – Fourth Class	4,635
St. Ann	1948	City – Fourth Class	13,020
St. John	1945	Home Rule	6,517
Shrewsbury	1913	City – Fourth Class	6,254
Sunset Hills	1957	City – Fourth Class	8,496
Sycamore Hills	1941	Village	668
Town and Country	1950	City – Fourth Class	10,815
Twin Oaks	1938	Village	343
University City	1906	Home Rule	36,262
Uplands Park	1941	Village	437
Valley Park	1917	City – Fourth Class	6,282
Velda City	1938	City – Fourth Class	1,495
Velda Village Hills	1945	Village	1,034
Vinita Park	1950	City – Fourth Class	1,785
Vinita Terrace	1940	Village	278
Warson Woods	1936	City – Fourth Class	1,840
Webster Groves	1896	Home Rule	22,345
Wellston	1949	City – Third Class	2,314
Westwood	1951	Village	289
Wilbur Park	1941	Village	454
Wildwood	1995	Home Rule	34,209
Winchester	1935	City – Fourth Class	1,544
Woodson Terrace	1954	City – Fourth Class	4,008

Source - Official Manual State of Missouri 2013-2014 (Blue Book), Secretary of State 2010 U.S. Census

A Mayor and 28-member Board of Aldermen govern the City of St. Louis. The three-member Board of Estimate and Apportionment, which is comprised of the Mayor, President of the Board of Aldermen, and the city Comptroller, must approve all financial decisions. The city is comprised of 28 political wards under a Mayoral government system.

**F. Inventory of Critical Assets and Key Essential Facilities**

Relevant facilities include medical facilities, schools, long-term facilities, day care centers and government structures. These facilities represent resources for care and shelter as well as for populations requiring a higher level of care and installations critical to community

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services. See Figures located in the Appendix – Map Sets – Critical Assets and Essential Facilities.

### Medical Facilities

In the five county area there are 43 medical facilities/hospitals. The majority of the hospitals are located in St. Louis County and the City of St. Louis. These hospitals offer: general acute care; long term acute care; psychiatric care; and rehabilitation. Physicians' offices, clinics and urgent care centers are too numerous to list in this document. Appendix D contains a complete listing of these hospitals by county.

### Long Term Care Facilities

Long-term facilities fulfill a range of needs, including retirement housing, assisted living, intermediate and long term continuing care. Residents may have mobility and/or cognition issues that present special problems. Long-term care facilities are likely to be more impacted in a disaster. Please refer to 2009 Plan Update for information on long term care facilities in the five county area. Tables in Appendix D show the changes from the 2009 Plan Update (new facility, change in name, change in capacity [beds available] or closed) by county.

Table 2-17 Long Term Care Facilities Changes since 2010

County	New Long Term Care Facilities	Name Change	Name Change and Capacity Change	Capacity Change	Closed Facilities
Franklin	2	2	0	7	0
Jefferson	0	5	0	7	1
St. Charles	5	1	1	6	1
St. Louis	20	10	2	15	3
City of St. Louis	2	5	2	6	4

Source – Missouri Long Term Care Facilities Directory, Senior and Disability Services, Missouri Department of Health and Senior Services

<http://health.mo.gov/seniors/nursinghomes/pdf/DIRECTORY.pdf>

### Day Care Centers

Child care centers represent yet another population that needs special consideration. Most day care centers cater to children ages 2-5, although some day care centers serve older adults. Those facilities represent specialized mitigation needs. The following tables show a current population in day care facilities. These are deemed "Facilities Requiring Special Consideration" for evacuation purposes in the County Emergency Operations Plans. Please refer to the 2009 Plan Update for information on day care facilities in the five county area. Appendix D contains tables delineating day care center changes from the 2009 Plan

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Update (new facility, change in name, change in capacity or closed). These Tables do not include information on day care centers which are operated out of a family home.

Table 2-18 Day Care Center Changes since 2010

County	New Day Care Facilities	Name Change	Name Change and Capacity Change	Capacity Change	Closed Facilities
Franklin	13	2	1	6	11
Jefferson	12	4	18	0	11
St. Charles	18	11	10	26	26
St. Louis	74	8	29	91	145
City of St. Louis	67	16	16	37	50

Source - Show Me Child Care Search, Missouri Department of Health and Senior Services  
<https://we3bapp01.dhss.mo.gov/childcaresearch/searchengine.aspx>

**Schools**

The five county area contains fifty public school districts with an enrollment of 282,439 students. Appendix D contains tables with information on the breakdown of school districts by county and general information on location, students and number of schools per district. The number of schools may not represent the number of buildings associated with a school district.

Table 2-19 School Districts by County

County	School Districts	Students	Schools
Franklin	10	16,549	41
Jefferson	11	35,377	61
St. Charles	5	59,389	74
St. Louis	23	143,897	257
City of St. Louis	1	27,227	74
<b>Total</b>	<b>50</b>	<b>282,439</b>	<b>507</b>

Source - Missouri School Directory 2013-2014, as of April 14, 2014, Missouri Department of Elementary and Secondary Education

There are 11 school districts in Franklin County with more than 16,000 students attending various, public elementary, middle, and high schools in Franklin County. (See Figure 2-12) Some districts extend into neighboring counties. In addition, there are approximately 4,000 students attending East Central College (community college). Schools represent yet another population that needs special consideration. Most schools have students that range from 5 through the age of 25, although some schools may have older adults. Schools and other facilities are deemed “Facilities Requiring Special Consideration” for evacuation purposes in the Franklin County Emergency Operations Plan. Appendix D contains information on enrollment and other data for each school district in the County.

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There are 11 public school districts in Jefferson County. More than 35,000 students attend various public elementary, middle, and high schools in Jefferson County. In addition there are over 5,000 students attending Jefferson College (community college). Schools represent yet another population that needs special consideration, especially in a disaster situation. Most schools have students that range from five through the age of 25. Figure 2-12 shows district boundaries. Some of the districts overlap into neighboring counties. These schools and other facilities are deemed “Facilities Requiring Special Consideration” for evacuation purposes in the Jefferson County Emergency Operations Plan. Appendix D contains information on enrollment and other data for each school district in the County.

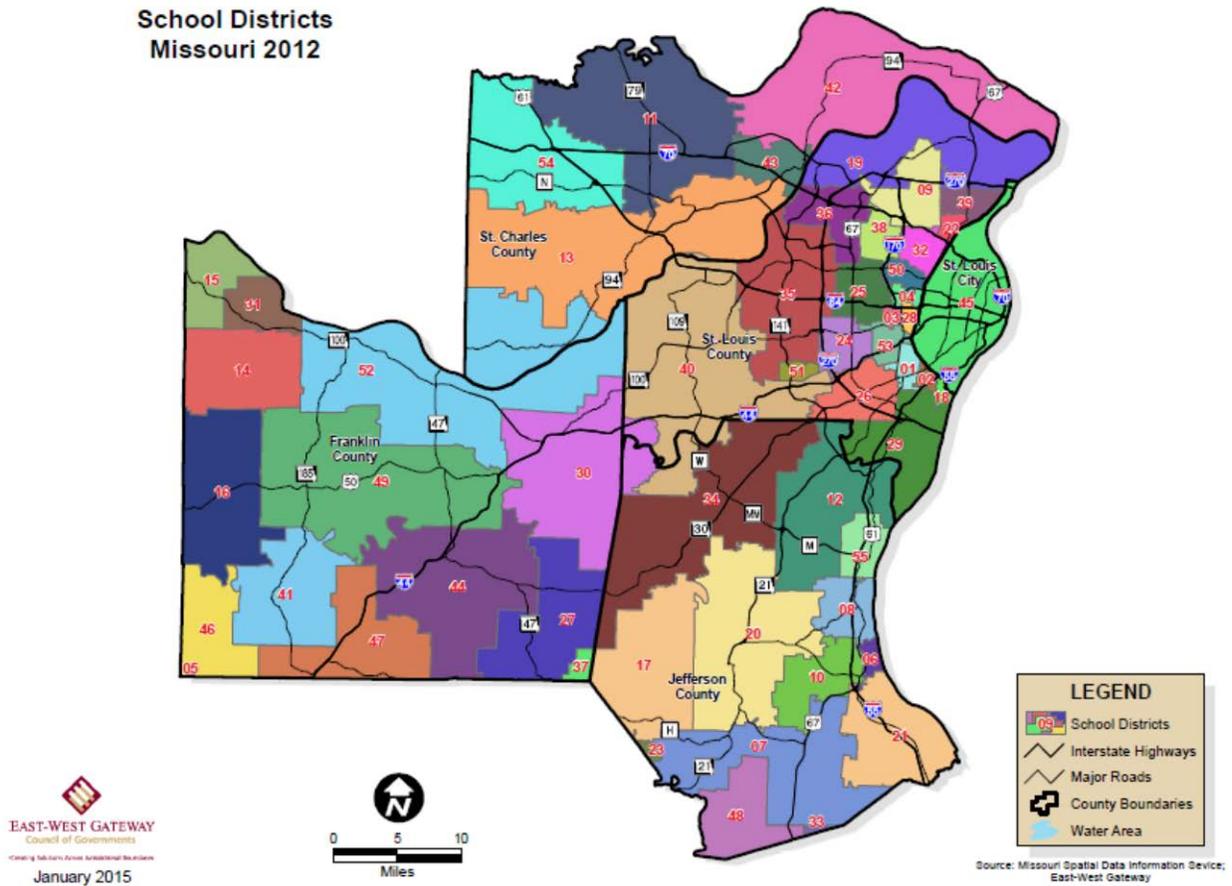
In St. Charles County approximately 59,000 students attend various public elementary, middle, junior high or high schools in the area from six school districts: Ft. Zumwalt R-II; Francis Howell R-III; Wentzville R-IV; Orchard Farm R-V; St. Charles R-VI and Washington R-I (which is in Franklin County). Schools represent yet another population that needs special consideration. Most schools have students that range from 5 through the age of 18, and colleges serve young adults from 18-24. These schools and other facilities are deemed “Facilities Requiring Special Consideration” for evacuation purposes in the St. Charles County Emergency Operations Plan. Some school districts overlap into adjacent counties. Appendix D contains information on enrollment and other data for each school district in the County.

There are 22 school districts in St. Louis County. More than 143,000 students attend various public elementary, middle, and high schools in St. Louis County. Schools represent yet another population that needs special consideration. Most schools have students that range in age from five to twenty-five. The following tables show a current population in schools. These schools and other facilities are deemed “Facilities Requiring Special Consideration” for evacuation purposes in the St. Louis County Emergency Operations Plans. Some school districts extend neighboring counties. Appendix D contains information on enrollment and other data for each school district in the County.

The City of St. Louis has one unified school district. More than 26,000 students attend public elementary, middle, and high schools in the City of St. Louis. There are 16 high schools, eight middle schools, one junior high school and 48 elementary schools. Schools represent yet another population that needs special consideration. These schools and other facilities are deemed “Facilities Requiring Special Consideration” for evacuation purposes in the City of St. Louis Emergency Operations Plans. See Figure 2-12 above. Appendix D contains information on enrollment and other data for each school district in the County.

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Figure 2-12 Public School Districts in the Five County Area



Number	School District	Number	School District	Number	School District
01	Aftton	20	Hillsboro R-III	39	Riverview Gardens
02	Bayless	21	Jefferson County R-VII	40	Rockwood
03	Brentwood	22	Jennings	41	Spring Bluff R-XV
04	Clayton	23	Kingston K-14*	42	Orchard Farm R-V
05	Crawford County R-I*	24	Kirkwood	43	St. Charles R-VI
06	Crystal City 47	25	Ladue	44	St. Clair R-XIII
07	DeSoto	26	Lindbergh R-VIII	45	St. Louis City
08	Dunklin R-V	27	Londell R-XIV	46	Strain-Japan R-XVI
09	Ferguson-Florissant	28	Maplewood-Richmond Heights	47	Sullivan
10	Festus R-6	29	Mehlville	48	Sunrise R-IX
11	Ft. Zumwalt R-II	30	Meramec Valley R-III	49	Union R-XI
12	Fox C-6	31	New Haven	50	University City
13	Francis Howell	32	Normandy	51	Valley Park
14	Franklin County R-II	33	N. St. Francois County R-I*	52	Washington
15	Gasconade County R-I*	34	Northwest R-I	53	Webster Groves
16	Gasconade County R-II	35	Parkway	54	Wentzville R-IV
17	Grandview R-II	36	Pattonville	55	Windsor C-I
18	Hancock Place	37	Richwoods R-VII*		
19	Hazelwood	38	Ritenour		

\*These school districts minimally abut the five county area and are not part of this plan update.

**Historic Properties/Districts, Archaeological Sites**

As part of the National Historic Preservation Act of 1966, a formal National Registry of Historic Places was created. The listing process is overseen by the National Park Service. The 1966 legislation also encouraged the creation state and tribal historic preservation offices. The Missouri State Historic Preservation Office (SHPO) was established in 1968 and is located in the Missouri Department of Natural Resources.

In accordance with the National Historic Preservation Act of 1966, the Archaeological and Historic Preservation Act of 1974 and the Antiquities Act of 1906, information regarding specific locations of archaeological sites cannot be released. Individuals in need of information, conducting archaeological studies may contact the SHPO for information on specific sites. Reference for further information can be made to Missouri Department of Natural Resources at <http://www.dnr.mo.gov/shpo/homepage.htm>. The Missouri Archaeological Society’s website <http://coas.missouri.edu/mas/> provides reference documents on archaeological sites in Missouri.

In the five county area there are 682 properties, districts and archaeological sites listed on the National Register of Historic (and Archaeological) Properties. Additional Information can be found on the Missouri state website at <http://www.dnr.mo.gov/shpo/mnrlist.htm>. Please refer to 2009 Plan Update for information on historic properties located in the five county area. Since 2009, 81 properties/districts have been added to the National Registry and two properties removed. Information on the changes to the National Registry from 2009 to 2014 by county can be found in Appendix D.

Table 2-20 Changes to Historic Properties/Districts Since 2009

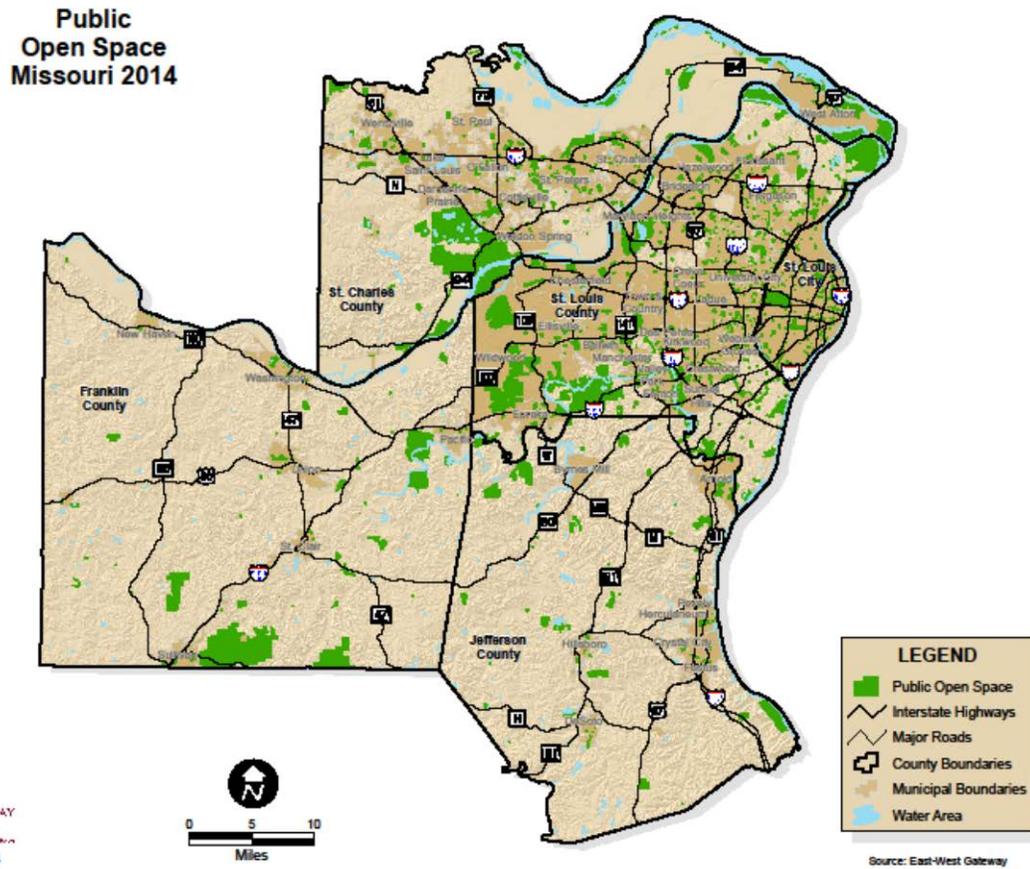
County	Additions since 2009	Removals since 2009	Total	Properties with Restricted Addresses
Franklin	2	0	60	1
Jefferson	2	0	14	4
St. Charles	1	0	32	0
St. Louis	12	0	178	5
City of St. Louis	64	2	398	1

Source - State Historic Preservation Office, Missouri Department of Natural Resources

**Government Facilities**

Considered government facilities are city, county, State and Federal government centers, police stations, fire stations, ambulance bases and emergency operations centers. This information is depicted on the regional maps. Government facilities by County and the City of St. Louis can be found in Appendix D.

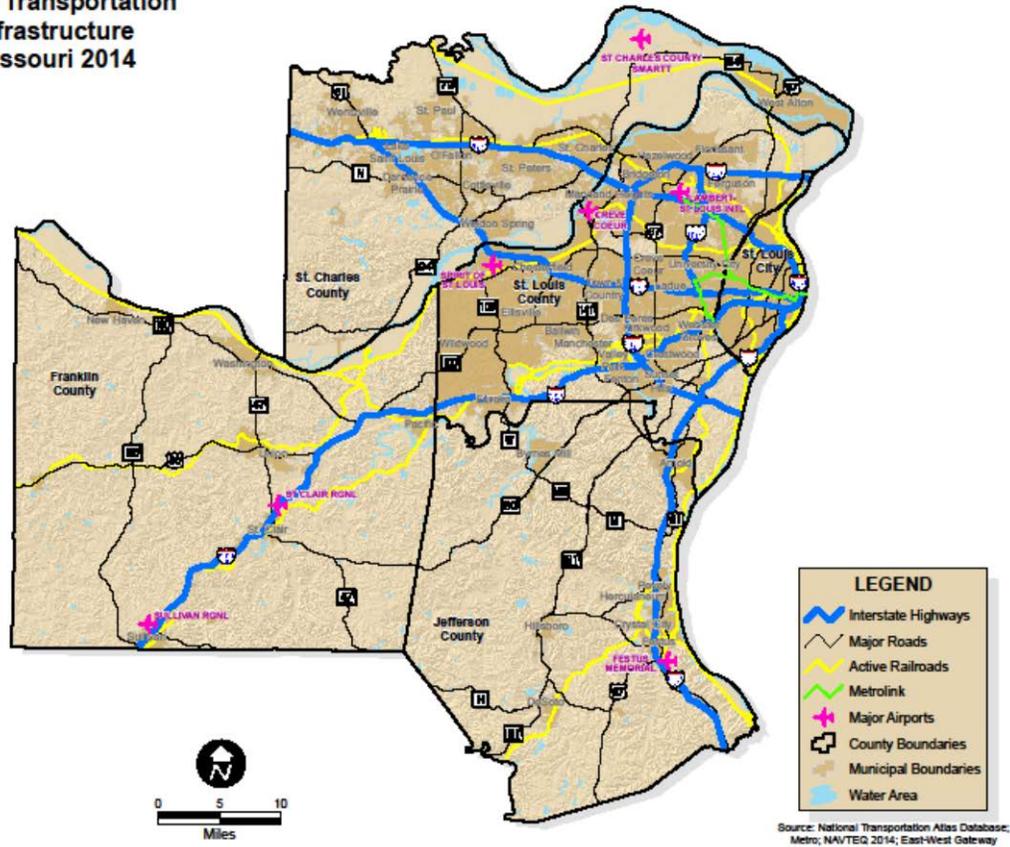
Figure 2-13 Recreation (Parks and Conservation Areas)



  
EAST-WEST GATEWAY  
Council of Governments  
for the Metropolitan Area  
November 2014

Figure 2-14 Transportation System

**Major Transportation Infrastructure Missouri 2014**



**EAST-WEST GATEWAY**  
 Council of Governments  
 For the Metropolitan St. Louis Area  
 November 2014

**Communications**

The following list of communications facilities is not all-inclusive, but represents the major providers of telecommunications service in the five county area.

Table 2-21 Telecommunications Providers

TELECOMMUNICATIONS PROVIDERS	
AT&T	Bartel Communications, Inc.
Birch Communications	Century Link
Charter Communications	Convergys Corporation
CyberTel	Digital Mojo
Digital Teleport, Inc.	Fiber Net Communications, Inc.
Freedom Communications USA	Global Crossing
I to I Consolidated	MCI

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TELECOMMUNICATIONS PROVIDERS	
MyLine	Navigator
Nuvox	One Choice
Sage Telecom	Socket
Talk America	Teletone, Inc.
Vonage	

Source - Greater St. Louis YP for Area Codes 314 and 636, February 2014 - 2015

**Water Systems**

Drinking water in the five county area is supplied by both publicly and privately owned entities. These include municipal systems and water supply districts which are prevalent in Franklin, Jefferson and St. Charles Counties. Some of these entities purchase treated water (from public or private entities) and operate their own distribution systems. Information on the public water systems (city, district, others) found in the five county area can be found in Appendix D.

Table 2-22 Water Systems by County

County	City Water Systems	Water District Systems	Miscellaneous Water Systems	Non-Community Water Systems
Franklin	9	4	28	34
Jefferson	6	10	50	20
St. Charles	9	2	2	18
St. Louis	3	0	3	20
City of St. Louis	1	0	0	0

Source - Census of Missouri Public Water Systems 2014, Missouri Department of Natural Resources <https://www.dnr.mo.gov/env/wpp/pdwb/2014-census.pdf>

Miscellaneous includes water systems serving subdivisions, mobile home parks, institutions and other facilities. Non-Community includes water systems serving schools, churches, retail facilities, industrial facilities, recreation and other facilities.

**Sewer Systems**

Most sewer systems are required to maintain a discharge permit through the Environmental Protection Agency’s National Pollution discharge elimination system (NPDES). Wastewater collection and treatment services can be provided by: municipalities; sewer districts; and public water and sewer districts. Some subdivisions operate their own treatment facility or contract with public water and sewer districts.

The Metropolitan St. Louis Sewer District (MSD) manages the surface drainage and sewage treatment system in all of the City of St. Louis and in St. Louis County east of Missouri Highway 109. MSD was created in 1954 and is a special service district created under the Missouri Constitution (Section 30, Article VI) and is responsible for all sewage collection and treatment as well as stormwater drainage in a 4,524 square mile area. MSD serves

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about 413,411 accounts with a population of about 1.3 million. The only public sewage system outside the MSD service area in St. Louis County is operated and maintained by the City of Eureka. Refer to the table below.

On-site sewage systems for rural dwellings can be found in Franklin, Jefferson and St. Charles County. As these systems are not required to be registered by MDNR, data on the number and location is not available from them. However, septic systems are regulated by Franklin County Health Department. The Code Enforcement Division of the Jefferson County Department of County Services and Code Enforcement issue construction and operation permits for new on-site sewage treatment systems in unincorporated portions of the county. The Building Division of the St. Charles County Community Development Department issues operating permits for new on-site private sewage disposal systems and any systems in place at time of purchase of property. The owner is required to maintain in force a service and maintenance agreement with a county-licensed on-site sewage disposal contractor. The St. Louis County Department of Public Works is responsible for issuing onsite sewage permits for new and repair systems in unincorporated areas of St. Louis County and in local municipalities that contract with the Department for plumbing code enforcement services.

Table 2-23 Permitted Wastewater Treatment Systems by County

Type	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
Municipal	9	10	6	1	NA
Sewer District	3	7	1	NA	NA
MSD	NA	NA	NA	1	1
Public Water and Sewer District	2	NA	2	NA	NA
Private Company	NA	2	NA	NA	NA

Source - Missouri Department of Natural Resources

Tables in Appendix D contain information on the wastewater treatment facilities/systems in the five county area.

### **Electricity and Gas Providers**

Electricity and natural gas providers in the five county area are presented in the following table. The cities of Sullivan in Franklin County and Kirkwood in St. Louis County own and operate their own electricity utilities and purchase electricity wholesale. In Franklin County, New Haven owns and operates a natural gas utility serving the residents of New Haven and Berger. The following figures present the extent of the service areas of the largest electricity and natural gas providers (Ameren and Laclede Gas).

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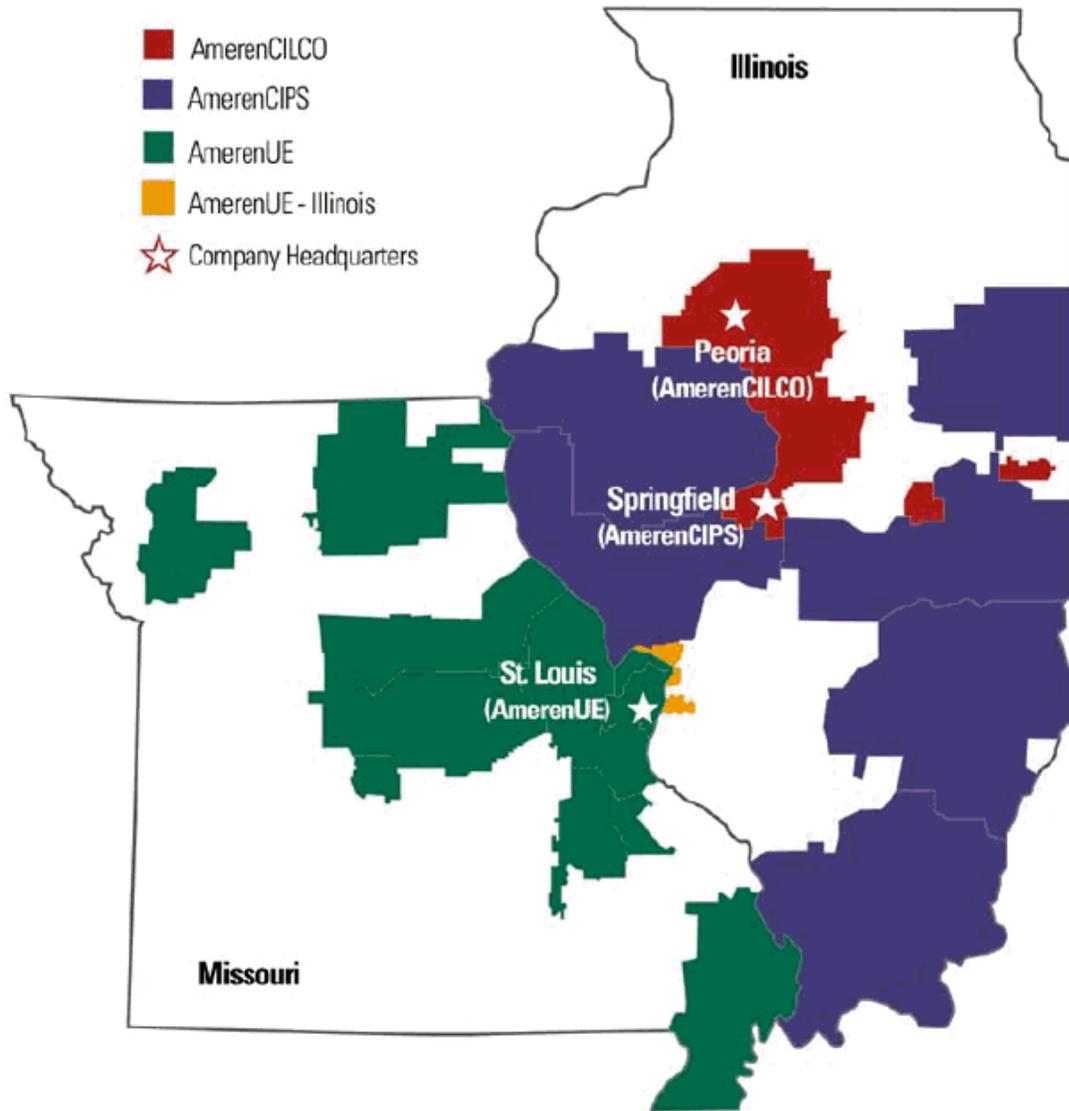
Table 2-24 Energy Utilities Providing Service in the Region

Utility Provider	Service Available in				
	Franklin County	Jefferson County	St. Charles County	St. Louis County	City of St. Louis
<b>Electricity</b>					
Ameren Missouri	X	X	X	X	X
Crawford Electric Cooperative, Inc.	X				
Cuivre River Electric Cooperative, Inc.			X		
Kirkwood Municipal				X	
Sullivan Municipal	X				
<b>Natural Gas</b>					
Ameren Missouri			X		
Berger Municipal	X				
Laclede Gas Company Missouri Natural Gas subsidiary	X	X	X	X	X
New Haven Municipal	X				

Source - Find A Utility Missouri Cities, June 2, 2014, Missouri Public Service Commission  
[www.psc.mo.gov/General/Find\\_A\\_UTILITY](http://www.psc.mo.gov/General/Find_A_UTILITY)

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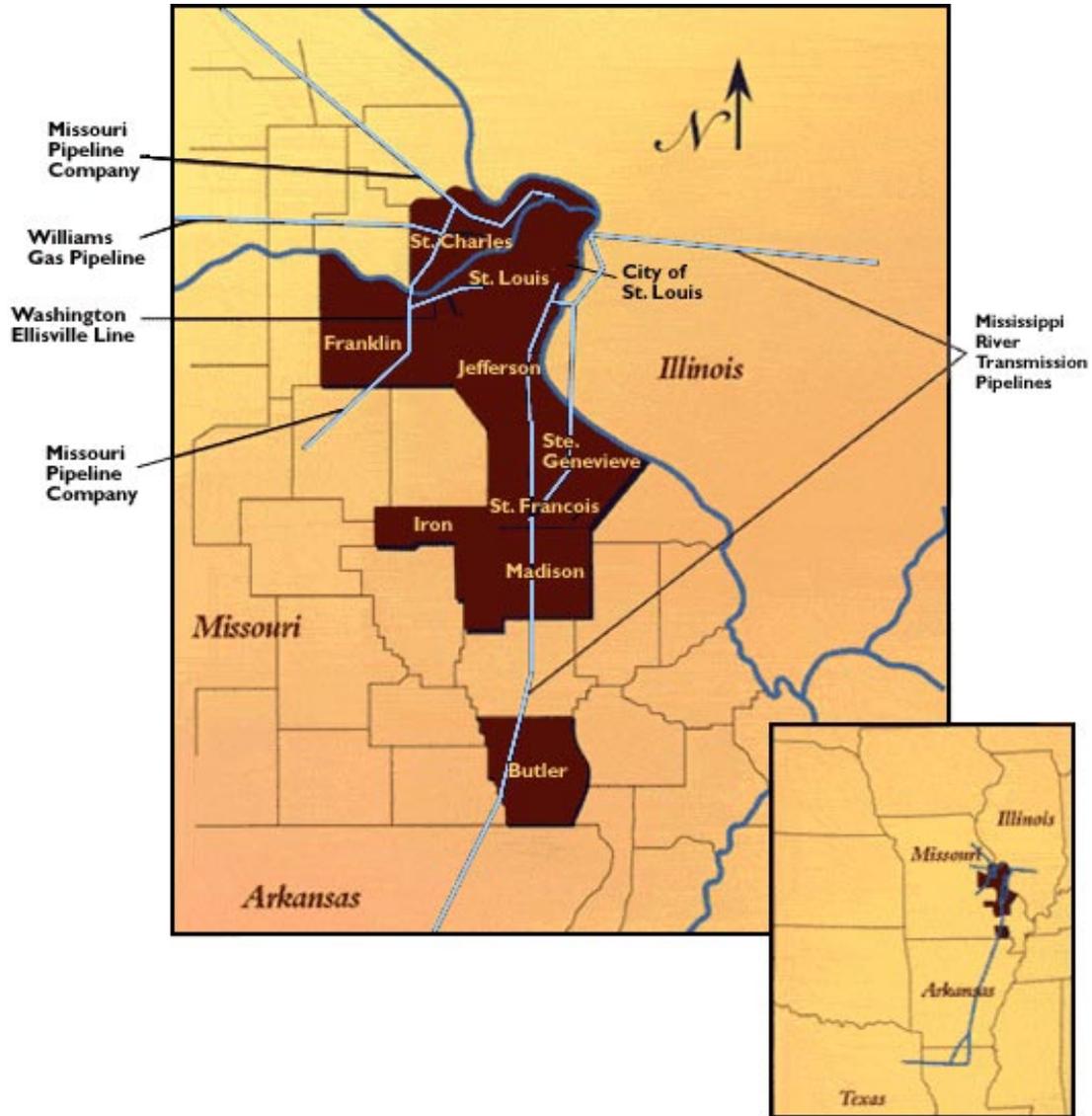
Figure 2–15 AMEREN ELECTRIC SERVICE COVERAGE



Source – Ameren

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Figure 2-16 NATURAL GAS SERVICE COVERAGE



Source: Laclede Gas Company  
720 Olive Street  
St. Louis, Missouri 63101  
314-342-0500  
Serves Missouri portion of region

## **Underground Infrastructures**

Due to homeland security concerns, underground utilities are not mapped in this plan. According to the Missouri One Call System, Inc. as of September 10, 2014, there are 173 companies within Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis are members of the Missouri One Call System. These facilities may have underground utilities. Emergency information concerning these utility lines is contained in each jurisdiction's Emergency Operations Plan. Appendix D contains a table of those companies which may have underground lines running through the five county area.

## **G. Development Trends**

Regionally, over the next thirty years, population growth is anticipated to be the strongest in St. Charles and Jefferson Counties. In St. Charles, most of the growth is predicted along the I-70 and I-64 freeways. Though some growth will probably still occur in the eastern sections of this area, it is more likely that most will occur in the areas west of Highway K in O'Fallon. Additional growth is predicted in northeast Jefferson County near I-55.

Employment growth is predicted to occur along major roadway corridors. Similar to population growth, it is anticipated that St. Charles County will receive a majority of employment growth along the I-70 and I-64 freeways. It is also anticipated that St. Louis County will see some growth sprinkled along major corridors, especially west of I-270 as well as north of I-70. Additional employment growth is likely to spread into Jefferson County along I-55.

At present, Franklin County is principally agricultural in nature, especially in the western portion of the county. About 80 percent of the county is classified as agricultural. Historically, the county has had a consistently upward growth pattern. However, there is expectation of continued out migration from the St. Louis metropolitan core. Of the county population of 101,492 in the year 2010, 48 percent lived outside incorporated areas. Franklin County has a current master plan, zoning, subdivision regulations, stormwater regulations, and a building code. Of the municipalities in the county, four answered in 2004 that they have master plans, four do not, and two did not answer. Eight have zoning, subdivision, and building codes, two do not, and one did not answer. Six have stormwater regulations, four do not, and one did not answer.

At present, Jefferson County is more densely developed in the northern third of the county; along Interstate 55, located along its eastern boundary; and the State Highway 21 and State Highway 30 corridors. Jefferson County's population was 218,733 in 2010. Approximately 60 percent of the residents live outside incorporated areas. Jefferson

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County has a current master plan, zoning, subdivision regulations, and a building code. Of the municipalities in the county, seven answered in 2004 that they have master plans and six did not answer. Seven have zoning, subdivision, stormwater, and building codes; six did not answer.

St. Charles County has been one of the fastest growing counties in the St. Louis metropolitan area. Projections are for this several decade long trend to continue. The county has grown in population from 52,970 in 1960 to 360,485 in 2010, an increase of over 580 percent. Of the 2010 population, 26 percent do not reside in an incorporated area. St. Charles County has a current master plan, zoning, subdivision regulations, stormwater regulations, and a building code. Of the municipalities in the county, four answered in 2004 that they have master plans, four do not, and two did not answer. Eight have zoning, subdivision, and building codes, two do not, and one did not answer. Six have stormwater regulations, four do not, and one did not answer

St. Louis County's population as of the 2010 census was 998,954. Most of the County has been urbanized. Approximately 85 percent of the population are residents of incorporated municipalities. St. Louis County has a current master plan, zoning, subdivision regulations, stormwater regulations, and a building code. Of the municipalities in the county responding to the survey, 48 answered that they have master plans, 11 do not; 58 have zoning, 2 do not; 43 have subdivision regulations, 15 do not; all have stormwater regulations as enacted through MSD and through additional regulations in some municipalities; all respondents have building codes.

The legal boundaries of the City of St. Louis were set in 1876. It cannot annex and is considered to be built out. There are areas of redevelopment in the City. Vacant and abandoned properties are present in various parts of the City. So far, there has been a major initiative to revitalize downtown St Louis drawing the support of government, business and civic leaders. St. Louis is already a regional center for activity in the areas of plant and life sciences, information technology, and advanced manufacturing.

## H. Economy, Employment and Industry

### Labor Force

For background information on employment and economy, see previous reports, Section 1 for each county. The following table provides an update on employment and top employers by county and the City of St. Louis.

Table 2-25 Workforce by County

Employment Status	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
Population 16 Years and Over	79,374	169,963	278,876	795,958	258,135
In Labor Force	52,100	117,053	201,989	533,564	169,952
Civilian Labor Force	52,062	116,897	201,665	532,730	169,782
Employed	47,642	106,632	188,433	487,834	145,620
Unemployed	4,420	10,265	13,232	44,896	24,162
Armed Forces	38	156	324	834	170
Not in Labor Force	27,274	52,910	76,887	262,494	88,183

Source -Selected Economic Characteristics, 2008-2012 American Community Survey 5-Year Estimates, U.S. Census Bureau

Table 2-26 Top-Five Employers by County 2013

Company Name	Employment
<b>Franklin</b>	
Wal-Mart Stores-Inc.	920
Meramec Valley R3 School District	790
County of Franklin Government	539
Sporlan Valve Company	500
Esselte Corporation	500
<b>Jefferson</b>	
Fox C-6 School District	1,530
Wal-Mart Stores-Inc.	1,125
County of Jefferson Government	888
Northwest R-1 School District	821
Jefferson Regional Medical Center	782
<b>St. Charles</b>	
Francis Howell School District	2,317
Fort Zumwalt School District R-2	2,294
Wal-Mart Stores-Inc.	1,540
Schnucks Markets-Inc.	1,304
County of St. Charles Government	1,265
<b>St. Louis</b>	
The Boeing Company	8,242
Schnucks Markets-Inc.	5,249

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Company Name	Employment
County of St. Louis Government	4,881
The Washington University	3,237
Dierbergs Markets-Inc.	3,211
<b>City of St. Louis</b>	
The Washington University	5,424
City of St. Louis Government	5,369
St. Louis City Public School District	4,872
U.S. Department of the Army	1,991
AT&T Corp.	1,820

Source – Dun & Bradstreet Million Dollar Database, 2012 Census of Government

**Unemployment Rate**

The unemployment rate for each County and the City of St. Louis as of 2011 is presented below.

Table 2-27 Unemployment by County

Category	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
Unemployment Rate (percent)	9.3	8.9	7.3	8.2	11.7
Unemployment	4,999	10,440	14,709	43,217	17,096
Labor Force	53,501	117,808	201,263	526,916	145,576

Source - Bureau of Labor Statistics (2011 Annual)

**Occupational Types**

The primary employment categories in Franklin County include the manufacturing industry, and the service industry. The agriculture and mining sector employ 499 individuals and 4,505 individuals are in construction. The major employment categories in Jefferson County include manufacturing, retail trade and educational services and health care.

Table 2-28 Occupational Groups and Employment by County

Occupation	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
Agriculture/Forestry/Fishing & Hunting/Mining	499	414	1,039	2,074	450
Construction	4,503	11,055	12,251	21,501	5,827
Manufacturing	10,402	13,243	24,248	49,753	11,636
Wholesale Trade	981	3,476	7,614	15,540	3,467
Retail Trade	5,373	13,134	22,932	54,740	13,373
Transportation & Warehousing/ Utilities	2,302	5,734	8,896	21,857	6,614
Information	559	2,067	4,322	12,695	3,724
Finance & Insurance/Real Estate &	2,089	7,782	18,687	45,414	9,020

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Rental & Leasing					
Professional/Scientific/ Management/Administrative & Waste Management Services	3,698	10,300	19,807	60,093	16,826
Educational Services/Health Care & Social Assistance	9,552	21,902	38,793	122,242	39,174
Arts/Entertainment/Recreation/ Accommodation & Food Services	4,031	7,901	16,130	43,888	19,623
Other Services except Public Administration	2,396	6,058	8,316	22,897	7,396
Public Administration	1,257	3,566	5,398	15,140	8,500
Civilian Employed Population 16 Years and Over	47,6421	106,632	188,433	487,834	145,620

Source - Selected Economic Characteristics, 2008-2012 American Community Survey 5-year Estimates, U.S. Census Bureau

**Assessed Valuation by County and Incorporated Units**

For each county, the following table presents total assessed valuation by incorporated units and the area outside of these incorporated units. Appendix C contains information on assessed valuation for each incorporated unit.

Table 2-29 Assessed Valuation by County (in dollars)

County	Incorporated Portion	Balance of County	Total
Franklin	631,241,034	660,622,256	1,291,863,290
Jefferson	712,525,924	1,478,298,769	2,190,824,693
St. Charles	4,833,644,042	1,346,016,358	6,179,660,400
St. Louis	15,791,815,780	4,812,151,860	20,603,967,640
City of St. Louis	4,535,054,781	NA	4,535,054,781

Source -

**Number of Dwelling Units**

In Franklin County, according to the 2008-2012 American Community Survey, there are a total of 39,038 occupied housing units in the County and 4,364 vacant. Approximately 24 percent of the units are renter occupied. Jefferson County has 81,159 occupied housing units with 83 percent home-owner occupied. Over eighty percent of the housing units in St. Charles County and St. Louis County are owner occupied. In the City of St. Louis, 54 percent of the housing units are occupied by renters and 20 percent are unoccupied.

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Table 2-30 Housing Units by County

Housing Units	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
Total Housing Units	43,402	87,706	141,259	437,803	175,855
Occupied Housing Units	39,038	81,159	134,693	404,151	139,840
Owner Occupied	29,755	67,341	109,008	288,602	63,757
Renter Occupied	9,263	13,818	25,685	115,549	76,083
Vacant Housing Units	4,384	6,547	6,566	33,652	36,015

Source - Selected Housing Characteristics, 2008-2012 American Community Survey 5-Year Estimates, U.S. Census Bureau

Table 2-31 Units in Residential Structures

Housing Units	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
Single Family Units	33,452	68,884	114,667	336,603	82,292
2 to 4 Units	2,400	3,403	6,491	27,895	52,898
5 to 19 Units	2,255	3,394	9,648	48,538	15,153
Buildings with 20 + Units	401	1,254	5,808	23,346	24,952
Mobile Homes	4,894	10,759	4,546	1,335	466
Boat, RV, Van, etc.	0	12	99	86	94

Source - Selected Housing Characteristics, 2008-2012 American Community Survey 5-Year Estimates, U.S. Census Bureau

Of Franklin County's residential dwellings, 49 percent of the homes were built after 1980. In Jefferson County, over 50 percent of the residential units were constructed after 1980. Approximately 51 percent of the housing units in St. Charles County were constructed after 1990. In St. Louis County only 26 percent have been built since 1980. Approximately 77 percent of the housing units in the City of St. Louis were built before 1960. Refer to Table 2-31 below.

Table 2-31 Age of Residential Structures

Jurisdiction	YEAR STRUCTURE BUILT								
	2010 - Later	2000 - 2009	1990 - 1999	1980 - 1989	1970 - 1979	1960 - 1969	1950 - 1959	1940 - 1949	1939 and Earlier
Franklin	25	7,345	7,669	6,412	6,838	4,166	3,561	21,347	5,002
Jefferson	394	16,701	18,171	12,772	15,098	9,567	8,040	2,973	4,040
St. Charles	704	37,716	33,338	27,394	20,317	10,681	5,641	1,837	3,631
St. Louis	535	15,100	40,498	51,449	74,832	81,317	87,524	31,627	44,930
City of St. Louis	91	7,300	4,993	6,664	8,378	11,901	20,472	18,068	97,988
Total	1,749	84,162	104,669	104,691	125,463	117,632	125,238	75,852	155,591

Selected Housing Characteristics, 2008-2012 American Community Survey 5-Year Estimates, U.S. Census Bureau

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**Average Unit Cost**

Table 2-32 Value of Owner-Occupied Homes by County

Home Value	Number of Homes				
	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
House Value < \$50,000	3,036	7,527	4,555	10,987	6,829
Value \$50,000 to \$99,999	4,912	7,942	3,465	44,605	17,414
Value \$100,000 to \$149,999	6,933	16,411	18,153	55,541	15,460
Value \$150,000 to \$199,999	5,691	16,946	31,916	54,635	11,395
Value \$200,000 to \$299,999	5,254	12,543	34,549	59,092	7,591
Value \$300,000 to \$499,999	2,757	5,182	13,393	39,755	3,321
Value \$500,000 to \$999,999	834	551	2,669	19,473	1,296
Value \$1 million or more	358	239	308	4,514	451
Median House Value	\$150,100	\$154,200	\$193,600	\$177,400	\$121,700

Source - Selected Housing Characteristics, 2008-2012 American Community Survey 5-Year Estimates, U.S. Census Bureau

**I. Regional and Local Capabilities**

**Community Partnerships**

All five counties are represented on the EWG Board of Directors by the chief elected official, along with mayors and citizen representatives. The twenty-four member Board provides coordination and communication on regional issues. The counties have representatives who work with Metro, EWG and MoDOT on regional transportation planning efforts. Examples include the expansion of the MetroLink light rail system (Metro), major transportation investment analysis corridor studies (EWG) and interstate highway improvement projects (MODOT).

EWG and the City of St. Louis collaborate on numerous issues including infrastructure, law enforcement and emergency services that includes three counties in Illinois which are also part of EWG. Illinois Department of Transportation, MoDOT, St. Louis County and the City of St. Louis collaborate on transportation issues where it applies to infrastructure systems across the Mississippi River and state lines. The city also collaborates with the United States Army Corps of Engineers (USACE) and the U.S. Coast Guard where the issues pertain to the Mississippi River transportation traffic and river flow.

**St. Louis Area Regional Response System (STARRS)**

The St. Louis Area Regional Response System (STARRS) is a consortium of key public and private organizations which has been organized to address critical security needs in the St. Louis (Missouri-Illinois) region. EWG is the fiscal agent for STARRS. The partnership between EWG and STARRS enables professionals in many key fields relating to emergency management to work together to better prepare the region to prevent and respond to

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natural disasters and terrorist acts, and provides for accountability to the region's chief elected officials.

The geographic divisions in the St. Louis region require that homeland security responses be carefully planned by a collaborative organization that spans the area's fragmented political landscape. In addition, the complexity of a regional response to a myriad of potential threats, whether naturally occurring or intentional, requires the involvement of a wide variety of disciplines including healthcare, public safety, public health, emergency response, communications and many others. It also requires a partnership between public and private sectors, since many key assets are privately owned and operated.

EWG receives funding from the Department of Homeland Security/Federal Emergency Management Agency to administer and implement the Urban Area Security Initiative (UASI) in the St. Louis region. The work under this grant includes updating the St. Louis Regional Emergency Resource Coordination plan for the St. Louis metropolitan area, providing support to critical incident response teams and Citizen Preparedness programs, supporting information and intelligence sharing among agencies and supporting cross-jurisdictional cooperation among emergency service providers. This grant also supports the design and installation of the St. Louis Regional Digital Microwave System, the purchase of equipment to support mass casualty capability, disaster preparedness and response and training exercises.

EWG receives funding from the Missouri Department of Health and Senior Services/U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness & Response to support hospitals in the St. Louis region in planning, preparing for and responding to all-hazard events. Staff supports plans for enhancing hospitals' surge capacity in mass fatality and patient care during a mass casualty incident. Other efforts include enhancement of hospitals' capacity to: treat patients with major trauma or burns; decontamination of patients and personnel, distribution of medicine and medical supplies during biological events and interoperable communications capability.

### **Community Organizations Active in Disaster**

In the last five years, Community Organizations Active in Disaster (COAD) groups have been organized in the five county area. COADS have a role in information sharing and serving as a resource to local emergency management agencies, local governments and residents. A COAD is a group of organizations, operating within a specific geography, and composed of representatives from the public, private and not-for-profit sectors. Organizations can include businesses, faith-based organizations, community organizations, human service organizations and community stakeholders with the involvement of government partners. A COAD can help to enhance a community's ability to mitigate, prepare for, respond to and recover from disasters, ensuring that human needs, inherent in a disaster situation, are evaluated and addressed.

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The St. Louis Area Regional Coalition of COADs (SLARCC) and its working groups provide access to a ranged of citizen organizations including non-profit service organizations, churches and government agencies. SLARCC is a way to reach and engage the interested public. SLARCC and STARRS have begun a comprehensive public awareness campaign, "All Ready?" to help foster a culture of emergency preparedness in the region. COADs have been established in St. Charles County and Jefferson County and there is one COAD for St. Louis County and the City of St. Louis.

### **Citizen Emergency Response Team**

People involved with a Citizen Emergency Response Team (CERT) are educated about disaster preparedness for hazards which may occur in their area and are trained in basic disaster response skills. With this training, CERT members can assist their neighbors or co-workers following a hazard event when first responders are not immediately available. CERT members could also participate in emergency preparedness projects. In the five county area, there are over 40 CERTS sponsored by municipal or county governments, fire departments/protection districts and two universities.

### **Law Enforcement**

The Franklin County's Sheriff's Department includes over 150 personnel. Communities in the County with police departments include: Berger; Gerald; New Haven; Pacific; St. Clair; Union; Washington; and Sullivan. The departments participate in mutual aid agreements with all incorporated areas within the county. The zone offices of the Franklin County Sheriff are located in New Haven and the Lonedell area.

The Jefferson County Sheriff's Department includes over 150 personnel. The following communities have police service: Crystal City; DeSoto; Festus; Hillsboro; Kimmswick; Pevely; Herculaneum; Byrnes Mill; Arnold; and Olympian Village. The departments participate in mutual aid agreements with all incorporated areas within the county. The Jefferson County Sheriff has three zone offices in the County. Officers working in the north zone are headquartered out of High Ridge. Officers working in the south zone are headquartered out of Hillsboro. Officers working in the east zone are headquartered out of Imperial.

The St. Charles County Police Department includes 130 commissioned law enforcement professionals and 57 civilian personnel. The Police Department participates in mutual aid agreements with all incorporated areas within the county. Officers are headquartered in the main facility at 101 Sheriff Dierker Court in O'Fallon, MO. The following municipalities contract with the Police Department for patrol service: Augusta; Portage des Sioux; St. Paul; Flint Hill; New Melle, Weldon Spring Heights; and West Alton. St. Charles County provides full-time law enforcement patrols to Dardenne Prairie and Weldon Spring. The following communities have their own police service: Cottleville; Foristell; Lake Saint Louis;

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O'Fallon; St. Charles; St. Peters; and Wentzville. The various community police departments participate in mutual aid agreements with the other communities in the metropolitan areas.

The St. Louis County Police Department, headquartered in Clayton provides police services to unincorporated areas of the County and can offer policing services to municipalities under contract. Currently St. Louis County provides complete police services to 17 municipalities. The department was established in 1955 and has a staff of approximately 835 commissioned officers and 250 civilian support staff. There are four divisions: Patrol; Special Operations; Criminal Investigations; and Operational Support. The Department maintains seven precinct stations and 13 substations. The Department has helicopter services available for rescue. There are approximately 62 municipal police departments in St. Louis County. Some municipalities may contract with neighboring municipalities for police services.

The City of St. Louis Metropolitan Police Department has three Area Patrol Stations and six Police Districts. The South Patrol, located at 3157 Sublette, covers Districts 1 and 2. The Central Patrol, located at 919 North Jefferson, covers Districts 3 and 4. The North District located at 4014 Union, covers Districts 5 and 6. Each Patrol Station has additional administrative and support staff. In addition, the City Police has: Bureau of Investigation and Support; Bureau of Auxiliary Services; Bureau of Professional Standards; and Bureau of Community Policing. There are a total of 1350 officers and 520 civilian employees. Administrative (Board of Police Commissioners, Office of the Chief) offices include a total of 215 staff. The Police Department acts as the City's primary 9-1-1 service. The dispatcher obtains information on the type of call and then routes the call to the particular Emergency Management Service (EMS) ambulance, fire and law enforcement departments that would pertain to the emergency. All call requiring EMS or fire department are transferred to the appropriate dispatcher. Depending upon the type of emergency, the EMS, fire and police departments may all be dispatched. The department participates in mutual aid agreements with the other communities in the metropolitan area.

### **Emergency Medical Services**

Franklin County has six ambulance districts that service the area. Seven ambulance districts serve Jefferson County. There is one ambulance district in St. Charles County and city of St. Charles has an EMS Department. In St. Louis County, 26 fire protection districts and fire departments provide ambulance service. Information on these districts can be found in the table below.

The EMS Bureau in the City of St. Louis is a uniformed division of the Fire Department and handles approximately 90,000 calls a year. All 12 ambulances contain advanced life support equipment. The EMS Bureau is also responsible for training and overseeing the

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First Responder Program operated by the Fire Department Fire Suppression Bureau. The mission of the St. Louis Fire Department's EMS Bureau is to provide the citizens and visitors of the City of St. Louis with the highest level of quality pre-hospital emergency care possible.

The St. Louis Fire Department has developed an EMS system that integrates three main components for the delivery of emergency medical care. First, EMS dispatchers screen calls and, in many cases, the EMS Dispatcher will provide the caller with "pre-arrival instructions," depending upon the medical emergency. The second component of the St. Louis Fire Department's EMS system is first response engine companies and associated fire suppression apparatus. Each apparatus in the fire department is equipped with basic life support equipment, including automatic external defibrillators (AEDs). All firefighters in the St. Louis Fire Department are medically certified or licensed as first responders, Emergency Medical Technicians (EMTs), or paramedics. An engine company is dispatched on all life-threatening calls. At the same time an engine company has been dispatched, the closest advanced life support ambulance with paramedics is also dispatched (third component).

The City of St. Louis has two private ambulance services including Abbott Ambulance (with 56 vehicles) and Gateway Ambulance Services (with 14 ambulances).

A table listing of the public ambulance services in the five county planning region can be found in Appendix E. This information is also available in the Annual Public Officials Directory prepared by EWG. ([www.ewgateway.org/pdf/files/library/pod/POD-Complete-2014.pdf](http://www.ewgateway.org/pdf/files/library/pod/POD-Complete-2014.pdf) )

### **ARCH Air Medical Services**

ARCH (Area Rescue Consortium of Hospitals) is the only St. Louis based medical helicopter/air ambulance service that has coverage in Jefferson, Franklin, Franklin, St. Louis Counties and St. Louis City. Seventy-five percent of their calls are hospital-to-hospital transports. Twenty-five percent of their calls are primary response situations, in which they are assisting an EMS crew with the transport of a patient with a serious, life-threatening emergency via their helicopter.

ARCH currently has nine bases in Missouri and Illinois and currently maintains eight twin-engine BK-117 helicopters, one BO105 helicopter (ARCH 6), one helicopter for pediatric patients and two fixed-wing Beechcraft King Air 100 aircraft, which are used to provide neonatal transfer service for Cardinal Glennon Children's Hospital and St. Louis Children's Hospital. Their dispatch and headquarters is located in St. Louis City on Scott Ave (near Interstate 64).

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### **Fire Protection**

Nine fire districts or departments, providing service from 31 locations, supply fire protection in Franklin County. Jefferson County contains 16 fire protection districts/departments. St. Charles County has ten fire protection districts and one municipal fire department to protect the residents and their property. St. Louis County contains 19 fire departments and 23 fire protection districts. Fire protection for Lambert-St. Louis International Airport is provided by the City of St. Louis. They are included in the table below.

The City of St. Louis Fire Department is the largest branch in the Department of Public Safety, and includes the Bureau of Emergency Medical Services, Fire Prevention Bureau and specialized units in Fire Suppression, Hazardous Materials, Rescue, Marine Operations and Accident Extrication. The Fire Marshal is in charge of the Fire Prevention Bureau and is responsible for enforcement of all fire and safety regulations. The Fire Department also has the responsibility for fire prevention and suppression at Lambert International Airport.

The St. Louis Fire Department employs approximately 900 personnel, including firefighters, emergency medical technicians, paramedics and civilians. Fire suppression apparatus is located at 30 firehouses around the city. The fire department can have a fire suppression apparatus to any block in the city within four minutes of being dispatched. The Fire Department's mission is to provide the best possible fire, rescue and emergency medical services for the protection of life, property, commerce and the environment in the City of St. Louis. All firefighters are trained in the latest fire suppression techniques, hazardous material recognition, medical first response and basic rescue techniques. A firefighter's base of knowledge must cover the areas of building construction, hydraulics, medical treatment, fire sprinkler design, safe driving practices and vehicle extrication techniques.

The Fire Suppression Bureau operates three shifts and is commanded by a Deputy Chief. The city is broken into six battalions or districts, each commanded by a Battalion Chief. The goal of the Bureau of Fire Prevention is to reduce or eliminate the loss of life or property due to fire through code enforcement, public education, and the promulgation of good engineering practices.

Fire protection districts are independent taxing jurisdictions. Fire departments exist as part of municipal government and the cost of fire protection is included in the municipal tax rate. A table showing the fire protection districts and fire departments in the five county planning region can be found in Appendix E. This information is also available in the Annual Public Officials Directory prepared by EWG.

([www.ewgateway.org/pdf/files/library/pod/POD-Complete-2014.pdf](http://www.ewgateway.org/pdf/files/library/pod/POD-Complete-2014.pdf) )

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### **Emergency Management Services**

By County Court Order of September 22, 1983, Franklin County created an emergency management organization responsible for the preparation and implementation of emergency functions for Franklin County in accordance with Chapter 44 of the Revised State Statutes of the State of Missouri Emergency Operations Plan. In accordance with State law and County ordinance, the Franklin County Emergency Management Agency is responsible for emergency management of the unincorporated area of Franklin County and assist municipalities with emergency management activities, when requested.

Franklin County's operations are conducted from the Emergency Operations Center at 401 E. Springfield in Union. Commissioned offices and civilian employees staff the Emergency Operations Center. The Emergency Operations Center staff works in concert with the State Emergency Management Agency (SEMA), and the Federal Emergency Management Agency (FEMA), insuring that the interests of residents of Franklin County are well addressed. In addition, an important function of the Franklin County Emergency Management is the structuring of mandated State and Federal exercises of the Franklin County Basic Emergency Operations Plan. An extensive radio communications operation is a focal point of the Center. Its significance is at the forefront during times of local disaster when it is imperative to bring the needed resources together to face a common challenge.

Additional training is provided to the general public regarding severe weather and how best to identify their onset and the proper precautions in that event. A full-time staff is assigned to maintain the integrity, operation, and maintenance of the outdoor early warning sirens and weather sighters.

The Franklin County Sheriff's Department is manned 24 hours a day and has the communications equipment to communicate with city, county, and state departments or agencies. This includes contact with the State Highway Patrol, Troop C; area fire, ambulance, and police departments, and local government agencies. Franklin County has a mutual aid agreement set up with the surrounding communities for emergency services.

Emergency management for Jefferson County is conducted and coordinated by the Jefferson County Office of Emergency Management. The address for the Emergency Management Office is the Jefferson County Courthouse, 300 Main Street, Hillsboro, MO 63050. They help to protect, preserve and enhance the quality of life of county residents by working with the community in managing the mitigation of, preparedness for, response to, and recovery from natural and technological disasters and intentional destructive acts. Their focus is on the preservation of: the lives and health of citizens, the environment within which they live, and their property. They cooperate with participating agencies, municipalities, organizations, industries and media, then providing the citizens of the county with information to prepare for and recover from disasters.

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Jefferson County has installed an effective CodeRED service, which is a reverse calling system to enable emergency managers to notify residents of emergencies, such as tornados. Residents sign up to receive calls and receive notification within 5 to 30 minutes depending on the event and scale of calling required.

St. Charles County has an Emergency Operations Plan in place. The St. Charles County Division of Emergency Management (DEM) is responsible for the coordination of mitigation, preparedness, and response and recovery efforts pertaining to major emergencies or disasters arising from natural or manmade causes. This is in accordance with State Statutes and Federal Laws. They provide a number of services important to community awareness and preparedness. Services include providing information to the public sector, businesses, industries, schools, hospitals, senior centers, disability centers and organizations to promote disaster planning. The agency has a full-time professional staff. DEM works with all the private and public schools to aid their emergency planning and exercising programs.

DEM will assist all local governments in the development of their plans, exercising and training programs. The agency maintains a modern federally funded Emergency Operations Center that serves St. Charles County, Missouri. The EOC meets all FEMA requirements, as a dedicated Direction & Control Facility with state of the art computer, communication, early detection and warning systems to protect our community. Tours of the County EOC are available by appointment to organizations interested in emergency management.

The St. Charles County DEM Staff are experienced professionals. The entire staff is required to have completed the FEMA Professional Development Series of emergency management certification. All staff members are required to maintain the highest degree of professionalism within each of their respective job specialties.

St. Charles County provides enhanced 9-1-1 services for the safety of its residences, businesses and travelers. The services are provided Countywide. Equipment, database contents for a Master Street Address Guide (MSAG), network connections and maintenance/ restoration services are purchased or leased by County Government. The networks and systems are constructed with redundancy and recoverability in mind. At present, the 9-1-1 System is partially funded by 2 percent levy of the base rate of all wired telephone lines (of up to 100 lines) located within the county and is collected from each telephone company operating in St. Charles County.

St. Charles County Department of Dispatch and Alarm, which answers all fire and ambulance calls countywide, has tele-communicators who have been trained to provide Emergency Medical Dispatching and Pre-Arrival Instructions.

The St. Louis County Police Department's Office of Emergency Management (OEM) is located at 1150 Hanna Road in Ballwin in southwest St. Louis County and is staffed by

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both commissioned and civilian personnel. The unit operates from the Emergency Operations Center (EOC), a self-contained structure with extensive radio communications operations. The OEM is tasked with preparing members of local government, law enforcement, and the public and private sectors, with how to prevent, prepare for, respond to, and recover from disasters. The OEM staff coordinates and interacts with many public and private sector planning commissions and groups in order to be better prepared in the event of a disaster. The OEM staff works in concert with the State Emergency Management Agency (SEMA), and the Federal Emergency Management Agency (FEMA). In addition, an important function of the Office of Emergency Management is the structuring of mandated State and Federal exercises of the St. Louis County Basic Emergency Operations Plan.

Additional training is provided to the general public regarding severe weather and how best to identify their onset and the proper precautions in that event. A full-time staff is assigned to maintain the integrity, operation, and maintenance of the 208 outdoor early warning sirens.

In accordance with State law and County ordinance, the OEM coordinates all activities of the St. Louis County Local Emergency Planning Committee (LEPC) in responding to hazardous materials issues and concerns, i.e. storage of chemicals, and response to and recovery from chemical spills and releases. The OEM works hand-in-hand with the St. Louis County Hazardous Materials Emergency Response Team (HMERT) by providing training and funding for equipment purchases.

Emergency (9-1-1) calls are taken by the St. Louis County Police Department. The dispatcher obtains information on the type of call and then routes the call to the particular EMS, fire and law enforcement departments that would pertain to the emergency. The EMS, fire or police department would then dispatch emergency response vehicles to the emergency. St. Louis County has a mutual aid agreement set up with the surrounding communities for emergency services.

The City of St. Louis Emergency Management Agency is responsible for the operation and maintenance of the emergency Operations Center and its communications equipment, oversees the operation and maintenance of an outdoor warning siren system and maintains the city's mobile emergency communications van. CEMA is the lead agency representing the city for planning and developing response plans to events of disaster or other emergencies. The agency is also involved with emergency preparedness training for citizens.

### **School Capabilities**

Missouri law requires school districts in a Modified Mercalli Zone VII or above at a magnitude 7.6 earthquake to prepare earthquake preparedness and safety information,

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such as earthquake procedures and a disaster plan; conduct earthquake drills twice each year; and provide training. In addition, this earthquake emergency procedure system should include protective measures to be taken before, during and following an earthquake. Each school district should make its earthquake emergency procedure systems available for public review. Missouri statutes, RSMO 260.451, 160.454, 160.455 and 160.457, provide that “the governing body of each school district shall request assistance from the State Emergency Management Agency (SEMA) and any local emergency management agency located within its district boundaries to develop and establish the earthquake emergency procedure system.” These requirements affect school districts located in Jefferson, St. Charles and St. Louis Counties and the City of St. Louis. (See Table 2-33) Franklin County is located in Zone VI, but is contiguous to Zone CII along its eastern and northern borders.

Table 2-33 School Districts with Earthquake Emergency Procedure System

School District	County
Affton 101	St. Louis
Bayless	St. Louis
Brentwood	St. Louis
Clayton	St. Louis
Crystal City 47	Jefferson
DeSoto 73	Jefferson
Dunklin R-V	Jefferson
Ferguson-Florissant	St. Louis
Festus R-VI	Jefferson
Fort Zumwalt R-II	St. Charles
Fox C-6	Jefferson
Francis Howell R-III	St. Charles
Grandview R-II	Jefferson
Hancock Place	St. Louis
Hazelwood	St. Louis
Hillsboro R-III	Jefferson
Jefferson County R-VII	Jefferson
Jennings	St. Louis
Kirkwood	St. Louis
Ladue	St. Louis
Lindbergh R-VIII	St. Louis
Maplewood-Richmond Heights	St. Louis
Mehlville R-IX	St. Louis
Normandy	St. Louis
Northwest R-I	Jefferson
Orchard Farm R-V	St. Charles
Parkway	St. Louis
Pattonville R-III	St. Louis
Ritenour	St. Louis
Riverview Gardens	St. Louis
Rockwood R-VI	St. Louis
Special School District	St. Louis

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School District	County
St. Charles R-VI (City of St. Charles)	St. Charles
St. Louis City Public	City of St. Louis
Sunrise R-IX	Jefferson
University City	St. Louis
Valley Park	St. Louis
Webster Groves	St. Louis
Wentzville R-IV	St. Charles
Windsor C-I	Jefferson

Source - Missouri Revised Statutes

Missouri law requires that at the beginning of the school year, all school districts in Missouri shall distribute to their students earthquake safety information which has been prepared by FEMA, SEMA (Earthquake Safety for Missouri Schools) or by agencies which are authorities in the area of earthquake safety. In many school districts earthquake safety information is also available on their websites.

The following table contains mitigation actions of local school districts based on a review of St. Louis Post-Dispatch articles and results from a 2014 survey of hazard mitigation actions at school districts in the five county area.

Table 2-34 School Mitigation Activities

School District	County	Mitigation Actions
DeSoto 73	Jefferson	Reviewing plans for notification and redirection of families displaced and bus routes affected with flooding. With damages to buildings, working through avenues to continue services when part of facility is damaged. Emergency Operations Plan includes Protection of People with Special Needs Plan and Evacuation Plan.
Fort Zumwalt R-II	St. Charles	Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Fox C-6	Jefferson	Earthquake safety fact sheet Emergency Operations Plan for district and each building which include Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Francis Howell R-III	St. Charles	Emergency Operations Plan includes Protection of People with Special Needs Plan, Shelter in Place Plan and Evacuation Plan.
Gasconade County R-II	Gasconade-Franklin	Emergency Operations Plan includes Protection of Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Hazelwood	St. Louis	Tornado safe room Seismic retrofits Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Jefferson County R-VII	Jefferson	Earthquake safety fact sheet Emergency Operations Plan for district and each building
Jennings	St. Louis	District has Protection of People with Special Needs Plan, Storm Shelter Plan and Shelter in Place Plan.

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School District	County	Mitigation Actions
Maplewood-Richmond Heights	St. Louis	Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Mehlville R-IX	St. Louis	Emergency Operations Plan includes Protection of People with Special Needs Plan and Evacuation Plan.
Meramec Valley R-III	Franklin	Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Orchard Farm R-V	St. Charles	In 2014 District obtained grant funding for construction of a 7,700 square foot safe room to be part of new Early Childhood Center.
Ritenour	St. Louis	Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Riverview Gardens	St. Louis	Asbestos abatement and mold remediation Emergency Operations Plan includes Evacuation Plan and Storm Shelter Plan.
Rockwood R-VI	St. Louis	District and all school facilities have crisis and safety plans. All Rockwood schools have an emergency preparedness plan. These plans are reviewed annually and school crisis teams receive training.
St. Charles R-VI (City of St. Charles)	St. Charles	SEMA earthquake handout Earthquakes discussed in student handbook
St. Louis City Public	City of St. Louis	Information on tornado safety and earthquakes Each school building is encouraged to hold drill twice a year
Sullivan	Franklin	Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Valley Park	St. Louis	Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan.
Washington (School District of)	Franklin	District and all school facilities has crisis and safety plans. Emergency Operations Plan includes Protection of People with Special Needs Plan, Evacuation Plan, Storm Shelter Plan and Shelter in Place Plan. School district personnel practice drills on a regular basis (i.e., fire, tornado and school intruder).
Wentzville R-IV	St. Charles	Holt High School has a Teen CERT program

**Codes/Regulations for Building, Fire, Zoning**

Following are Codes in effect for Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis which can be found for free at the International Code Council's website: [www.iccsafe.org](http://www.iccsafe.org) . These units of government review, amend and adopt these codes on a regular basis.

Table 2-35 Building Codes by County

Code	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
International Residential Code 2009	X	X	X	X	X
International Building Code 2009	X	X	X	X	X

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Code	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
International Fire Code 2009	X	X	X	X	X
International Mechanical Code 2009	X	X	X	X	X
International Plumbing Code 2009	X	X	X		
Uniform Plumbing Code 2009				X	X
Dangerous Building Code		X			
Other Codes	X	X	X	X	X

Other codes include but are not limited to: International Existing Building Code 2009; International Fuel Gas Code 2009; International Energy Conservation Code 2009; National Electrical Code 2008; International Property Maintenance Code 2009; National Electrical Code 2011; and Commercial Building Code 2009.

The Franklin County Planning and Zoning Department's mission is to provide professional service to support the present and future citizenry of Franklin County. The Planning Commission consists of ten-member group, representing each township within the County. The Board of Zoning Adjustment consists of a five-member group.

The St. Louis County Department of Public Works, by County Charter, is responsible for code enforcement of County ordinances that regulate building construction within the unincorporated areas of St. Louis County. Located within St. Louis County are 90 municipalities. Since the mid-1950's, the Department of Public Works has offered code enforcement services by contract to these municipalities. A total of 84 municipalities and one fire protection district have contacts with St. Louis County. A municipality may have a contract for one to 14 different codes/ordinances. Each municipality contracting with St. Louis County maintains Zoning Enforcement responsibility at their local level. Department of Public Works is interested in promoting uniformity of construction regulations throughout the entire area because uniformity and consistency in building code enforcement will result in better construction quality for any hazards that might occur.

**J. Existing Community Plans**

Table 2-36 Plans by County

County	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Franklin	X	X	X	IBC 2009	X	X	X
Jefferson	X	X	X	IBC 2009	X	X	X
St. Charles	X	X	X	IBC 2009	X	X	X
St. Louis	X	X	X	IBC 2009	X	X	X
City of St. Louis	X	X	X	IBC 2009		X	X

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The websites of the counties and the City of St. Louis have additional information on the plans, ordinances and programs in place. These units of government review and update these documents and programs on a regular basis. The East-West Gateway Council of Governments (EWG) will encourage these governments to continue incorporating the all-hazard planning principles into their local plans and ordinances. Appendix B has a section with contact information for local governments.

The Community Policy Analysis Center (CPAC) at the University of Missouri developed for the Franklin County Planning Task Force a Baseline Report. This report described the demographic, economic and fiscal conditions/projections and analysis to be used for Franklin County’s 2010 Master Plan, adopted in 2001.

The most recent Franklin County Master Plan was adopted in 2012. Franklin County has developed the Unified Land Use Regulations, Master Plan and Comprehensive Economic Development Strategy. The Land Regulations were recommended pursuant to provisions of Sections 64.800 through 64.905 RSMo by the Franklin County Planning and Zoning Commission and adopted by the County Commission of Franklin County to promote health, safety and welfare for Franklin County residents. The Land Use Regulations went into effect December 31, 1992. Zoning originally became effective on December 31, 1986. The Land Use Regulations were designed to implement the planning policies adopted by Franklin County Commission, as reflected in the Official Master Plan and other planning documents. The Planning and Zoning Commission, advisory committee and the Planning and Zoning Department develop community plans. Powers of the Planning and Zoning Commission are to prepare the master plan for the county, planning for the county, review, amend, and appeal certain regulations. A Board of Zoning Adjustment exists to interpret and evaluate variances of the regulations. The Planning Director is considered to be the administrative head of the Planning and Zoning Department.

Franklin County also has standards within the Land Use Regulations for floodplain management, drainage, erosion and stormwater management per Article 11, Section 241-269. Article 7 addresses zoning standards.

Table 2-37 Community Plans and Codes by Incorporated Unit Franklin County

Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Berger		X					X
Charmwood							
Gerald	X	X	X	IBC 2009	X		X
Leslie							
Miramiguoa Park							
New Haven	X	X	X	IBC 2009	X	X	X
Oak Grove	X	X	X	BOCA			

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<b>Village</b>							
<b>Pacific</b>	Y	X	X	IBC 2003	X	X	X
<b>Parkway</b>	N	X			X		
<b>St. Clair</b>	X	X	X	IBC 2009	X	X	X
<b>Sullivan</b>	X	X	X	IBC 2009	X	X	X
<b>Union</b>	X	X	X	IBC 2009	X	X	X
<b>Washington</b>	X	X	X	IBC 2009	X	X	X

The websites of the incorporated units within Franklin County have additional information on the plans, ordinances and programs in place. These units review and update these documents and programs on a regular basis. EWG will encourage local communities to continue incorporating the all-hazard planning principles into their local plans and ordinances. Appendix B has a section with contact information for local governments.

The Planning Division within the Jefferson County Department of Land Use, Development and Code Enforcement conducts the planning efforts for the county government primarily in the area of land use, but increasingly in the areas of infrastructure and public services. The Division maintains and implements the County's Zoning Ordinance. This service may include information on permitted uses for a specific piece of property, building setbacks, current zoning, and information on processes available to change zoning. This service is generally paid for by the citizens of Jefferson County as part of the one-half cent sales tax collected for general government operations. The Division conducts numerous research efforts on countywide issues as well as on site-specific issues. This research may include environmental analyses, project feasibility studies, and reviews of project proposals. The Jefferson County Unified Development Code was adopted in 2008.

The Jefferson County Planning Division is organized into three sections, each of which reports to the Manager of the Planning Division. The Current Planning Section is responsible for daily operations including planning and zoning issues and proposed development. The second section is the Comprehensive Planning Section and is responsible for long-range planning functions including watershed management plans, the Master Plan and other special area or functional plans. The third section is the Technical Operations, which is responsible for technical operations and inspection efforts of the Division. The Planning Division produces plans and reports, the Comprehensive Master Plan, program guides and demographics, maps and statistics. Planning documents released to date include Jefferson County's Master Plan, Rock Creek Watershed Management Plan, Jefferson County Transportation Mobility Plan, Jefferson County Transit Needs Study and the Jefferson County Economic Development Plan.

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Table 2-38 Community Plans and Codes by Incorporated Units Jefferson County

Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Arnold	X	X	X	IBC 2009	X	X	X
Byrnes Mill	X	X	X	IBC 2003	X	X	X
Cedar Hill Lakes							
Crystal City	X	X	X	IBC 2003	X	X	X
DeSoto	X	X	X	IBC 2009	X	X	X
Festus	X	X	X	IBC 2009	X	X	X
Herculaneum			X	Unknown	X	X	X
Hillsboro	X	X	X	X	X	X	X
Kimmswick							
Lake Tekakwitha							
Olympian Village							
Parkdale							
Peaceful Village							
Pevely	X	X	X	IBC 2006	X	X	X
Scotsdale	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

The websites of the incorporated units in Jefferson County have additional information on the plans, ordinances and programs in place. These units review and update these documents and programs on a regular basis. EWG will encourage local communities to continue incorporating the all-hazard planning principles into their local plans and ordinances. Appendix B has a section with contact information for local governments.

In St. Charles County, long range and special planning studies that the department has completed in recent years include the St. Charles County Master Plan, Envision 2025 in unincorporated St. Charles County (approved July 2013). The 2025 Plan serves as the framework that directs growth and development in the County and guides staff and elected officials in their decisions of land use issues such as rezoning requests or subdivision approval. *The Unified Development Ordinance* completed in 1999, provides information regarding zoning and subdivision development requirements. The Master Plan Envision 2025 addresses a wide range of issues facing county citizens.

Table 2-39 Community Plans and Codes by Incorporated Unit St. Charles County

Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Augusta	X						
Cottleville	X	X	X	IBC 2003	X	X	X
Dardenne Prairie	X	X	X	IBC 2009	X	X	X

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Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Flint Hill	X		X	IBC 2009	X	X	X
Foristell	X	X	X	IBC 2009	X	X	
Josephville			X				
Lake Saint Louis	X	X	X	IBC 2009	X	X	X
New Melle	X		X		X	X	
O'Fallon	X	X	X	IBC 2009	X	X	X
Portage des Sioux							
St. Charles	X	X	X	IBC 2009	X	X	X
St. Paul	X		X		X	X	
St. Peters	X	X	X	IBC 2009	X	X	X
Weldon Spring	X	X	X	IBC 1999 Contract with County	X		X
Weldon Spring Heights	X		X		X		
Wentzville	X	X	X	IBC 2009	X	X	X
West Alton	X	X	X		X	X	X

The websites of the incorporated units in St. Charles County have additional information on the plans, ordinances and programs in place. These units review and update these documents and programs on a regular basis. EWG will encourage local communities to continue incorporating the all-hazard planning principles into their local plans and ordinances. Appendix B has a section with contact information for local governments.

As St. Louis County has grown and changed, so has the nature of the County's plan. With increasing urbanization and a diminishing amount of vacant land, St. Louis County's plans have moved from a general land use orientation to one that focuses more on strategic policy development. The latest plan, Imaging Tomorrow for St. Louis County: Strategic Plan 2013, focused on aligning resources to address the most critical issues facing St. Louis County. Based on extensive public input and analysis of data and trends, following policy framework for strategy development was identified: healthy, engaged residents; desirable, connected communities; and accessible attractive opportunities. The plan included a variety of interdepartmental strategies to address the key issues.

Since the mid-1950's, the Department of Public Works has offered code enforcement services by contract to these municipalities. A total of 84 municipalities and one fire protection district have contacts with St. Louis County. A municipality may have a contract for one to 14 different codes/ordinances. Each municipality contracting with St. Louis County maintains Zoning Enforcement responsibility at their local level.

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Table 2-40 Community Plans and Codes by Incorporated Units St. Louis County

Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Ballwin	X	X	X	IBC 2009	X	X	X
Bel-Nor		X	X		X		
Bel-Ridge		X	X				
Bella Villa				IBC 2009			
Bellefontaine Neighbors	X		Y	IBC 2009	X		X
Bellerive Acres	X	X	X	IBC 1999	X	X	
Berkeley		X	X	IBC 2009	X	X	X
Beverly Hills	X	X	X		X	X	X
Black Jack	X	X	X	IBC 2009	X	X	X
Breckenridge Hills	X		X		X		X
Brentwood	X	X	X	IBC 2009	X	X	X
Bridgeton	X	X	X	IBC 2003	X	X	X
Calverton Park				IBC 2009			
Champ		X	X		X		
Charlack	X	X	X	IBC 2009			
Chesterfield	X	X	X	IBC 2009	X	X	X
Clarkson Valley	X	X	X	IBC 2009	X	X	X
Clayton	X	X	X	IBC 2009	X	X	X
Cool Valley	X	X	X	IBC 2006	X	X	X
Country Club Hills		X	X	IBC 2009	X	X	
Country Life Acres				IBC 2009			
Crestwood	X	X	X	IBC 2009	X	X	X
Creve Coeur	X	X	X	IBC 2009	X	X	X
Crystal Lake Park		X	X	IBC 2009		X	X
Dellwood	X	X	X	IBC 2009	X	X	
Des Peres	X	X	X	IBC 2009	X	X	X
Edmundson				IBC 2009			
Ellisville	X	X	X	IBC 2009	X	X	X
Eureka	X	X	X	IBC 2009	X	X	X
Fenton	X	X	X	IBC 2009	X	X	X
Ferguson	X	X	X	IBC 2006	X	X	X
Flordell Hills							
Florissant	X	X	X	IBC 2009	X	X	X
Frontenac		X	X	IBC 2006	X	X	
Glen Echo Park	X			IBC 2009			
Glendale	X	X	X	IBC 2009	X		X
Grantwood Village	X	X	X	IBC 2009	X	X	X
Green Park	X	X	X	IBC 2009	X	X	X
Greendale	X	X	X	IBC 2009	X		X
Hanley Hills			X	IBC 2009			

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Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Hazelwood	X	X	X	IBC 2009	X	X	X
Hillsdale			X	IBC 2003	X		
Huntleigh		X	X	IBC 2009	X		
Jennings		X		IBC 2006			X
Kinloch	X		X	X	X		
Kirkwood		X	X	IBC 2009	X	X	X
Ladue	X	X	X	IBC 2006	X	X	X
Lakeshire		X		IBC 1999		X	
Mackenzie				IBC 2009			
Manchester	X	X	X	IBC 2009	X	X	X
Maplewood	X	X	X	IBC 2009	X	X	X
Marlborough	X		X	IBC 2009	X		
Maryland Heights	X	X	X	IBC 2009	X	X	X
Moline Acres			X	IBC 2009		X	
Normandy	X		X	IBC 2006		X	
Northwoods		X	X	IBC 2003		X	X
Norwood Court				IBC 2009			
Oakland	X	X	X	IBC 2009	X		
Olivette	X	X	X	IBC 2006	X	X	X
Overland	X	X	X	IBC 2003	X	X	X
Pagedale	X	X	X	IBC 2009	N	X	X
Pasadena Hills				IBC 1999			
Pasadena Park			X	X			
Pine Lawn			X	X		X	
Richmond Heights	X	X	X	IBC 2012	X	X	
Riverview			X	IBC 2009			
Rock Hill	X	X	X	IBC 2009	X	X	X
St. Ann			X	IBC 2006	X	X	X
St. John	X	X	X	IBC 2003	X	X	X
Shrewsbury		X	X	IBC 2006	X	X	
Sunset Hills	X		X	IBC 2009	X	X	X
Sycamore Hills			X	IBC 2009			
Town and Country	X		X	IBC 2003	X	X	X
Twin Oaks	X		X	IBC 2009	X	X	
University City	X		X	IBC 2012	X	X	X
Uplands Park				IBC 2009			
Valley Park		X	X	IBC 2009	X	X	X
Velda City			X				X
Velda Village Hills				IBC 2009			
Vinita Park		X	X	IBC 2009	X	X	
Vinita Terrace				IBC 2009			
Warson			X	IBC 2009	X		X

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Community	Comprehensive Plan	Emergency Operations Plan	Zoning Ordinance	Building Code	Subdivision Ordinance	Stormwater Regulation	Floodplain Regulation
Woods							
Webster Groves	X	X	X	IBC 2009	X	X	X
Wellston							
Westwood				IBC 2009		X	
Wilbur Park	X		X	IBC 2009			
Wildwood	X	X	X	IBC 2009	X	X	X
Winchester	X	X	X	IBC 2009	X	X	X
Woodson Terrace	X	X	X	IBC 2009	X	X	

The websites of the incorporated units in St. Louis County have additional information on the plans, ordinances and programs in place. These units review and update these documents and programs on a regular basis. EWG will encourage local communities to continue incorporating the all-hazard planning principles into their local plans and ordinances. Appendix B has a section with contact information for local governments.

The City of St. Louis operates as a first class city. As established by Article XIII, Section 15 in the St. Louis Charter states that the Department of Public Safety is responsible for enforcement of all codes, ordinances regulating protection of public health, safety and welfare as it relates to existing buildings and new construction floodplain issues, fire safety requirements, seismic construction on new or vastly improved construction. The Building Division, within the Department of Public Safety, administers and enforces the International Building Code 2009. For all construction projects in areas designated as flood areas per FEMA Floodway or FIRM maps, a floodway development permit must be issued even though a building permit may not be required.

The city has zoning and subdivision ordinances adopted, as well as ordinances pertaining to property maintenance, fire prevention, smoke, and carbon dioxide detectors. The Strategic Land Use Plan document was approved in 2005 and is amended on an annual basis. The Zoning Ordinance is administered by the office of the Zoning Administrator and includes twelve categories: single family, multifamily, vacant or unclassified, commercial, industrial, institutional, transportation, parks/recreation, and cemeteries. The current ordinance of the City of St. Louis was adopted in 1986 and has not been revised. There are twelve (12) different zoning districts. Mobile Home Parks are not a permitted use in any zoning district. Communication towers are regulated by height in each zoning district. Junkyard and solid waste storage/disposal uses are a conditional use in the "K" Unrestricted District. The zoning ordinance has a section on flood plain areas. The City reviews and updates their ordinances, documents and programs on a regular basis.

## **K. National Flood Insurance (NFIP)**

### **Flood Mitigation Efforts**

The Community Rating System (CRS) is a voluntary program for communities participating in the National Flood Insurance Program (NFIP). The CRS was developed to provide incentives, in the form of NFIP insurance premium discounts, for those communities which go beyond minimum floodplain management requirements and implement activities to reduce or eliminate exposure to floods. Under the CRS, communities or counties are rated on a scale of one to 10; the lower the class, the better the rating. These communities conduct advanced elements of hazard mitigation to meet FEMA guidelines.

St. Charles County was awarded a National Flood Insurance Program's CRS Class 7 rating for its efforts to reduce loss of lives and mitigate property damage from floods in its quest to bring the county to being disaster resistant. A Class 7 rating enables residents in unincorporated sections of St. Charles County who have flood insurance and live in a Special Flood Hazard Area to receive a 15 percent discount on their flood insurance premiums. Those who do not live in a SFHA can receive a 10 percent reduction. For more information, go to [www.sccmo.org/203/community-development](http://www.sccmo.org/203/community-development).

The City of Maryland Heights in St. Louis County was given a National Flood Insurance Program's CRS Class 9 rating for its efforts to reduce loss of lives and mitigate property damage from floods in its quest to bring the city to being disaster resistant. A Class 9 rating enables residents of Maryland Heights who have flood insurance and live in a Special Flood Hazard Area to receive a five percent discount on their flood insurance premiums. Those who do not live in a SFHA can receive a five percent reduction. For additional information on CRS activities in Maryland Heights, go to the Community Development department at [www.marylandheights.com](http://www.marylandheights.com).

The City of Florissant in St. Louis County received a National Flood Insurance Program's CRS Class 8 rating for its efforts to reduce loss of lives and mitigate property damage from floods in its quest to bring the city to being disaster resistant. A Class 8 rating enables residents of Florissant who have flood insurance and live in a Special Flood Hazard Area to receive a 10 percent discount on their flood insurance premiums. Those who do not live in a SFHA can receive a five percent reduction. For more information, go to the Engineering Division of Florissant Public Works Department at [www.florissantmo.com](http://www.florissantmo.com).

Franklin County's NFIP participation number is 290493, effective October 16, 1984.

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Table 2-41 Franklin County National Flood Insurance Program Participating Municipalities

COMMUNITY NAME	INIT FHBM	INIT FIRM	CURR EFF	EMERG DATE
Berger, City of	08/30/74	06/15/82	10/18/11	06/15/82
Franklin County, Unincorporated	01/17/78	10/16/84	10/18/11	10/16/84
Gerald, City of	06/04/76	08/01/01	(NSFHA)	08/01/01
Miramiguo Park, Village of		10/18/11	10/18/11	
New Haven, City of	03/05/76	02/18/81	10/18/11	02/18/81
St. Clair, City of	04/12/74	10/18/11	(NSFHA)	09/10/84
Union, City of	03/08/74	03/02/83	03/02/83	03/02/83
Washington, City of	01/09/74	11/03/82	10/18/11	11/03/82
Pacific, City of (Franklin/St. Louis	10/26/73	03/15/77	10/18/11	03/15/77
Sullivan, City of (Franklin/Crawford)	03/29/74	06/15/81	10/18/11	06/15/81
Oak Grove, Village of	06/03/77	08/19/86	08/19/86	06/03/78
<b>MUNICIPALITIES NOT PARTICIPATING</b>				
Oak Grove Village - sanction date June 3, 1978				
Miramiguo Park – sanction date October 18, 2012				

The National Flood Insurance Policy member number for Jefferson County is 290808.

Table 2-42 Jefferson County National Flood Insurance Program Participating Municipalities

COMMUNITY NAME	INIT FHBM	INIT FIRM	CURR EFF	EMERG DATE
Arnold, City of	06/28/74	01/16/80	04/05/06	01/16/80
Byrnes Mill, City of	07/29/80	05/16/83	04/05/06	05/16/83
Crystal City, City of	03/15/74	09/01/77	04/05/06	09/01/77
DeSoto, City of		05/26/72	04/05/06	05/26/72
Festus, City of	10/18/74	02/14/76	04/05/06	02/14/76
Herculaneum, City of	05/17/74	05/15/78	04/05/06	05/15/78
Hillsboro, City of	10/22/76	04/01/84	04/05/06	04/01/04
Jefferson County Unincorporated	07/29/80	05/16/83	04/05/06	05/16/83
Kimmswick, City of	11/01/74	01/06/82	04/05/06	01/06/82
Pevely, City of	10/29/76	09/18/85	04/05/06	09/18/85
Scotsdale, Town of		05/16/83	04/05/06	10/21/02
Cedar Hill Lakes, Village of		04/05/06	04/05/06	04/05/07
<b>MUNICIPALITIES NOT PARTICIPATING</b>				
Cedar Hills Lake - sanction date April 5, 2007				

St. Charles County participates in the NFIP program. Their member number is 290315.

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Table 2-43 St. Charles County National Flood Insurance Program Participating Municipalities

<b>COMMUNITY NAME</b>	<b>INIT FHBM</b>	<b>INIT FIRM</b>	<b>CURR EFF</b>	<b>EMERG DAT</b>
<b>Augusta, Village of</b>	12/06/74	11/19/86	08/02/96	01/31/01
<b>Cottleville, City of</b>		09/15/78	08/02/96	02/01/90
<b>Dardenne Prairie, City of</b>		12/15/92	03/17/03	03/13/95
<b>Flinthill, Village of</b>	12/09/80	11/19/86	08/02/96	11/19/86
<b>Foristell (St. Charle/Warren)</b>		12/15/92	12/06/99	02/24/93
<b>Lake St. Louis, City of</b>	05/08/79	09/18/87	03/17/03	09/18/87
<b>O'Fallon, City of</b>	02/01/74	03/16/81	03/17/03	03/16/81
<b>New Melle</b>		08/02/96	(NSFHA)	03/30/99
<b>Portage des Sioux, City of</b>	12/28/73	04/01/77	08/02/96	04/01/77
<b>St. Charles County Unincorporated</b>		09/15/78	03/17/03	09/15/78
<b>St. Charles, City of</b>	03/22/74	03/15/77	08/02/96	03/22/74
<b>St. Paul, City of</b>		12/15/92	03/17/03	02/13/98
<b>St. Peters, City of</b>	12/07/73	05/01/79	08/02/96	05/01/79
<b>Weldon Spring, City of</b>		12/15/92	08/02/96	07/02/93
<b>Wentzville, City of</b>	12/05/75	12/15/92	03/17/03	07/28/73
<b>West Alton, Town of</b>		09/15/78	08/02/96	07/09/97

St. Charles County is very active with floodplain management, located at the confluence of two of the largest rivers in the United States. St. Charles County participates in the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP). The County has adopted zoning regulations designed to protect the health, safety and general welfare and to minimize losses. St. Charles County established that all new construction or substantial improvement (50 percent or more of the structure's market value) within the floodway fringe district be elevated to one (1) foot above the Base Flood Elevation (BFE). The BFE is provided on the Flood Insurance Rate Maps (FIRM). Ordinance Section 400.120 establishes a Flood Plain Vision Board composed of seven (7) qualified residents of St. Charles County. St. Charles County has adopted the Flood Insurance Rate Map, the Floodway, the Density Floodway Map, and the Flood Insurance Study dated March 23, 2003, provided by the Federal Emergency Management Agency. (Ord. No. 99-99 §1, 7-12-99; Ord. No. 01-054 §1, 4-25-01). In accordance with the county charter, (Section 405.285) any uses permitted by the underlying zoning districts shall be permitted in the "FW", "FF", and "DF" Districts upon meeting all of the conditions, regulations, and requirements prescribed in the Article of the *Unified Development Ordinance*. The UDO requires that the land use in the floodplain, for the most part, be agricultural. In addition, floodplain permitting requires a United States Corps of Engineers (USCOE) 404 permit and in some instances, a State of Missouri 401 permit to be submitted, along with the project application form for review and approval.

St. Louis County participates in the NFIP. The member number is 290327.

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Table 2-45 St. Louis County National Flood Insurance Program Participating Municipalities

COMMUNITY NAME	INIT FHBM	INIT FIRM	CURR EFF	EMERG DAT
Ballwin, City of	06/07/74	09/30/76	08/02/95	01/02/81
Bel-Nor, Village of	04/05/74		(NSFHA)	08/26/77
Bel-Ridge, Village of	03/29/74	02/18/81	08/02/95	02/18/81
Bella Villa, City of	07/26/74	07/16/79	08/02/95	07/16/79
Bellefontaine Neighbors, City of	06/14/74	09/29/78	08/02/95	09/29/78
Berkeley, City of	12/24/76	08/01/79	08/23/00	08/01/79
Black Jack, City of	08/16/74	01/02/81	08/02/95	01/02/81
Breckenridge Hills, City of	12/07/73	10/15/80	08/02/95	10/15/80
Brentwood, City of	12/28/73	05/16/77	08/02/95	05/16/77
Bridgeton, City of	02/08/74	09/01/78	08/02/95	09/01/78
Charlack, City of	02/14/75	11/23/84	08/02/95	11/23/84
Chesterfield, City of		09/15/78	08/02/95	09/15/78
Clarkson Valley, City of	07/26/74	04/08/77	08/02/95	04/08/77
Clayton, City of	04/05/74	02/14/76	08/02/95	02/14/76
Cool Valley, Village of	05/03/74	05/16/77	08/02/95	05/16/77
Country Club Hills, City of	05/07/76		(NSFHA)	05/25/78
Crestwood, City of	05/03/74	05/02/77	08/02/95	05/02/77
Creve Coeur, City of	02/01/74	08/01/78	08/23/00	08/01/78
Crystal Lake Park, City of	05/13/77	08/02/95	(NSFHA)	08/01/86
Dellwood, City of	08/13/76	06/27/78	(NSFHA)	06/27/78
Des Peres, City of	05/13/77	06/15/79	08/23/00	06/15/79
Edmundson, City of			01/02/50	08/31/04
Ellisville, City of	05/10/74	09/09/80	08/02/95	09/09/80
Eureka, City of	01/09/74	07/05/77	08/02/95	07/05/77
Fenton, City of	05/17/74	01/19/78	08/02/95	01/19/78
Ferguson, City of	09/14/73	01/19/78	08/23/00	01/19/78
Flordell Hills, City of	05/03/74		(NSFHA)	06/10/80
Florissant, City of	11/09/73	02/04/81	08/02/95	02/04/81
Frontenac, City of	01/23/74	02/18/81	08/02/95	02/18/81
Glendale, City of	12/28/73		(NSFHA)	08/24/84
Grantwood Village, town of	03/08/74	01/16/81	08/02/95	01/16/81
Green Dale		08-23-00	(NSFHA)	12-02-14
Green Park, City of				08/12/98
Hanley Hills, Village of	08/02/74	08/01/80	08/02/95	08/01/80
Hazelwood, City of	01/09/74	04/01/80	08/23/00	04/01/80
Hillsdale, Village of	04/05/74		(NSFHA)	08/24/84
Huntleigh, town of	06/25/76	08/02/95	08/23/00	12/30/98
Jennings, City of	02/01/74	06/15/79	08/02/95	06/15/79
Kirkwood, City of	12/10/76	04/03/87	08/23/00	04/03/87
Ladue, City of	03/15/74	03/16/76	08/23/00	03/16/76
Lakeshire, City of	05/10/74	08/19/85	08/02/95	08/19/85
Mackenzie, Village of	10/05/73	09/29/78	08/02/95	09/29/78
Manchester, City of	12/14/73	10/15/80	08/02/95	10/15/80
Maplewood, City of		11/23/73	08/02/95	11/23/73
Marlborough, Village of	05/31/74		(NSFHA)	01/26/83

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COMMUNITY NAME	INIT FHBM	INIT FIRM	CURR EFF	EMERG DAT
Maryland Heights, City of		09/15/78	08/02/95	09/30/88
Moline Acres, City of	06/14/74	05/19/81	08/02/95	05/19/81
Normandy, City of	06/11/76		(NSFHA)	05/25/78
Northwoods, City of	04/05/74	12/02/80	08/02/95	12/02/80
Norwood Court, Village of	05/23/78	03/18/80	08/02/95	03/18/80
Oakland, City of	11/01/74	01/16/81	08/02/95	01/16/81
Olivette, City of	02/22/74	07/03/78	08/02/95	07/03/78
Overland, City of	01/23/74	10/15/80	08/02/95	10/15/80
Pagedale, City of	12/17/73	06/01/78	08/02/95	06/01/78
Pasadena Hills, City of	07/11/75		(NSFHA)	09/10/84
Pine Lawn, City of	04/05/74		(NSFHA)	01/03/85
Richmond Heights, City of	12/21/73	05/16/77	08/23/00	05/16/77
Riverview, Village of	06/28/74	04/17/79	08/02/95	04/17/79
Rock Hill, City of	09/14/73	05/16/77	08/02/95	05/16/77
Shrewsbury, City of	03/29/74	01/16/81	08/02/95	01/16/81
St. Ann, City of	02/01/74	07/16/79	08/02/95	07/16/79
St. John, City of	05/03/74	04/15/77	08/02/95	04/15/77
St. Louis County (Unincorporated)		09/15/78	08/23/00	09/15/78
Sunset Hills, City of	11/02/73	09/01/77	08/02/95	09/01/77
Sycamore Hills, Village of		08/02/95	(NSFHA)	04/30/82
Town and Country, City of	12/21/73	04/01/81	08/23/00	04/01/81
Twin Oaks		08/02/95	(NSFHA)	11/24/10
University City, City of	09/14/73	06/01/78	08/02/95	06/01/78
Valley Park, City of	12/17/73	06/15/82	08/23/00	06/15/82
Velda Village Hills, Village of	09/14/73	05/01/90	08/02/95	05/01/90
Velda City, City of	08/06/76		(NSFHA)	08/04/83
Vinita Park, City of	04/05/74		(NSFHA)	09/10/84
Warson Woods, City of	01/09/74		(NSFHA)	11/01/79
Webster Groves, City of	03/15/74	09/29/78	08/02/95	09/29/78
Wellston, City of	12/17/73	05/19/81	08/02/95	05/19/81
Westwood, Town of	05/28/76	08/02/95	08/23/00	05/26/98
Wildwood City of		08/02/95	08/02/95	02/28/97
Winchester, City of		09/30/76	08/02/95	09/30/76
Woodson Terrace, City of	04/05/75		(NSFHA)	06/20/76
Kinloch, City of	01/09/74	01/16/81	08/23/00	08/03/89(S)
The City of Green Park has adopted the St. Louis County (290327) FIRM panels 312 and 315.				
The Village of Peerless Park (290378) is defunct, and is now a part of St. Louis County.				
The City of Wildwood has adopted the St. Louis County [290327] FIRM.				
MUNICIPALITIES NOT PARTICIPATING				
290361 Kinloch – suspended 08/03/89				

St. Louis County addresses flood plain ordinance management issues through the following ordinance numbers 1003.101 and 1003.030. The MSD is a part of the floodplain development permit review process, as are the St. Louis County Highway Department and the St. Louis County Public Works Department. The Phase II Stormwater Management Plan, developed in collaboration with MSD, St. Louis County and 59+ municipalities the

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Phase II Stormwater Management Plan. The document includes a storm water plan to be used as a strategy to comply with the United States Environmental Protection Agency's ("USEPA") and MDNR's new regulations. St. Louis County stream water quality data reveals that the major storm water pollutants of concern in our area are trash, soil solids and animal wastes. MSD is dedicated to provide public education and outreach programs for Phase II Storm Water implementation.

A major issue, which affects many communities in the five county area, is damage from building in floodplains. Many homeowners in floodplains do not purchase flood insurance since they own their homes outright. Federal law requires flood insurance on houses with a federally backed mortgage. Homeowners underestimate flood risk since they consider the levee system as fail safe.

The City of St. Louis joined the National Flood Insurance program in 1979, with the NFIP Number 290483.

Table 2-46 City of St. Louis National Flood Insurance Program Participating Municipalities

COMMUNITY NAME	INIT FHBM	INIT FIRM	CURR EFF	EMERG DAT
St. Louis, City of	02/21/75	07/16/79	05/24/2011	1979

Detailed flood studies have been completed for St. Louis as of 1996. The Corps of Engineers had completed Community Rating System (CRS) studies in 1979. From 1993 through 1995, the city was involved in property acquisition programs funded by FEMA. Other community property protection measures included sandbagging along the River Des Peres during the 1993 flood. The Corps certified the city's existing flood control levees located at Laclede's Landing/Mississippi Riverfront. In addition, there is also a floodwall located at Riverview and Hall Street (north to the Gateway Arch Grounds) and south on the Mississippi River. Furthermore, there is a detention/retention reservoir located in the north part of city. A second location is also being designated. The last update of the floodplain management ordinance was February 13, 2002 with Ordinance # 65420. Currently, the ordinance allows for one foot additional freeboard required by new structures and for the elevation of existing structures. There is no requirement for a minimum elevation above grade required for structures outside the identified flood hazard area. The City of St. Louis uses FEMA's "No Rise and Elevation Certificates" as well as requiring Flood Plain Developments permits.

## **County Capability Assessment**

### **Mitigation Management Policies**

The Franklin County Emergency Management Agency is charged with preparing for disasters. That duty includes advising the County Commission on mitigation measures and implementing those measures deemed appropriate by the Commission. In general, the

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County's policies encourage cooperation and coordination within the Franklin County agencies; as well as cooperation, including mutual aid compacts, between neighboring counties and the municipalities within Franklin County. The Emergency Operations Plan (EOP) provides for an integrated countywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources.

The Jefferson County Office of Emergency Management is charged with preparing for disasters. That duty includes advising the County Council on mitigation measures and implementing those measures deemed appropriate by the Council. In general, the County's policies encourage cooperation and coordination within the Jefferson County agencies; as well as cooperation, including mutual aid compacts, between neighboring counties and the municipalities within Jefferson County. The Emergency Operations Plan (EOP) provides for an integrated countywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources.

The St. Charles County Division of Emergency Management is charged with preparing for disasters. That duty includes advising the County Executive and County Council on mitigation measures and implementing those measures deemed appropriate by the Council. In general, the County's policies encourage cooperation and coordination within the St. Charles County agencies; as well as cooperation, including mutual aid compacts, between neighboring counties and the municipalities within St. Charles County. The Emergency Operations Plan (EOP) provides for an integrated countywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources.

The St. Louis County Emergency Management Agency is charged with preparing for disasters. That duty includes advising the County Council on mitigation measures and implementing those measures deemed appropriate by the Council. In general, the County's policies encourage cooperation and coordination within the St. Louis County agencies; as well as cooperation, including mutual aid compacts, between neighboring counties and the municipalities within St. Louis County. The Emergency Operations Plan (EOP) provides for an integrated countywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources.

The City of St. Louis Emergency Management Agency is charged with preparing for disasters. That duty includes advising the Mayor and Board of Aldermen on mitigation measures and implementing those measures deemed appropriate by the Mayor and Board. In general, the city's policies encourage cooperation and coordination within the city's agencies, as well as cooperation, including mutual aid compacts, between neighboring counties and municipalities within the region. The Emergency Operations Plan (EOP) provides for an integrated citywide emergency preparedness and response plan, utilizing public, nonprofit, and private resources.

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The City of St. Louis is currently using Strategic Land Use Plan of the St. Louis Comprehensive Plan, adopted in January 2005. There have also been numerous localized plans. The city's current Emergency Operations Plan (EOP) provides for identifying facilities and resources that require special security during a disaster, promoting the development and maintenance of mutual aid agreements with nearby agencies, requiring participation in drills and exercises, and identifying human and capital resources available for disaster response. The EOP includes an evacuation plan and identifies hazard mitigation measures.

### **Mitigation Programs**

The main mitigation programs in Franklin County are floodplain management regulations and participation in and administration of the National Flood Insurance Program. The County coordinates with Missouri River levee districts through the U.S. Corps of Engineers. Additional programs include the following:

- The County's floodplain regulations are aimed at restricting any new development in the floodplain. The current ordinance requires two feet of additional freeboard for new structures and requires an increase, if necessary, to that elevation when structures are significantly reconstructed within the floodplain. Minimum elevation above grade for structures outside identified flood hazard areas is determined on a case- by- case basis.
- The County has participated in floodplain property acquisition, funded through FEMA's Hazard Mitigation Program.
- Stormwater management and sedimentation and erosion control standards reduce water hazards by implementing measures as set forth in Appendix I-1 through I-6 and Sections 261 through 264 of the Franklin County Unified Land Regulations.
- The county is able to receive NWS warnings and equipment is radio-activated. More than 70 percent of the county's population could be alerted within 30 minutes, and responders and key executive officials within 5 minutes.
- Elementary and secondary school students participate in an annual one-hour presentation on peacetime hazards and preparedness activities. Emergency management pamphlets are available to all county schools. Seasonal hazard awareness campaigns are conducted for extreme heat and cold weather hazards. Over the last five years, schools, community leaders and public sector employees have received limited emergency management training.
- The Emergency Management Agency's director and key personnel have completed full training in planning; operations; exercise design, development, and evaluation; and response and recovery. In areas of professional development and hazard mitigation, training has been substantial.
- Geographic Information System (GIS) capabilities have facilitated the development of limited hazard area base maps that are available to interested parties.

Missouri laws require school districts in a Modified Mercalli Zone VII or above at a magnitude 7.6 earthquake to provide for public view each year, an earthquake

## *St. Louis Regional Hazard Mitigation Plan*

preparedness and safety information, such as earthquake procedures and a disaster plan; and conduct earthquake drills twice each year. Missouri statutes RSMo 260.451, 160.453, 160.455, and 160.457 provide that “the governing body of each school district shall request assistance from the State Emergency Management Agency and any local emergency management agency located within its district boundaries to develop and establish the earthquake emergency procedure system.” While Franklin County is located in a Zone VI, it is contiguous to Zone VII areas along its eastern and northern borders.

The main mitigation programs in Jefferson County are floodplain management regulations and participation in and administration of the National Flood Insurance Program (NFIP). The county coordinates with Mississippi River levee districts through the U.S. Corps of Engineers. Additional programs include the following:

- The County’s floodplain regulations are aimed at restricting any new development in the floodplain. The current ordinance requires two feet of additional freeboard for new structures and requires an increase, if necessary, to that elevation when structures are significantly reconstructed within the floodplain. Minimum elevation is one foot above for structures in the identified regional floodplains.
- The county has participated in floodplain property acquisition, funded through FEMA’s Hazard Mitigation Program.
- Stormwater management and sedimentation and erosion control standards that comply with Phase II Federal Stormwater Regulations was implemented in 2004.
- Development is prohibited in identified floodways and wetlands.
- Development can occur on slopes steeper than 3 feet to one foot only after geotechnical analysis and receipt of an engineer’s recommendation.
- The county is able to receive NWS warnings; equipment is radio-activated. During waking hours, using all available communications, less than 50 percent of the county’s population could be alerted within 30 minutes; responders and key executive officials could be alerted within 5 minutes.
- The Emergency Management Agency’s director and key personnel have completed substantial training in all facets of emergency management. Emergency response personnel, EOC operations staff, and volunteer agencies have received training and education within the last five years.

Jefferson County is located in a Modified Mercalli Zone VII area. Missouri statutes require school districts in a Modified Mercalli Zone VII or above at a magnitude 7.6 earthquake to provide for public view each year, an earthquake preparedness and safety information, such as earthquake procedures and a disaster plan; and conduct earthquake drills twice each year. Missouri statutes RSMo 260.451, 160.453, 160.455, and 160.457 provide that “the governing body of each school district shall request assistance from the State Emergency Management Agency and any local emergency management agency located within its district boundaries to develop and establish the earthquake emergency procedure system.”

## *St. Louis Regional Hazard Mitigation Plan*

For St. Charles County, the main mitigation programs are the County's floodplain management regulations and participation in and administration of the National Flood Insurance Program. The County has a post-development redevelopment plan. The County coordinates with Missouri River and Mississippi levee districts through the U.S. Army Corps of Engineers. Additional programs:

- The County's floodplain regulations are aimed at restricting any new development in the floodplain. The current ordinance requires one foot of additional freeboard for new structures and requires structure to be elevated one foot above the 100-year floodplain when they are substantially (50 percent or more) improved or damaged. The County has participated in floodplain property acquisition, funded through FEMA's Hazard Mitigation Program.
- Stormwater management and sedimentation and erosion control standards reduce water hazards. The County has obtained a NPDES Phase II Federal Stormwater Regulations permit for unincorporated portion of the county.
- The County is able to receive National Weather Service warnings and equipment is radio-activated. St. Charles County maintains 72 outdoor warning sirens and indoor warning receivers in County facilities that allow public access.. Municipalities within the county maintain 64 outdoor warning sirens. There are all-channel cable override capabilities available through Charter Communications.
- Elementary and secondary school students receive instruction about hazards and emergency management programs concerning peacetime hazards, preparedness activities, and hazard mitigation. The Division of Emergency Management, through the Training and Exercise Officer, conducts public outreach programs concerning earthquakes, tornado and severe warm weather storms and severe winter storms. Over the last five years, schools and universities received substantial emergency management presentations; other public and private sectors received limited training.
- The Division of Emergency Management director and key personnel have completed substantial training in all segments of emergency management, with the exception of disaster mitigation, in which training was rated as limited.
- Geographic Information System (GIS) capabilities have facilitated the development of limited hazard area base maps that are available to interested parties.
- St. Charles County is in a Modified Mercalli Zone VII area. Missouri laws require school districts in a Modified Mercalli Zone VII or above at a magnitude 7.6 earthquake to provide for public view each year, an earthquake preparedness and safety information, such as earthquake procedures and a disaster plan; and conduct earthquake drills twice

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each year. Missouri statutes RSMo 260.451, 160.453, 160.455, and 160.457 provide that “the governing body of each school district shall request assistance from the State Emergency Management Agency and any local emergency management agency located within its district boundaries to develop and establish the earthquake emergency procedure system.”

In St. Louis County, the main mitigation programs are the county’s floodplain management regulations and participation in and administration of the National Flood Insurance Program. The county coordinates with Mississippi River and Missouri River levee districts through the U.S. Corps of Engineers. Additional programs include the following:

- The county’s floodplain regulations are aimed at restricting any new development in the floodplain.
- The county has participated in floodplain property acquisition, funded through FEMA’s Hazard Mitigation Program.
- Stormwater management and sedimentation and erosion control standards reduce water hazards. St. Louis Metropolitan Sewer District (MSD) coordinates compliance programs associated with storm water management program in the county. MSD and 60 co-permittees have been issued a Phase II storm water permit. Some municipalities have instituted their own standards in addition to those of MSD’s.
- The county is able to receive NWS warnings and warning equipment is radio-activated, with over 200 sirens located throughout the county. More than 85 percent of the county’s population could be alerted within 30 minutes, and responders and key executive officials within 15 minutes.
- Elementary and secondary school students receive instruction about hazards and emergency management programs as a unit in their curriculum concerning, peacetime hazards, preparedness activities, and hazard mitigation. Seasonal hazard awareness campaigns are conducted. During the last five years, private and public sectors have received limited to substantial emergency management training. The Office of Emergency Management offers extensive preparation and prevention information through internet links available on their web site.
- The Emergency Management Agency’s director and key personnel have completed substantial training in all facets of emergency management during the last five years.
- Geographic Information System (GIS) capabilities have facilitated the development of limited hazard area base maps that are available to interested parties.

St. Louis County is located in a Modified Mercalli Zone VII area. Missouri laws require school districts in a Modified Mercalli Zone VII or above at a magnitude 7.6 earthquake, to provide for public view each year, earthquake preparedness and safety information, such as earthquake procedures and a disaster plan; and conduct earthquake drills twice each year. Missouri statutes RSMo 260.451, 160.453, 160.455, and 160.457 provide that “the governing body of each school district shall request assistance from the State Emergency

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Management Agency and any local emergency management agency located within its district boundaries to develop and establish the earthquake emergency procedure system.”

In the City of St. Louis the main mitigation programs are the floodplain management regulations and participation in and administration of the National Flood Insurance Program. The city coordinates with Mississippi River and Missouri River levee districts through the U.S. Army Corps of Engineers.

Additional programs include the following:

- The city’s floodplain regulations are aimed at restricting any new development in the floodplain. The current ordinance requires one foot of additional freeboard for new structures and requires an increase, if necessary, to that elevation when structures are significantly reconstructed within the floodplain. The city has participated in floodplain property acquisition, funded through FEMA’s Hazard Mitigation Program.
- Stormwater management and sedimentation and erosion control standards to reduce water hazards by implementing measures as set forth by MSD and City regulations.
- The city is able to receive NWS warnings and equipment is radio-activated. Fifty to 69 percent of the county’s population could be alerted within 30 minutes, and key executive officials within fifteen minutes.
- Seasonal hazard awareness campaigns are conducted for extreme heat and cold weather hazards. Over the last five years, schools and universities, community leaders, business and labor organizations, service and nonprofit groups, and citizens at large have received at least limited emergency management education, and public sector employees have received substantial emergency management training.
- The Emergency Management Agency’s director and key personnel have completed full development: planning; operations; exercise design, development, and evaluation; response and recovery; and disaster mitigation.
- Geographic Information System (GIS) capabilities have facilitated the development of limited hazard area base maps that are available to interested parties.

The City of St. Louis is located in a Modified Mercalli Zone VII area. Missouri statutes require school districts in a Modified Mercalli Zone VII or above at a magnitude 7.6 earthquake to provide for public view each year an earthquake preparedness and safety information system, such as earthquake procedures and a disaster plan, and conduct earthquake drills twice each year. Missouri statutes RSMo 260.451, 160.453, 160.455, and 160.457 provide that “the governing body of each school district shall request assistance from the State Emergency Management Agency and any local emergency

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management agency located within its district boundaries to develop and establish the earthquake emergency procedure system.”

### **County Capabilities (Organization, Staffing, Training)**

The capabilities of emergency management, fire protection, law enforcement, and emergency medical services in Franklin County are detailed earlier in this Section. The EOC is located in the Franklin County Jail Complex on Highway V (#1 Bruns Lane) in Union. An alternate EOC is located at the Union Fire District Station #1, Old Highway 50 West, Union. A command post is also available on a mutual aid basis with the St. Charles County Emergency Management Agency.

The EOC has survivable communications for coordinating with, the Emergency Alert System, commercial and public broadcast stations, the State Emergency Management Agency, cities within the county, and neighboring jurisdictions. Communication and warning systems are tested on a regular basis. Warning sirens are located in all cities except Gerald. Each municipality tests the sirens monthly. A substantial amount of the county’s unincorporated area is not within hearing range of sirens.

Countywide, substantial emergency response equipment is available to respond to events. Within Franklin County, there are a total of nine fire protection districts or fire departments, six ambulance districts, and two ambulance services. In addition to the Franklin County Sheriff’s Department, there are seven municipal police departments. Substantial vehicle and heavy equipment is available through municipal and county public works departments. Several private sources of equipment, manpower, and materials have been identified and listed as “available on call” in the Franklin County EOP. A Civil Air Patrol squadron and a local chapter of the American Red Cross are based in Franklin County. Two hospitals are located in the county and most St. Louis metropolitan area medical facilities are located within a one-hour drive from any location in Franklin County. Franklin County has conducted at least one full-scale EOP exercise, which, tested and evaluated alert notification, coordination and control, and communications.

The capabilities of Jefferson County emergency management, fire protection, law enforcement, and emergency medical services are detailed earlier in this Section. The EOC is located in the Jefferson County Courthouse in Hillsboro. A primary alternate EOC is located at the 911 Center in Hillsboro. Many, if not all, of Jefferson County municipalities, have sirens that are radio-activated to provide NWS warnings. Beyond that, Jefferson County 911 Dispatch has a CodeRed Warning System. This is an automated system tied to the NWS that automatically calls everyone in the affected area if they have signed up with Code Red. In most cases, calls will be generated within 5 minutes of the emergency notification. In addition, Code Red can be used for other than NWS-originated emergencies. Communication and warning systems are tested on a regular basis. Five municipalities responding to the questionnaire have sirens, tested on a monthly basis.

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Countywide, substantial emergency response equipment is available to respond to events. Within Jefferson County, there are a total of nineteen fire protection districts or fire departments and seven ambulance districts. In addition to the Jefferson County Sheriff's Department, there are ten municipal police departments. Substantial vehicle and heavy equipment is available through municipal and county public works departments. American Red Cross has a service center in the county. One hospital is located in the county, and most St. Louis metropolitan area medical facilities are located within a one-hour drive from any location in Jefferson County. Jefferson County has conducted at least one full-scale EOP exercise within the last four years including testing and evaluating alert notification, coordination and control, and communications.

The capabilities of St. Charles County emergency management, fire protection, law enforcement, and emergency medical services are detailed earlier in this section. The Emergency Operations Center (EOC) is located at 301 N. 2<sup>nd</sup> Street, St. Charles. The facility is well equipped for sustained operations over an extended period of time. Alternate EOC sites include the cities of St. Charles, St. Peters, and O'Fallon. A command post is also available on a mutual aid basis with neighboring counties.

The EOC has survivable communications for operating forces, the Emergency Alert System, commercial and public broadcast stations, the State Emergency Management Agency, cities within the County, and neighboring jurisdictions. Communication and warning systems are tested on a regular basis. Countywide, substantial emergency response equipment is available to respond to events. Within the county, there are a total of twelve fire protection districts or fire departments. One ambulance district serves the county. In addition to the St. Charles County Police Department, there are nine municipal police departments. Substantial vehicle and heavy equipment is available through municipal and county public works departments. Also, several private sources of equipment, manpower, and materials have been identified. Four hospitals are located in the county and most St. Louis metropolitan area medical facilities are located within a one-hour drive from any location in St. Charles County.

The county has conducted at least one full-scale EOP exercise within the last four years; testing and evaluating alert notification, coordination and control, and communications.

The capabilities of St. Louis County emergency management, fire protection, law enforcement, and emergency medical services are detailed at earlier in this Section. The St. Louis County EOC is located in Chesterfield. The facility is equipped for sustained operations over an extended period of time. Alternate sites for the EOC have been identified. The EOC has survivable communications for operating forces, the Emergency Alert System, commercial and public broadcast stations, the State Emergency Management Agency, cities within the county, and neighboring jurisdictions. The County has a fully equipped Mobile Command Center. Communication and warning systems are tested on a regular basis.

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Countywide, substantial emergency response equipment is available to respond to events. Within the County, there are 19 Fire Protection Districts and 23 municipal Fire Departments, and 26 Emergency Medical and Ambulance Services. In addition to the St. Louis County Police Department, there are 62 municipal police departments. Substantial vehicle and heavy equipment is available through municipal and county public works departments. Several private sources of equipment, manpower, and materials have been identified. A local chapter of the American Red Cross serves St. Louis County. The County owns and operates The Spirit of St. Louis Airport, located in Chesterfield.

The county has conducted at least one full-scale EOP exercise within the last four years, testing and evaluating alert notification, coordination and control, and communications.

The capabilities of emergency management, fire protection, law enforcement, and emergency medical services in the City of St. Louis are detailed earlier in this Section. The St. Louis City Emergency Management Agency (CEMA) maintains an Emergency Operations Center (EOC), located at 1315 Chestnut Street. The facility is well equipped for sustained operations over an extended period of time. An alternate EOC is located at the St. Louis Fire Department Headquarters located at 1421 N. Jefferson Street. CEMA has a Mobile Command Van vehicle, and Police Department and Fire Department Mobile Command Posts can be utilized. The EOC has survivable communications for operating forces, the Emergency Alert System, commercial and public broadcast stations, the State Emergency Management Agency and neighboring governmental jurisdictions. Communication and warning systems are tested on a regular basis. Warning sirens are strategically located throughout the city.

Citywide, substantial emergency response equipment is available to respond to events. The Fire Department has 30 engine houses with fire suppression apparatus, rescue squads, and fire boats. The Bureau of Emergency Medical Services (EMS) operates 12 ambulances and there are private ambulance services that operate within the city. The City Police Department is organized into six Police Districts, operating out of three Patrol Area stations in addition to the main headquarters of the Department. The Sheriff's Office and Marshall's Office also have assets available for emergency response efforts. Substantial vehicle and heavy equipment is available through the Departments of Public Utilities; Streets; and Parks, Recreation, and Forestry. Private sources of equipment, manpower, and materials have been identified. The American Red Cross operates a service center and the Salvation Army has facilities in the city. The city has identified 13 hospitals located within the city and 15 located in St. Louis County. Additional St. Louis Metropolitan area medical facilities are located within a one-hour drive from any location in St. Louis.

## **Responsibilities and Authorities**

Franklin County government and their municipal governments have indicated the following:

- County has legal basis for authority to order an evacuation. Municipalities: Nine have legal basis; one does not; one does not know.
- County has legal basis for redirecting funds for emergency use. Municipalities: Six have legal basis; three do not; two do not know.
- County has legal basis for ordering a curfew. Municipalities: Nine have legal basis; one does not know.
- County has legal basis for commandeering facilities, equipment, and materials. Municipalities: Eight have legal basis; one does not; one does not know.
- County has legal basis to authorize lines of succession to carry out emergency activities. Municipalities: Eight have legal basis; two do not know.
- County has system to safeguard records to conduct emergency operations. Municipalities: Seven have system to safeguard; one does not; two do not know.
- County has system to safeguard vital records to reconstitute local government. Municipalities: Seven have system to safeguard; one does not; two do not know.
- County has developed an all-hazard vulnerability analysis to assess potential consequences of disasters. Municipalities: Four have done analysis; four have not; two do not know
- County has a multi-hazard emergency operations plan. Municipalities: Five have multi-hazard plan; four do not; one does not know.
- County has mutual aid compacts with other jurisdictions. Municipalities: Six have mutual aid compacts; three do not; one does not know.

Jefferson County government and their municipal governments have indicated the following:

- County has legal basis for authority to order an evacuation. Municipalities: Six have legal basis.
- County has legal basis for redirecting funds for emergency use. Municipalities: Five have legal basis; one answered not applicable.
- County has a legal basis for ordering a curfew . Municipalities: Five have legal basis
- County has legal basis to authorize lines of succession to carry out emergency activities Municipalities: Six have legal basis.
- County has a system to safeguard records to conduct emergency operations. Municipalities: Five have system to safeguard; one does not
- County has a legal basis for commandeering facilities, equipment, and materials. Municipalities: Five have legal basis; one does not.

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- County has a system to safeguard vital records to reconstitute local government  
Municipalities: Six have system to safeguard.
- County has developed an all-hazard vulnerability analysis to assess potential consequences of disasters.  
Municipalities: Five have done analysis; one has not.
- County has a multi-hazard emergency operations plan.  
Municipalities: Six have a multi-hazard plan.
- County has mutual aid compacts with other jurisdictions  
Municipalities: Six have mutual aid compacts.
- County EOP addresses the protection of people with special needs  
Municipalities: Four address the protection; two do not.

St. Charles County government and their municipal governments who responded to the 2003 questionnaire indicated the following:

- County does not have legal basis for authority to order an evacuation.  
Municipalities: Five have legal basis; two do not; four do not know.
- County has legal basis for redirecting funds for emergency use. Municipalities: Six have legal basis; two do not; four do not know.
- County has legal basis for ordering a curfew. Municipalities: Eight have legal basis; two do not; two do not know.
- County has legal basis for commandeering facilities, equipment, and materials.  
Municipalities: Six have legal basis; two do not; five do not know.
- County has legal basis to authorize lines of succession to carry out emergency activities. Municipalities: Ten have legal basis; two do not; one does not know.
- County has system to safeguard records to conduct emergency operations.  
Municipalities: Six have system to safeguard; five do not; one does not know.
- County has system to safeguard vital records to reconstitute local government.  
Municipalities: Nine have system to safeguard; one does not; one does not know.
- County has developed an all-hazard vulnerability analysis to assess potential consequences of disasters. Municipalities: Six have done analysis; six have not.
- County has a multi-hazard emergency operations plan. Municipalities: Four have multi-hazard plan; seven do not; one does not know/not applicable.
- County has mutual aid compacts with other jurisdictions. Municipalities: Nine have mutual aid compacts; four do not.
- County EOP addresses the protection of people with special needs. Municipalities: One addresses the protection; four do not; three do not know/not applicable.

St. Louis County government and their municipal governments who responded to the 2003 questionnaire indicate the following:

- County has legal basis for authority to order an evacuation  
Municipalities: Thirty have legal basis; nine do not know.

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- County has legal basis for redirecting funds for emergency use.  
Municipalities: Thirty have legal basis; seventeen do not; nine do not know.
- County has legal basis for ordering a curfew.  
Municipalities: Thirty have legal basis; eleven do not know.
- County has legal basis for commandeering facilities, equipment, and materials.  
Municipalities: Thirty-two have legal basis; thirteen do not; ten do not know; one responded not applicable.
- County has legal basis to authorize lines of succession to carry out emergency activities.  
Municipalities: Forty-seven have legal basis; eleven do not; three do not know.
- County has system to safeguard records to conduct emergency operations.  
Municipalities: Forty-three have system to safeguard; seven do not; six do not know; three responded not applicable.
- County has system to safeguard vital records to reconstitute local government.  
Municipalities: Forty-seven have system to safeguard; five do not; six do not know; one responded not applicable.
- County has developed an all-hazard vulnerability analysis to assess potential consequences of disasters.  
Municipalities: Twenty-six have done analysis; thirty have not; three do not know.
- County has a multi-hazard emergency operations plan.  
Municipalities: Thirty-six have multi-hazard plan; twenty-two do not; one does not know
- County has mutual aid compacts with other jurisdictions  
Municipalities: Forty-eight have mutual aid compacts; eleven do not; one does not know
- County EOP addresses the protection of people with special needs  
Municipalities: Thirty-two address the protection; twenty-one do not; six do not know.

City of St. Louis questionnaire indicate that the city has:

- The legal basis for authority to order an evacuation.
- The legal basis for redirecting funds for emergency use.
- The legal basis for ordering a curfew.
- The legal basis for commandeering facilities, equipment, and materials.
- The legal basis to authorize lines of succession to carry out emergency activities.
- A system to safeguard records to conduct emergency operations.
- A system to safeguard vital records to reconstitute local government.
- Developed an all-hazard vulnerability analysis to assess potential consequences of disasters.
- A multi-hazard emergency operations plan.
- Mutual aid compacts with other jurisdictions.
- An EOP that addresses the protection of people with special needs.

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### **Intergovernmental and Interagency Coordination**

The Franklin County Emergency Management Agency, the Jefferson County Office of Emergency Management, St. Charles County Division of Emergency Management, St. Louis County Office of Emergency Management and the City of St. Louis Emergency Management Agency interact with municipalities and single purpose governments on a regular basis to maintain communication and coordination of policies related to emergency management.

### **Vulnerability Assessment of County Policies and Development Trends**

#### **Commitments to a Comprehensive Mitigation Program**

Franklin County, Jefferson County, St. Charles County, St. Louis County and the City of St. Louis each have a well-established Emergency Management organization. These agencies regularly update their EOP, addressing mitigation measures for hazards, both natural and man-made, incorporating any changes to the plan necessitated by changes in transportation infrastructure and land use.

#### **Laws, Regulations and Policies Related to Development in Hazard-prone Areas**

The floodplain management ordinances of Franklin County, Jefferson County, St. Charles County, St. Louis County and their respective municipalities and the City of St. Louis are based on policies to protect health and welfare of people and minimize damage to public infrastructure and physical structures. They also restrict avoidable increases in flood height or velocity and protect individuals from buying land unsuited for the intended use due to a flood hazard.

#### **County Laws, Regulations and Policies Related to Hazard Mitigation in General**

Zoning and floodplain ordinances in Franklin, Jefferson, St. Charles, and St. Louis Counties and the City of St. Louis, coupled with the enforcement of building codes and the approval process for subdivisions and new or reconstructive development in assures that hazards are addressed in the proposal and planning stages of the development process.

Stormwater regulations of Franklin County and St. Charles County and most municipalities are designed to minimize the harmful physical and economic effects of erosion, sedimentation, and flooding from stormwater runoff. This is accomplished through the requirement of measures to mitigate erosion, both during and after construction; the detention and controlled discharge of the differential runoff from the development; couple with a well-designed stormwater conveyance system.

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Stormwater regulations that Jefferson County adopted in 2010 as part of the Unified Development Order along with regulations of seven responding municipalities are designed to minimize the harmful physical and economic effects of erosion, sedimentation, and flooding from stormwater runoff. This is accomplished through measures to mitigate erosion, both during and after construction; the detention and controlled discharge of the differential runoff from the development; coupled with a well-designed stormwater conveyance system.

Stormwater regulations of St. Louis County, Metropolitan St. Louis Sewer District (MSD), and several municipalities are designed to minimize the harmful physical and economic effects of erosion, sedimentation, and flooding as a result of water runoff. This is accomplished through the requirement of measures to mitigate erosion, both during and after construction; the detention and controlled discharge of the differential runoff from the development using structural and/or non-structural approaches; and a well-designed stormwater conveyance system.

Missouri statute RSMo 319.203 requires that cities and counties in the Level VII earthquake zone pass “an ordinance of order” regarding earthquake preparedness and building requirements demonstrating compliance with 319.207 for certain types of structures. This statute applies to Jefferson County and St. Louis County. The City of St. Louis is located in a Level VII zone.

City of St. Louis stormwater regulations (primarily through MSD regulations) are designed to minimize the harmful physical and economic effects of erosion, sedimentation, and flooding from stormwater runoff. This is accomplished through the requirement of measures to mitigate erosion, both during and after construction; and the detention and controlled discharge of the differential runoff from the development.

### **How Local Risk Assessments are Incorporated and Prioritized into Local Planning**

Of the hazard risks Franklin County and Jefferson County, St. Charles County, St. Louis County and the City of St. Louis have exposure to, riverine and flash flooding hazard risks are foremost in frequency and potential magnitude in loss of people and property. Enforcement of zoning, floodplain, stormwater ordinances, and placement of public infrastructure provide the most effective tools to minimize known risks.

The counties, City of St. Louis and municipalities recognize the danger and economic impact of severe winter storms. Clearing of snow and ice from roadways is a main priority during these events. The Missouri Department of Transportation has responsibility for the interstate and state designated highways within the county. County Highway Departments and municipalities clear their respective roadways, prioritizing known hazardous stretches of roadways, school bus stops, and intersections in efforts to reduce accidents and maintain the movement of people and goods. The City of St. Louis Street Department

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clears roadways, prioritizing known hazardous stretches of roadways, bus stops, and intersections in efforts to reduce accidents and maintain the movement of people and goods.

### **Current Criteria used to Prioritize Mitigation Funding in Counties and City of St. Louis**

Mitigation funding is based upon the combination of expected damage, the assumed frequency of damage, and the likelihood of death or injury to people.

### **Integration of Hazard Mitigation with the City/County Department's Plans**

A city or county EOP and its floodplain, zoning, subdivision, and building code ordinances developed and enforced in an integrated fashion insure that avoidable disasters are prevented, and the vulnerability of people and property to the effects of disasters is reduced.

### **How the Counties and the City of St. Louis Determines Cost-Effectiveness of Mitigation Programs**

Cost-effectiveness is considered on a case-by-case basis; dependent upon the scope of damages, estimated savings in future hazard events, the type of mitigation project, and the probable hazard to human life in future events. A FEMA cost/benefit analysis criterion is required for FEMA funded projects.

### **Mitigation Funding Options, Including Current and Potential Sources of Federal, State, Local, Private Funds**

Franklin County and Jefferson County, St. Charles County and St. Louis County and their respective municipalities and the City of St. Louis have utilized federal or state funds when disaster declarations have been made in the case of heavy widespread damages. Sources have included FEMA, SEMA, the Missouri Department of Natural Resources and Department of Economic Development. In addition to local government general revenue funds, the county and most of the municipalities have either a dedicated transportation and/or capital improvements sales/use tax that can be used to fund mitigation projects. These projects are generally reactive or reconstructive in nature. In some cases, private property owners cost share in these projects. Private funds are expended when necessary mitigation measures are incorporated into a development plan.

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### **How Governments Meet Requirements for Hazard Mitigation Funding Programs**

Governmental jurisdictions meet the requirements for hazard mitigation funding programs if the project conforms to Missouri's Hazard Mitigation Plan, provides a beneficial impact on the disaster area, meeting environmental requirements, solves the problem independently, and is cost-effective. Adoption of the Resolution of Intent to Participate in All-Hazard Mitigation will insure that a county or municipality is eligible for hazard mitigation funding programs.

### **Recommendations for Improvement**

Recommended improvements for Franklin County include working with the Municipal League to build a strong local COAD (Community Organizations Active in Disaster, see page 45) that can support pre-disaster planning and post-disaster response. The county could develop a reliable warning system for dam failures for those living downstream from dams, encourage relocation of communities whose government facilities and emergency services are located within the floodplain area, and evaluate need for structural protection of water treatment facility along local rivers. Additional recommended improvements consist of ensuring compliance with building codes; ensuring schools are safe with respect to flood, wind and earthquake hazards.

Recommended enhancements for Jefferson County include working with the County Municipal League to strengthen the local COAD organization of local government and non-profit organizations to improve and expand coordination between communities and volunteer groups. Additional recommendations include encouraging residents to register for the new CodeRED Service to provide rapid warning for weather related emergencies, educating for public safety, and prioritizing assistance to smaller communities for training.

Recommended improvements for St. Charles County include the continued expansion of participation in the COAD, where the county is leading the way regionally in planning and advance preparation for disaster response; ensuring that current building codes are adopted and enforced; evaluating school safety and sport parks for high wind and other hazards; and taking FEMA training for safe schools. Additional recommended improvements include encouragement of public education for all hazards to include preparedness/safety kits, American Red Cross training, shelter locations, development of community partnerships with businesses to assist during disasters to assist those special needs populations with basic survival requirements, encouragement of community mitigation plans to include collaboration with Department of Community Health for heat wave hazard with special needs populations (back up emergency services, fan distribution and cooling centers), encouragement of correct design, construction, and maintenance of private dams by County and communities, consider County cooperating with legislature to obtain legislative fix to dam failure problem. Other recommended improvements consist of encouragement of safe burn practices by developers in County, encouragement of

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underground utility lines burial and removal of trees around power lines, encouragement of retrofits for buildings, and collaboration with MoDOT on prioritization of overpasses and routes for earthquake hazard, development of mitigation plan to include historic home preservation, and education on procedures for automatic shutoff valves for water/oil/gas storage tanks.

Recommended improvements for St. Louis County include the continued expansion of the COAD to include all municipalities and local organizations. The County can also continue to coordinate with the state and municipalities to elevate bridges, and clean/dredge creek beds; and with MSD to prioritize problem stormwater areas. The County can also encourage active multijurisdictional cooperation in mitigation flood buyouts; and evaluation of utilizing city and county revenues to fund stormwater management projects. Further recommended improvements include development of code enforcement training for building officials, encouragement of communities to use FEMA training program for school building structural safety evaluation, encouragement of training for PTO, DARE, School resource officers, and Citizens Emergency Response Team (CERT) training.

The City of St. Louis made recommendations pertaining to earthquake hazards including the retrofit for nursing homes, upgrade existing lifeline facilities to meet minimum seismic building codes, have escape routes upgrade one bridge that provides access out of the city, and creation of backup infrastructure for pump stations. The city has several departments represented at the Hazard Mitigation workshops and has demonstrated an interest in improving communications among the various departments to enhance disaster response.

The Missouri Seismic Safety Commission (under Missouri statutes RSMo 44.227, 44.229, 44.231, 44.233, 44.235, and 44.277) has developed a Strategic Plan for earthquake safety in Missouri. This plan contains recommendations for earthquake mitigation. Use of the Strategic Plan by Franklin County and Jefferson County, St. Charles County, St. Louis County and the City of St. Louis would facilitate mitigation planning.

Missouri has an organization called Structural Assessment and Visual Evaluation (SAVE) coalition. The Coalition's objective is to assist the Missouri State Emergency Management Agency (SEMA) in the execution of its responsibilities with respect to the use of qualified volunteers in the emergency assessment of buildings following catastrophic events. S.A.V.E. volunteers consist of architects, professional engineers, and other qualified professionals that assist SEMA in assessing buildings and vertical structures following catastrophic events. The S.A.V.E. Coalition also includes the American Institute of Architects/Missouri (AIA/MO), the American Society of Civil Engineers (ASCE), the Consulting Engineers Council of MO (CECMO), and the Missouri Society of Professional Engineers (MSPE).

The capability assessments for Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis are summarized below at the end of this section.

CAPABILITY ASSESSMENT WORKSHEETS

Franklin County\*

Policies and Programs (ex. Zoning Ordinance)	Document Reference (ex. Comprehensive Plan & page number)	Effective-ness for Mitigation (ex. low, medium, high)**	Rationale for Effectiveness (ex. low because allows development in floodplain)
Floodplain management	County Floodplain Management Ordinance	High	New construction and improvements are not allowed without extensive mitigation requirements. Any encroachments such as fill, new construction, or other developments within in the floodway must not create any increase in flood levels within the community during a base flood discharge. Requires 2 feet freeboard.
Multi-hazard emergency plan	County Emergency Operations Plan	Medium	Consider more formal mutual aid agreements, improve the Emergency Operations Center, warning systems in rural areas, emergency response equipment, training for volunteer agencies and the private sector, and public preparedness education.
Stormwater regulations	County Stormwater and Subdivision Regulations	Medium	Stormwater runoff, sediment and erosion management provides effective measures to deal with increasing development trends.
Building regulations	County IBC 2009	Medium	County has building inspectors that ensure construction is built to code.
Flood insurance	Joined NFIP 10/16/84 #290443	High	The county administers and participates fully in the NFIP.
Missouri River Levee issues	Levee districts	Medium	Coordination with county jurisdictions through US Corps of Engineers.

\*No changes were made from previous plan update except for updating year of most recent building code.

\*\* High – Policy and Program in place and in use

Medium – Policy and Program in place but needs refinement, increased involvement

Low – Policy and Program in place but elements work against mitigation

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**Jefferson County\***

Policies and Programs (ex. Zoning Ordinance)	Document Reference (ex. Comprehensive Plan & page number)	Effective-ness for Mitigation (ex. low, medium, high)**	Rationale for Effectiveness (ex. low because allows development in floodplain)
Floodplain management	County Floodplain Management Ordinance	High	New construction and improvements are not allowed without extensive mitigation requirements. Any encroachments such as fill, new construction, or other developments within in the floodway must not create any increase in flood levels within the community during a base flood discharge. Requires 2 feet freeboard.
Multi-hazard emergency plan	County Emergency Operations Plan	Medium	Consider more formal mutual aid agreements, improve the Emergency Operations Center, warning systems in rural areas, emergency response equipment, training for volunteer agencies and the private sector, and public preparedness education.
Stormwater regulations	County Stormwater and Subdivision Regulations	Medium	Stormwater runoff, sediment and erosion management provides effective measures to deal with increasing development trends.
Building regulations	County IBC 2009	Medium	The county has building inspectors that ensure construction is built to code.
Flood insurance	Joined NFIP 5/16/83 #290808	High	The county administers and participates fully in the NFIP.
Mississippi River Levee issues	Levee districts	Medium	Coordination with county jurisdictions through US Corps of Engineers.

\*No changes were made from previous plan update except for updating year of most recent building code.

\*\* High – Policy and Program in place and in use

Medium – Policy and Program in place but needs refinement, increased involvement

Low – Policy and Program in place but elements work against mitigation

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**ST. CHARLES COUNTY\***

Policies and Programs (ex. Zoning Ordinance)	Document Reference (ex. Comprehensive Plan & page number)	Effective-ness for Mitigation (ex. low, medium, high)**	Rationale for Effectiveness (ex. low because allows development in floodplain)
Floodplain management	County Floodplain Management Ordinance	High	New construction and improvements are not allowed without extensive mitigation requirements. Any encroachments such as fill, new construction, or other developments within in the floodway must not create any increase in flood levels within the community during a base flood discharge. Requires 2 feet freeboard. Must be 1 ft above 100 of flood level.
Multi-hazard emergency plan	County Emergency Operations Plan	Medium	Consider more formal mutual aid agreements, improve the Emergency Operations Center, warning systems in rural areas, emergency response equipment, training for volunteer agencies and the private sector, and public preparedness education.
Stormwater regulations	County Stormwater/ Erosion and Subdivision Regulations Stream Maintenance Ord.	Medium	Stormwater runoff, sediment and erosion management provides effective measures to deal with increasing development trends.
Building regulations	County IBC 2009	Medium	County has building inspectors that ensure construction is built to code.
Flood insurance	Joined NFIP 9/15/78 #290315	High	The county administers and participates fully in the NFIP.
Missouri and Mississippi Rivers levee issues	Levee districts	Medium	Coordination with county jurisdictions through US Corps of Engineers.

\*No changes were made from previous plan update except for updating year of most recent building code.

\*\* High – Policy and Program in place and in use

Medium – Policy and Program in place but needs refinement, increased involvement

Low – Policy and Program in place but elements work against mitigation

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**ST. LOUIS COUNTY\***

Policies and Programs (ex. Zoning Ordinance)	Document Reference (ex. Comprehensive Plan & page number)	Effective-ness for Mitigation (ex. low, medium, high)**	Rationale for Effectiveness (ex. low because allows development in floodplain)
Floodplain management	County Floodplain Management Ordinance	High	New construction and improvements are not allowed without extensive mitigation requirements. Any encroachments such as fill, new construction, or other developments within in the floodway must not create any increase in flood levels within the community during a base flood discharge. Requires 2 feet freeboard.
Multi-hazard emergency plan	County Emergency Operations Plan	Medium	Consider more formal mutual aid agreements, improve the Emergency Operations Center, warning systems in rural areas, emergency response equipment, training for volunteer agencies and the private sector, and public preparedness education.
Stormwater regulations	County Stormwater and Subdivision Regulations  Phase II Stormwater Management Plan (MSD, 59 local governments)	Medium	Stormwater runoff, sediment and erosion management provides effective measures to deal with increasing development trends.
Building regulations	County IBC 2009	Medium	County has building inspectors that ensure construction is built to code
Flood insurance	Joined NFIP 9/15/78 #290327	High	The county administers and participates fully in the NFIP.
Missouri River levee issues	Levee districts	Medium	Coordination with county jurisdictions through US Corps of Engineers.

\*No changes were made from previous plan update except for updating year of most recent building code.

\*\* High – Policy and Program in place and in use

Medium – Policy and Program in place but needs refinement, increased involvement

Low – Policy and Program in place but elements work against mitigation

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**CITY OF ST. LOUIS\***

Policies and Programs (ex. Zoning Ordinance)	Document Reference (ex. Comprehensive Plan & page number)	Effective-ness for Mitigation (ex. low, medium, high)**	Rationale for Effectiveness (ex. low because allows development in floodplain)
Floodplain management	City Floodplain Management Ordinance	High	New construction and improvements are not allowed without extensive mitigation requirements. Any encroachments such as fill, new construction, or other developments within in the floodway must not create any increase in flood levels within the community during a base flood discharge.
Multi-hazard emergency plan	City Emergency Operations Plan	Medium	Consider more formal mutual aid agreements, improve the Emergency Operations Center, warning systems in rural areas, emergency response equipment, training for volunteer agencies and the private sector, and public preparedness education.
Stormwater regulations	City Stormwater and Subdivision Regulations Phase II Stormwater Management Plan (MSD, 59 local governments)	Medium	Stormwater runoff, sediment and erosion management provides effective measures to deal with increasing development trends.
Building regulations	IBC 2009	Medium	City has building inspectors that ensure construction is built to code.
Flood insurance	Joined NFIP 7/16/79 #290385	High	The city administers and participates fully in the NFIP.
Mississippi Missouri River levee issues	Levee districts	Medium	Coordination with county jurisdictions through the Corps of Engineers.

\*No changes were made from previous plan update except for updating year of most recent building code.

\*\* High – Policy and Program in place and in use

Medium – Policy and Program in place but needs refinement, increased involvement

Low – Policy and Program in place but elements work against mitigation

## **L. Media Relations**

There are 42 AM/FM radio stations and seven television stations located in the five county area. In addition, 17 local and regional newspapers are published for this area. Information on these media outlets are presented in Appendix F. Emergency management agencies have access to and utilize media wherever possible to inform and educate residents about potential risk, disaster preparedness and strategies for hazard risk reduction. Special public awareness Campaigns such as the All Ready Campaign are designed to be delivered in cooperation with local media.

St. Louis Regional Hazard Mitigation Plan

Update for 2015-20

Prepared for Franklin, Jefferson, St. Charles, St. Louis Counties

and the City of St. Louis

Prepared By

East-West Gateway Council of Governments

**Chapter 3, A**, of 4 chapters

**HAZARDS AND RISK ASSESSMENT**

Approved July 13, 2015

314-421-4220

One S. Memorial Drive, Suite 1600

St. Louis, MO 63102

## Chapter 3

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**A. HAZARDS AND RISK ASSESSMENT**

- B1 A description of the type, location, and extent of all natural hazards that can affect each jurisdiction in the St. Louis, Missouri Metropolitan Region, Req 201.6(c)(2)(i)
- B2 Previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? Req 201.6(c)(2)(i)

Risk Assessment Terminology

Natural Hazard – source of harm or difficulty created by a meteorological, environmental or geological event
Community Assets – the people, structures, facilities and systems that have value to a community
Risk – the potential for damage, loss or other impacts created by the interaction of natural hazards with community assets
Risk Assessment – product or process that collects information and assigns values to risks for the purpose of informing priorities, developing or comparing course of action and informing decision making

Source - FEMA, Local Mitigation Plan Review Guide, October 2011

**Hazard Identification and Elimination Process**

The five counties in eastern Missouri share common geographic, climatic and related risk factors that make them susceptible to certain hazards. In this section EWG has addressed the natural hazards that all counties and communities share in common. For a more detailed (albeit redundant), county by county description of hazards, one can consult the previous plan, adopted in March 2010, which is available on the EWG website.<sup>1</sup> Many sources<sup>2</sup> were researched for data relating to hazards. Eight major natural hazards are the focus of this mitigation study. (See Table 3-1) In Section 3A, these eight hazards are briefly discussed and the hazard experiences for the previous ten years, 2005-2014 are described by county. (For more background on each county and the hazard experience before 2010, please refer to the March 2010 plan cited in footnote 1.)

In order to identify the natural hazards relevant to the five county area, the above information sources were searched for incidents of all possible hazards occurring within this area. Some hazards are regional in scope and some are localized. Both were included

<sup>1</sup> [http://www.ewgateway.org/ProgProj/Emergency\\_Response/HazMit/hazmit.htm](http://www.ewgateway.org/ProgProj/Emergency_Response/HazMit/hazmit.htm)

<sup>2</sup> Primary sources included FEMA, SEMA, National Climate Data Center (NCDC) and the National Oceanic and Atmospheric Administration (NOAA). The U.S. Geological Survey (USGS) and Center for Earthquake Research and Information (CERI), CUSEC were major sources for earthquake information. Missouri MDNR’s Dam and Reservoir Safety Program provided major information concerning dams. Findings from research were based on the following sources: USACE, National Park Service, National Forest Service, Missouri Department of Resources, St. Louis University, State of Missouri Climatologist, Missouri Department of Conservation, University of Missouri, Columbia, Federal Emergency Management Agency, and State Emergency Management Agency

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in the hazard profiles. Hazard event histories and repetitive loss information were used to identify relevant hazards.

Table 3-1 Natural Hazards

2015 Plan Update	2010 Plan Update
Tornado	Tornado/Windstorm
Thunderstorm/Hail/Lightning	Flood (including Levee)
Flood (including Levee)	Winter
Winter	Drought
Drought	Heat
Heat	Earthquake/Landslide
Earthquake	Dam
Dam	Fire
Fire	

For this Plan Update, landslide was removed due to the limited spatial extent of this hazard and minimal damage recorded. (No events were recorded for previous five and ten year periods.)

Each of these natural disasters can precipitate cascading hazards or those hazards caused as a result of natural disasters. Cascading hazards could include interruption of power supply, water supply, business and transportation. Disasters also can cause civil unrest, electrical grid failure, interruption of transportation services and environmental health hazards. Any of these alone or in combination could possibly impact emergency response activities.

Based on lack of documented historical occurrence and research, the following natural hazards were not be evaluated for the purposes of this Hazard Mitigation Plan: coastal storms, hurricanes, tsunamis, avalanche and volcanic activity. These hazards do not exist within the five county area due to their geographic location and geologic conditions.

### Limitations for National Climatic Database Data

It should be pointed out that the Storm Events Database of the National Climatic Data Center is an official publication of the National Oceanic and Atmospheric Administration (NOAA). The Database which documents the occurrence of storms and other significant weather phenomena which have 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 Storm Data 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 Storm Data should be cautious as the NWS does not guarantee the accuracy or validity of the information.

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For damage amounts, the NWS makes a best guess using all available data at the time of publication. The damage amounts are received from a variety of sources, including those listed above in the data sources section. Property and crop damage should be considered as a broad estimate. When listing property and crop damage, the figures indicated are the best guess made by the NWS from the available sources of information at the time of the printing.

At this time, the only lightning data contained within the Storm Data are lightning events that result in fatality, injury and/or property and crop damage. These events are reported to the NWS for inclusion in the Storm Events Database.

Tornadoes may contain multiple segments. A tornado that crosses a county line or state line is considered a separate segment. Also, a tornado that lifts off the ground for less than five minutes or 2.5 miles is considered a separate segment. If the tornado lifts off the ground for greater than five minutes or 2.5 miles, it is considered a separate tornado. Tornadoes reported in Storm Data and the Storm Events Database are in segments.

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 October 2014, as entered by NOAA's NWS. Due to changes in the data collection and processing procedures over time, there are unique 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.

Tornado – From 1950 through 1954, only tornado events reported.

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.

All Event Types (48 from Directive 10-1605) – From 1996 to present, 48 event types have been extracted from the Unformatted Text Files

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

### **Disaster Declarations**

Table 3-2 summarizes the Presidential Disaster Declarations issued since 2010 which included part of the five county area. The declaration in 2011 is for the Good Friday tornado which injured five and caused an estimated \$30 million property damage in seven

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municipalities in north St. Louis County and at Lambert St. Louis International Airport. The 2013 declaration covers damages from Mississippi River flooding in St. Charles and St. Louis Counties.

Table 3-2 Disaster Declarations for Five County Area 2010-2014

Declaration Number	Date (Incident Date)	Disaster Description	Counties Involved*
DR-1980	May 9, 2011 (April 19 – June 6)	Severe Storms, Tornadoes and Flooding	St. Louis
DR-4130	July 18, 2013 (May 29 – June 10)	Severe Storms, Straight-line Winds, Tornadoes and Flooding	St. Charles St. Louis

\* Disaster declaration covered additional Missouri counties

Source – FEMA

### Risk Assessment and Vulnerability

The remainder of this chapter contains in depth analyses of the eight natural hazards which may potentially affect the five county area. For each hazard, there is information on the probable location of the hazard or areas anticipated to be affected by them, its event history from 2005 to 2014, probability of hazard occurrence, severity of the hazard and vulnerability of five county area to a particular hazard. To assemble this information, multiple data sources were researched.

The Appendix – Map Sets – Critical and Essential Facilities contains a series of regional and individual county maps highlighting locations and those critical and essential facilities, including school buildings, projected to be impacted by the natural hazards examined in this document. (Additional information can be found in the 2010 Plan Update.)

To determine overall risk, the probability of a hazard event taking place and the severity of the consequences of such an event were considered. Historic records for 2005- October 2014 were reviewed to establish probability. Only the total number of years in which hazard events occurred, not the number of hazard events, were used to estimate probability. Probability was classified as low, medium or high.

Low- Hazard has little or no chance of happening (less than one percent chance of occurrence in any given year).

Medium – Hazard has a reasonable probability of occurring (between one and ten percent chance of occurrence in any given year).

High – The probability is considered sufficiently high to assume that the event will occur (between 10 and 100 percent chance of occurrence in any given year).

Severity was defined as the deaths, injuries or damage which could result from a hazard. Severity was also classified as low, medium or high.

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Low – Few or minor damages or injuries are likely.

Medium – Injuries to personnel and damage to property and the environment is expected.

High – Deaths and major injuries and damages will likely occur.

The potential percentage of the land area of a county which could be affected by a hazard is classified on a scale of one to four and is defined as:

Less than ten percent (1)

10 to 25 percent (2)

25 to 50 percent (3)

More than 50 percent (4)

Overall risk was determined by averaging probability with severity. For probability and severity, low was assigned a value of one, medium assigned a value of two and high a value of three. For example, for a hazard with a high probability (3) and a high severity (3) the formula would be  $[(3 + 3)/2 = 3 \text{ or high}]$ . All fractions were rounded up to the next whole number.

The following tables contain a summary analysis of each of the natural hazards which could affect Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis and the municipalities within them. Some hazards, such as flooding and dam failure may occur in more specific locations.

Table 3-3 Franklin County Hazard Summary 2005 –October 31, 2014

Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
<b>Tornado*</b>	1	Rank - High Damage – 40K Deaths - 0 Injuries - 0	Rank - High Total Events - 7 Years with 1+ events - 3 Probability – 30%	High
<b>Severe Thunderstorm Wind* (wind speed ≥ 67 mph)</b>	1	Rank - Medium Damage – 0 Deaths - 0 Injuries - 2	Rank - High Total Events - 6 Years with 1+ events - 4 Probability – 40%	High
<b>Hail*</b>	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 106 Years with 1+ events - 10 Probability – 100%	Medium
<b>Lightning*</b>	1	Rank - Low Damage – K Deaths - 0 Injuries - 0	Rank - Medium Total Events - 1 Years with 1+ events - 1 Probability – 10%	Medium
<b>Flood* (Riverine Flash)</b>	3	Rank - Medium Damage – 5K Deaths - 0 Injuries - 0	Rank - High Total Events - 16 Years with 1+ events - 8 Probability – 80%	High
<b>Severe Winter Weather*</b>	4	Rank - High Damage – 200K	Rank - High Total Events - 20	High

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Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
(winter storm, winter weather, heavy snow, cold/wind chill)		Deaths - 0 Injuries - 0	Years with 1+ events - 9 Probability – 90%	
Drought*	4	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 5 Years with 1+ events - 2 Probability – 20%	Medium
Heat* (Heat. Excessive Heat)	4	Rank - Medium Damage – 0 Deaths - 0 Injuries - 5	Rank - High Total Events - 29 Years with 1+ events - 8 Probability – 80%	High
Earthquake** 1 event – 2.3 magnitude	3	Rank - High Estimated	Rank - High 25 – 45% chance magnitude 6.0 earthquake may occur through 2053 Total Events – 1 Years with 1+ events - 1 Probability – 10%	High
Dam Failure*** No events on record	2	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low
Wildland Fire**** No events on record	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low

\* Storms Event Database, National Climatic Data Center

\*\* USGS

\*\*\* Missouri Department of Natural Resources

\*\*\*\* Missouri Department of Conservation

Table 3-4 Jefferson County Hazard Summary 2005 –October 31, 2014

Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
Tornado*	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 10 Years with 1+ events - 4 Probability – 40%	Medium
Severe Thunderstorm Wind* (wind speed ≥ 67 mph)	1	Rank - Medium Damage – 0 Deaths - 0 Injuries - 14	Rank - High Total Events - 26 Years with 1+ events - 6 Probability – 60%	High
Hail*	1	Rank - High Damage – 34K Deaths - 0 Injuries - 0	Rank - High Total Events - 115 Years with 1+ events - 10 Probability – 100%	High
Lightning*	1	Rank - Medium Damage – 2K	Rank - High Total Events - 3	High

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Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
		Deaths - 0 Injuries - 0	Years with 1+ events - 2 Probability – 20%	
Flood* (Riverine Flash)	3	Rank – High Damage – 0 Deaths - 1 Injuries - 0	Rank - High Total Events - 11 Years with 1+ events - 7 Probability – 70%	High
Severe Winter Weather* (winter storm, winter weather, heavy snow, cold/wind chill)	4	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 18 Years with 1+ events - 9 Probability – 90%	Medium
Drought*	4	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 6 Years with 1+ events - 3 Probability – 30%	Medium
Heat* (Heat. Excessive Heat)	4	Rank - High Damage – 0 Deaths - 1 Injuries - 0	Rank - High Total Events - 30 Years with 1+ events - 8 Probability – 80%	High
Earthquake** 2 events – 2.9 and 2.8 magnitude	3	Rank - High Estimated	Rank - High 25 – 45% chance magnitude 6.0 earthquake may occur through 2053 Total Events - 2 Years with 1+ events - 2 Probability – 20%	High
Dam Failure*** No events on record	2	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low
Wildland Fire**** No events on record	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low

\* Storms Event Database, National Climatic Data Center

\*\* USGS

\*\*\* Missouri Department of Natural Resources

\*\*\*\* Missouri Department of Conservation

Table 3-5 St. Charles County Hazard Summary 2005 –October 31, 2014

Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
Tornado*	1	Rank - High Damage – 50M Deaths - 0 Injuries - 8	Rank - High Total Events - 8 Years with 1+ events - 6 Probability – 60%	High
Severe Thunderstorm Wind* (wind speed)	1	Rank - High Damage – 200K	Rank - High Total Events - 22	High

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Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
≥ 67 mph)		Deaths - 0 Injuries - 2	Years with 1+ events - 8 Probability – 80%	
Hail*	1	Rank - Medium Damage – 5K Deaths - 0 Injuries - 0	Rank - High Total Events - 136 Years with 1+ events - 10 Probability – 100%	High
Lightning*	1	Rank - High Damage – 479 Deaths - 0 Injuries - 3	Rank - High Total Events - 4 Years with 1+ events - 4 Probability – 40%	High
Flood* (Riverine Flash)	3	Rank - Medium Damage – 12.5M Deaths - 0 Injuries - 0	Rank - High Total Events - 24 Years with 1+ events - 7 Probability – 70%	High
Severe Winter Weather* (winter storm, winter weather, heavy snow, cold/wind chill)	4	Rank - High Damage – 20M Deaths - 0 Injuries - 0	Rank - High Total Events - 18 Years with 1+ events - 8 Probability – 80%	High
Drought*	4	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 5 Years with 1+ events - 2 Probability – 20%	Medium
Heat* (Heat. Excessive Heat)	4	Rank - High Damage – 0 Deaths - 1 Injuries - 0	Rank - High Total Events - 33 Years with 1+ events - 9 Probability – 90%	High
Earthquake**	3	Rank - High Estimated	Rank - High 25 – 45% chance magnitude 6.0 earthquake may occur through 2053	High
Dam Failure*** No events on record	2	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low
Wildland Fire**** No events on record	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low

\* Storms Event Database, National Climatic Data Center

\*\* USGS

\*\*\* Missouri Department of Natural Resources

\*\*\*\* Missouri Department of Conservation

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Table 3-6 St. Louis County Hazard Summary 2005 –October 31, 2014

Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
Tornado*	1	Rank - High Damage – 45M Deaths - 1 Injuries - 13	Rank - High Total Events - 17 Years with 1+ events - 6 Probability – 60%	High
Severe Thunderstorm Wind* (wind speed ≥ 67 mph)	1	Rank - High Damage – 25K Deaths - 1 Injuries - 1	Rank - High Total Events - 69 Years with 1+ events - 8 Probability – 80%	High
Hail*	1	Rank - High Damage – 855K Deaths - 0 Injuries - 1	Rank - High Total Events - 183 Years with 1+ events - 10 Probability – 100%	High
Lightning*	1	Rank - High Damage – 0 Deaths - 3 Injuries - 4	Rank - High Total Events - 6 Years with 1+ events - 4 Probability – 40%	High
Flood* (Riverine Flash)	3	Rank - High Damage – 102k Deaths - 3 Injuries - 0	Rank - High Total Events - 28 Years with 1+ events - 8 Probability – 80%	High
Severe Winter Weather* (winter storm, winter weather, heavy snow, cold/wind chill)	4	Rank - High Damage – 43.7M Deaths - 0 Injuries - 14	Rank - High Total Events - 20 Years with 1+ events - 9 Probability – 90%	High
Drought*	4	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 4 Years with 1+ events - 2 Probability – 20%	Medium
Heat* (Heat. Excessive Heat)	4	Rank - High Damage – 0 Deaths - 15 Injuries – 1,755	Rank - High Total Events - 35 Years with 1+ events - 9 Probability – 90%	High
Earthquake**	3	Rank - High Estimated	Rank - High 25 – 45% chance magnitude 6.0 earthquake may occur through 2053	High
Dam Failure*** No events on record	2	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low
Wildland Fire**** No events on record	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low

\* Storms Event Database, National Climatic Data Center

\*\* USGS

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\*\*\* Missouri Department of Natural Resources

\*\*\*\* Missouri Department of Conservation

Table 3-7 City of St. Louis Hazard Summary 2005 –October 31, 2014

Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
Tornado*	1	Rank - Medium Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 3 Years with 1+ events - 3 Probability – 30%	High
Severe Thunderstorm Wind* (wind speed ≥ 67 mph)	1	Rank - High Damage – 259K Deaths - 0 Injuries - 32	Rank - High Total Events - 8 Years with 1+ events - 2 Probability – 20%	High
Hail*	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 31 Years with 1+ events - 10 Probability – 100%	Medium
Lightning*	1	Rank - Medium Damage – 0 Deaths - 0 Injuries - 4	Rank - Medium Total Events - 3 Years with 1+ events - 1 Probability – 10%	Medium
Flood* (Riverine Flash)	3	Rank - High Damage – 102K Deaths - 0 Injuries - 0	Rank - High Total Events - 12 Years with 1+ events - 6 Probability – 60%	High
Severe Winter Weather* (winter storm, winter weather, heavy snow, cold/wind chill)	4	Rank - High Damage – 200K Deaths - 0 Injuries - 0	Rank - High Total Events - 20 Years with 1+ events - 9 Probability – 90%	High
Drought*	4	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - High Total Events - 4 Years with 1+ events - 2 Probability – 20%	Medium
Heat* (Heat. Excessive Heat)	4	Rank - High Damage – 0 Deaths - 44 Injuries – 1,442	Rank - High Total Events - 39 Years with 1+ events - 9 Probability – 90%	High
Earthquake**	3	Rank - High Estimated	Rank - High 25 – 45% chance magnitude 6.0 earthquake may occur through 2053	High
Dam Failure*** No high hazard dams	1	Rank - Low Damage – 0 Deaths - 0 Injuries - 0	Rank - Low Total Events - 0 Years with 1+ events - 0 Probability – 0%	Low
Wildland Fire**** No events on record	1	Rank - Low Damage – 0 Deaths - 0	Rank - Low Total Events - 0 Years with 1+ events - 0	Low

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Hazard	% Land Area Affected	Severity	Probability of Occurrence	Overall Risk
		Injuries - 0	Probability – 0%	

\* Storms Event Database, National Climatic Data Center

\*\* USGS

\*\*\* Missouri Department of Natural Resources

\*\*\*\* Missouri Department of Conservation

**Problem Statement**

Two problems are relevant to any type of natural disaster mitigation:

1. A common concern is that the public is poorly informed about how to respond to a serious disaster. Since the ability to respond quickly to a disaster can greatly reduce the risk to human life or human injury, the community needs a well-informed public and a plan for both individual response and responsibility and for coordinated agency response to disasters of any kind.
  - a. The problem of building awareness is high when there have been no recent disasters, and the public and volunteer agencies can be complacent and unprepared when an event occurs.
  - b. Engaging volunteers who can be prepared is an important step in addressing any or all of the potential hazards the region faces.
  - c. Special populations have specific needs and challenges and agencies can work to help them be prepared.
  - d. Likewise communities that train volunteers to respond to disasters can minimize the secondary impact of a disaster.
  
2. Citizens expect immediate and effective response to any disaster, no matter how unexpected, or how severe. Local governments and school districts face a challenge to be prepared for any disaster, and to be able to respond effectively.
  - a. Many response efforts must begin with good communication, especially to provide advance notice of a disaster whenever possible.
  - b. In addition, public facilities are often the best locations to provide relief to people in need immediately following a disaster, so communities must be prepared to make cost-effective preparations in advance of a natural disaster.
  - c. Communications among departments and between emergency management, police, fire, and health departments as well as communications among communities affected can be stressed during a

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disaster, especially if normal electric power sources are cut off. Therefore, planning for effective warning systems, and for effective communications immediately following a disaster is a high priority.

### **1. Flood Hazard Profile**

#### **Background**

A variety of factors affect the type and severity of flooding throughout the five county area. Urban development patterns, infrastructure and topography are key factors affecting flooding profiles for the five county area. Flooding poses a threat to lives, safety and can cause severe damage to public and private property. With the exception of fire, floods are the most common and widespread of all disasters. Most communities in the United States have experienced some kind of flooding, after spring rains, heavy thunderstorms, or winter snow thaws.

Riverine flooding includes headwater, backwater, and interior drainage. Floods can be slow, or fast rising, dependent on the intensity over a certain length of time of the rainstorms in the watershed, or from rapid snowmelt or ice. Floods generally develop over a period of days. During heavy rains from storm systems, including severe thunderstorms, water flows down the watershed, collecting in, and then overtopping valley streams and rivers.

Flash flooding is characterized by rapid accumulation or runoff of surface waters from any source. This type of flooding can occur within six hours of a rain event, after a dam or levee failure or sudden release of water held by an ice or debris dam. Flash floods can catch people unprepared. Because flash flood can develop in just a matter of hours, most flood-related deaths result from this type of flooding. Most flash flooding is caused by slow-moving thunderstorms or heavy rains.

Several factors contribute to both riverine and flash flooding. Two key elements are rainfall intensity (the rate of rainfall) and duration (length of time that the rainfall lasts). Type of ground cover, soil type and topography all play important roles in flooding.

Flooding potential is further exacerbated in urban areas (disturbed lands) with impervious pavements, by the increased runoff up from two to six times over what would occur on undisturbed terrain. Soils lose their ability to absorb rain as land is converted from fields or woodlands to buildings and pavement. During periods of urban flooding, streets become rivers, and basements and viaducts become death traps as they fill with water.

Floodplains are located in lowland areas, relatively flat and adjoin rivers and streams. These lowland areas adjacent to rivers and stream banks serve to carry excess floodwater during rapid runoff. The term "base flood" or 100-year flood is the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year, based on

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historical records. A 500-year flood is defined as the area in the floodplain that has a 0.2 percent probability of occurring in any given year. While unlikely, it is possible to have two 100 or even 500 year floods within years or months of each other. The primary use for these terms is for the determination of flood insurance rates in flood hazard areas. Using historic weather and hydrograph data experts derive the estimated rate of flow or discharge of a river or creek. After extensive study and coordination with Federal and State agencies, this group recommended the 1-percent-annual-chance flood (also referred to as the 100-year or "Base Flood") be used as the standard for the NFIP.

The 1-percent-annual-chance flood was chosen on the basis that it provide a higher level of protection while not imposing overly stringent requirements or the burden of excessive costs on property owners. The 1-percent-annual-chance flood (or 100-year flood) represents a magnitude and frequency that has a statistical probability of being equaled or exceeded in any given year, or the 100-year flood has a 26 percent (or 1 in 4) chance of occurring over the life of a 30-year mortgage.

### **Location**

Please refer to the individual county maps in the Appendix – Map Sets – Flood Hazard and Potential Composite Flood Loss showing those areas, critical assets, school buildings, roadways and places (incorporated/unincorporated) with concentrations of mobile homes which are susceptible to flooding (located in Special Flood Hazard Areas [SFHA]) based on the most recent FEMA Flood Insurance Rate Maps (FIRMs). As part of the FEMA Map Modernization program, updated FIRMs have been released for in 2011 for Franklin County and the City of St. Louis; 2015 for St. Louis County; and 2006 for Jefferson County. The most recent FIRM for St. Charles County was released in 1996.

The Metropolitan St. Louis region straddles two of the largest watersheds/ivers in the United States, the Mississippi and the Missouri Rivers. All five counties have communities located along either the Missouri or Mississippi Rivers. St. Charles and St. Louis counties both have borders on the Missouri and Mississippi Rivers. The five counties are all highly susceptible to annual flooding events in the spring. Through analysis of existing federal Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies, it has been determined that the region including St. Louis County, St. Charles County, Franklin County, Jefferson County and the City of St. Louis have 100-year and 500-year floodplains and may be affected by the flooding hazard. The floodplains of the two great rivers are wide and have experienced considerable development in recent decades. A variety of factors affect the type and severity of flooding throughout the planning region, including urban development and infrastructure, and topography. Conditions such as low topographic locations, unstable soils, and heavy rain events for extended periods of time in the low lying areas make these areas more vulnerable to flood hazards. Locations that are typically affected are identified on the National Flood Insurance Rate Maps as Special Flood Hazard Areas.

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In certain portions of the five county area, steep slopes induce high velocities as the water flows downhill and downstream, in many cases producing flash flooding. Because some development areas are located in floodplains, floodwaters have the potential to affect or severely impact communities. These conditions in areas where flash floods are a problem make response operations and evacuations difficult, adversely affecting the safety of residents. On other rivers and streams in the region, the risk of flash flooding as the result of heavy rains is high, and the amount of advance warning time is significantly shorter. The Meramec River which flows 220 miles from the Ozark highlands northeast through Franklin County and forms much of the border between Jefferson and St. Louis County is large enough to experience gradual rise in flood waters, but many of its tributaries are small enough that they can experience significant flash flooding. The event narrative section of the Event Details page from the Storm Events Database identifies roads and intersections which have been affected by flash flooding. Additional information is available from the respective County/City Emergency Management Office.

### **Hazard Event History**

Major floods have affected the citizens of this five county area, as early as 1785. In 1993, 1994, 2001, 2010 and 2013 major flood events occurred in the five county area.

The largest disaster to impact to the region in recent years was the flood of 1993. Its size and impact was unprecedented and has been considered the most costly and devastating flood to ravage the central U.S. in modern history. Rivers involved included: Mississippi River, Missouri River, Meramec River, River des Peres and associated tributaries. The number of record river levels, its aerial extent, the number of persons displaced, amount of property damage and its duration surpassed all earlier U.S. floods in modern times. The two most important aspects of the flood of 1993 were its intensity and its duration. Refer to Figure 3-1 below.<sup>3</sup> The five county area is located at the confluence of the Missouri and Mississippi Rivers.

Areas hardest hit by the 1993 flooding were along the Mississippi River, Missouri River, Meramec River, River des Peres and associated tributaries. The existing levee systems found in the five county area endured extreme pressures from the extend duration of high river levels and experienced various levels of damage. Levee systems in St. Charles County were overtopped in the 1973 and 1993 floods. In St. Louis County the Monarch levee in Chesterfield failed and Missouri River floodwaters inundated the Chesterfield Valley. Damages to levees caused a chain reaction of economic problems.

Using data from various federal, state and local sources, the U.S. Army Corps of Engineers assembled information on estimated damages and costs of the 1993 flood. This data is presented in Table 3-8.

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<sup>3</sup> For detailed discussion of the 1993 flood in the five counties, see EWG's regional Hazard Mitigation plan approved in March 2010.

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In 1993 well over 20 million acres were flooded, covering parts of nine states. More than 50,000 homes were damaged or destroyed, and over 85,000 residents had to evacuate their homes. Some of the flooding occurred as levees collapsed after being weakened by constant pressure from rising waters. Total crop losses due to flooding or saturated fields exceeded 35 million acres and many farm animals perished in the rising water.

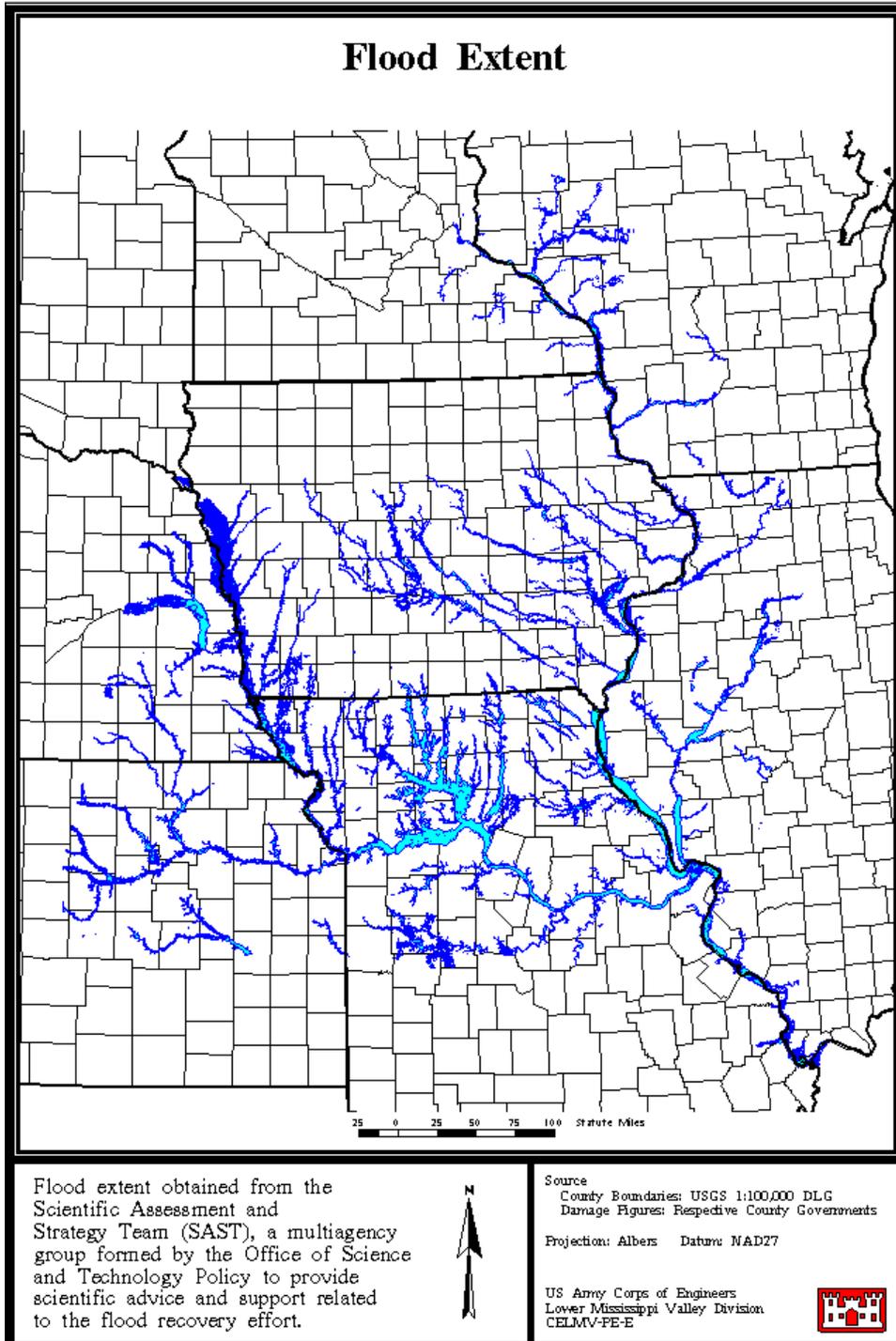
Table 3-8 Flood of 1993 Damage Estimates by County

Damages to	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis
<b>Commercial &amp; Industrial Properties</b>	\$100K - \$500K	> \$10M	> \$10M	> \$10M	> \$10M
<b>Public Facilities</b>	\$1M - \$4.9M	\$1M - \$4.9M	> \$5M	\$1M - \$4.9M	\$1M - \$4.9M
<b>Residential Properties</b>	\$1 - \$4.9 million	> \$5M	> \$5M	> \$5M	\$1M - \$4.9M
<b>Transportation System</b>	\$1M - \$4.9M	\$1M - \$4.9M	> \$5M	> \$5M	> \$5M
<b>Utilities</b>	\$1M - \$4.9M	\$1M - \$4.9M	> \$5M	> \$5M	> \$5M
<b>Emergency Expenses</b>	\$100K - \$499K	> \$1M	> \$1M	> \$1M	> \$1M

Source - -U.S. Army Corps of Engineers, Lower Mississippi Valley Division

The Mississippi River at St. Louis crested at 49.6 feet on August 1, 1993, nearly 20 feet above flood stage. The waters in some areas remained above flood stage for many weeks and receded slowly. Many locations experienced two crests during the flooding. Commuting during the 1993 floods was interrupted when the Clark Bridge (connecting St. Charles County and Alton Illinois) over the Mississippi River was closed due to water covering U.S. Route 67. Travel on U.S. Route 40-I-64 was also interrupted when the Missouri River overtopped the Monarch levee in St. Louis County. In addition, the Washington Bridge carrying State Highway 47 over the Missouri River from Franklin County to Warren County was closed due to flooding. Rail transportation had to be halted when the Missouri Pacific tracks in Franklin County were flooded. Prolonged flooding of highways created economic loss and hardship on the five county area. These highways provide critical access to employment, healthcare, emergency services, education, retail and commerce activities and the transportation of goods and services.

FIGURE 3-1 1993 MIDWEST FLOOD: The St. Louis, Missouri Region is at the confluence of the Missouri and Mississippi Rivers, thus receiving all the waters that flow into the basin from north and west.



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The largest disaster to impact the five county area in recent years was the flood of 1993. Its size and impact was unprecedented and has been considered the most costly and devastating flood in the U.S. in recent history. In the 2001 flood, covering a 14 state area including Missouri, there was a total of \$1.9 billion dollars in damage and costs and at least three deaths. In the 1993 flood, there was approximately \$21 billion in damages and costs and 50 deaths (NOAA).

Since 2010 there have been six flood events on the Missouri River and Mississippi River and 32 flash flood events in the five county area. For information about previous events, please refer to the 2009-2010 Plan Update. Information on historic river crests for the Mississippi, Missouri and Meramec Rivers from 1785 – 2013 can be found in Appendix G.

Table 3-9 Length of Flood Events 2010 – July 31, 2014

Date/County	River	Storm Events Database Event Description
<b>June 9 – 30, 2010</b>		
Franklin	Missouri	Moderate
<b>June 14 – 30, 2010</b>		
St. Charles, St. Louis	Mississippi	Moderate
<b>June 16 – 30, 2010</b>		
Jefferson, City of St. Louis	Mississippi	Moderate
<b>April 14 – 30, 2013</b>		
St. Charles	Mississippi	Major Crested April 25, remained above flood stage into May
<b>June 1 – 15, 2013</b>		
City of St. Louis	Mississippi	Major Crested June 4
<b>June 1 – 30, 2013</b>		
St. Charles	Mississippi	Major Crested June 4, remained in flood into July

Source - National Climatic Data Center, Storm Events Database

Table 3-10 2010 – 2014 Flood Events

Start Date	Gauge Location	County	River	Property Damage	Crop Damage
6/9/10	Berger	Franklin	Missouri	0	0
6/14/10	Larimore	St. Louis	Mississippi	0	0
6/14/10	St. Paul	St. Charles	Mississippi	0	0
6/16/10	Baden Neighborhood	City of St. Louis	Mississippi	0	0
6/16/10	Wickes	Jefferson	Mississippi	0	0
4/14/13	Peruque	St. Charles	Mississippi	\$10K	\$20K

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Start Date	Gauge Location	County	River	Property Damage	Crop Damage
6/01/13	Baden Neighborhood	City of St. Louis	Mississippi	\$1K	0
6/01/13	St. Paul	St. Charles	Mississippi	\$3K	\$3K
<b>Total Events - 8</b>			<b>Total</b>	\$14K	\$23K

Source - National Climatic Data Center, Storm Events Database

Table 3-11 Flash Flood Events by Year from 2010 – July 31, 2014

County	2010	2011	2012	2013	2014	Total
Franklin	2	1	0	2	1	6
Jefferson	1	2	0	1*	0	4
St. Charles	2	2	0	2	1	7
St. Louis	3	5	0	2	1	11
City of St. Louis	1	2	0	1	0	4
<b>Total</b>	9	12	0	8	3	32

\*1 Fatality in DeSoto

Source - National Climatic Data Center, Storm Events Database

**Probability of Occurrence - High**

Flood risk is high but more predictable. Floods along the Missouri and Mississippi river tend to be the result of significant precipitation over large areas of land, and as a result there is usually ample time to prepare for the arrival of the floodwaters. Therefore risk of loss of human life is relatively low. The exception to this low level risk would occur in the case of an unexpected levee failure which could send flood waters rushing into land that people believe is protected. Although there have been cases of flood overtopping agricultural levees, according to the US Army Corps of Engineers (USACE), there have been no cases of a federal urban levee failure within the region. The USACE regularly inspects levees and levee districts work to maintain them, so the risk of levee failure is low. Nevertheless, the recent development of new levees and the significant increase in investment in floodplains protected by levees does make levee failure a risk to consider.

According to the National Weather Service, March through July have the highest average monthly precipitation (between 3 – 4 inches). However, significant rain events can occur any time of the year leading to flash floods. Flooding in each of the five counties is likely to occur in the future.

Table 3-12 2005 – October 2014 County Summary Riverine and Flash Flood Events

County	Events	Years with Events	Deaths	Injuries	Property Damage	Crop Damage
Franklin	16	8	0	0	\$5K	\$5K
Jefferson	11	7	1	0	0	0
St. Charles	24	7	0	0	\$1.8M	\$10.8

July 13, 2015

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<b>St. Louis</b>	28	8	3	0	\$102K	0
<b>City of St. Louis</b>	12	6	0	0	\$102K	0

Source – National Climatic Data Center, Storm Events Database

**Severity - High**

Percentage of Land Area Affected by Hazard – 25 to 50 percent

Damage incurred as a result of flooding includes the stormwater inundation of residences, outbuildings, businesses, churches and leaving behind mud, rock, trees, debris, trash, and chemical pollutants. Depending upon the severity of the flood, the volume and rate of flow of the water, the floodwater may be capable of carrying vehicles, whole or parts of buildings, etc. Floodwaters often leave behind layers of thick muddy ooze. Since 2010, the five county area has experienced four deaths resulting from flash flood events and \$2.1 million in property damage and \$10.8 million in crop damage from flash and riverine flooding.

Depending upon the weather forecasts, the speed or onset of flash floods can be almost instantaneous. Flash flood warnings are issued by the National Weather Service and the media (television stations, the Weather Channel and radio stations). U.S. Army Corps of Engineers and U.S. Geological Survey (USGS) produce river stage warnings which enable communities to plan for flood events.

According to SEMA’s Severity Ratings Table, the 1993 floods would classify as critical. During these floods, some facilities were closed for more than 24 hours. Other flood events had minimal impact on the quality of life, no critical facilities or services were shut down for more than 24 hours. The probable future severity of future floods could range from critical to catastrophic in the floodplain areas to negligible in areas outside of the floodplains.

Flood risk is high but more predictable. Floods along the Missouri and Mississippi river tend to be the result of significant precipitation over large areas of land, and as a result there is usually ample time to prepare for the arrival of the floodwaters. Therefore risk of loss of human life is relatively low. The exception to this low level risk would occur in the case of an unexpected levee failure which could send flood waters rushing into land that people believe is protected. Although there have been cases of flood overtopping agricultural levees, according to the US Army Corps of Engineers (USACE), there have been no cases of a federal urban levee failure within the region. The USACE regularly inspects levees and levee districts work to maintain them, so the risk of levee failure is low. Nevertheless, the recent development of new levees and the significant increase in investment in floodplains protected by levees does make levee failure a risk to consider.

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### **Vulnerability**

Flood hazard vulnerability information from the 2010 Missouri State Hazard Mitigation Plan was utilized to estimate vulnerability in the five county area. Missouri utilized the HAZUS model and digital Flood Insurance Rate maps to compute potential flood impact analysis and prepare a county-by-county assessment of potential loss. The HAZUS model output was used with GIS to develop maps of those communities with floodplain boundaries. These maps can be found in the Appendix – Map Sets – Flood Hazards – Flood HAZUS.

### **Repetitive Loss Properties**

The properties in and near the floodplains of the five county area (City of St. Louis, St. Louis County, St. Charles County, Jefferson County and Franklin County) are subject to flooding events almost annually. Since flooding is such a pervasive problem, many residents have purchased flood insurance to help recover from losses incurred from flooding events, been bought out, or have rebuilt to construction standards. Flood insurance covers building structures and/or their contents. Although flood insurance assists in recovery, it can provide an inappropriate sense of protection from flooding. Many residents and businesses that have flood damage rebuilt in the same vulnerable areas, only to be flooded again. These properties are termed Repetitive Loss properties. A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than \$1,000 were by the National Flood Insurance Program (NFIP) within any rolling ten year period, since 1978. Repetitive Loss properties are very troublesome because they continue to expose lives and valuable property to the flooding hazard. Local governments as well as federal agencies such as FEMA recognize this problem in the floodplain insurance program and attempt to remove the risk from repetitive loss properties through projects such as acquiring land and relocating the home or by elevating the structures.

Continued repetitive loss claims from flood events lead to an increased amount of damage caused by floods, higher insurance rates, and contribute to the rising cost of taxpayer funded disaster relief for flood victims.

In those areas potentially subject to flood, residents have purchased flood insurance to help recover from losses incurred from flooding events, have sold property, or have rebuilt structures to reflect construction standards. Flood insurance covers only the improved land, or the actual building structures. (See Table 3-13) The number of policies may not include all structures at risk of flooding.

Although flood insurance assists in recovery, it can provide an inappropriate sense of protection from flooding. Many residents and businesses that have flood damage rebuilt in the same vulnerable areas, only to be flooded again. These properties are termed repetitive loss properties and continue to expose lives and property to flooding hazards. Local governments, as well as federal agencies such as FEMA, recognize this problem of

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floodplain insurance and attempt to remove the risk from repetitive loss properties through different types of projects. Continued repetitive loss claims from flood events lead to an increased amount of damage caused by floods, higher insurance rates, and contribute to the rising cost of taxpayer-funded disaster relief for flood victims. The largest single drain on flood insurance reserve funds is repetitive claims from repetitive loss properties (Galloway report).

**Table 3-13 Five County Area National Flood Insurance Program Policy Statistics**

County	Policies in Force	Insurance in Force Whole \$	Written Premium \$ In Force
<b>Franklin</b>			
Incorporated	305	46,339,981	17,376,397
Unincorporated	165	22,555,000	138,218
<b>Jefferson</b>			
Incorporated	348	62,065,200	411,594
Unincorporated	797	126,729,400	853,375
<b>St. Charles</b>			
Incorporated	855	288,654,200	916,495
Unincorporated	992	188,724,100	1,011,546
<b>St. Louis</b>			
Incorporated	3,238	777,257,500	5,065,588
Unincorporated	1,177	275,964,800	1,642,889
<b>City of St. Louis</b>			
City of St. Louis	390	112,910,100	633,888

Insurance in Force – Coverage amount for policies in force.

Written Premium in Force – The premium paid for the policies in force.

Source - FEMA September 30, 2014

Appendix G contains a summary of repetitive losses by county and repetitive loss properties since 2009 for incorporated and unincorporated areas by residential and commercial categories. Only losses from communities participating in the NFIP are included. These amounts may not represent all the structures at risk of flooding. Please refer to 2009 Plan Update for information on historical repetitive losses by county.

**Table 3-14 Payments for Repetitive Loss Properties by County**

Community		Payments (Rounded in Dollars)				Losses	Properties
Name	Number	Buildings	Contents	Total	Average		
<b>Franklin County</b>							
Berger	290132	25,672	11,248	36,920	5,274	7	2
Pacific	290134	138,788	10,977	149,765	14,977	10	4
St. Clair	290135	16,051	4,904	20,955	10,478	2	1
Washington	290138	3,220	0	3,220	1,610	2	1
Franklin County	290493	1,130,166	493,511	1,623,677	14,497	112	37
<b>Jefferson County</b>							
Arnold	290188	1,159,692	209,918	1,369,609	17,337	79	18
Crystal City	290189	1,844,719	892,611	2,737,330	27,102	101	23
DeSoto	295263	43,939	0	43,939	10,985	4	2
Festus	290191	385,746	121,114	506,861	15,839	32	9

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Community		Payments (Rounded in Dollars)				Losses	Properties
Name	Number	Buildings	Contents	Total	Average		
Herculaneum	290192	207,471	31,299	238,769	29,846	8	3
Pevely	290677	9,828	21,233	31,061	15,530	2	1
Jefferson County	290808	12,217,731	3,725,861	15,943,591	15,540	1026	236
<b>St. Charles County</b>							
Lake St. Louis	290868	5,752	1,050	6,802	3,401	2	1
O'Fallon	290316	235,132	59,018	294,150	12,256	24	6
Portage des Sioux	290317	3,229,943	3,608,711	6,838,654	28,494	240	32
St. Charles	290318	3,196,673	331,505	3,528,178	27,564	128	35
St. Peters	290319	160,196	27,709	187,906	11,053	17	5
Wentzville	290320	13,498	0	13,498	6,749	2	1
West Alton	290924	7,638,142	2,969,653	10,607,795	16,472	644	139
St. Charles County	290315	20,415,201	6,409,831	26,825,032	16,860	1591	309
<b>St. Louis County</b>							
Ballwin	290328	82,164	20,543	102,707	7,901	13	3
Bellefontaine Neighbors	290330	44,958.54	16,524.70	61,483.24	5,124	12	4
Berkeley	290335	0	18,975	18,975	9,488	2	1
Breckenridge Hills	290337	262,925	40,312	303,237	7,775	39	16
Brentwood	290338	5,717,440	8,983,572	14,701,012	84,006	175	32
Bridgeton	290339	143,119	26,831	169,950	15,450	11	5
Chesterfield	290896	1,167,370	1,046,111	2,213,481	58,250	38	15
Cool Valley	290342	6,428	1,475	7,903	3,952	2	1
Country Club Hills	290346	14,774	5,262	20,035	10,018	2	1
Crestwood	290343	64,718	61,377	126,095	25,219	5	2
Creve Coeur	290344	94,664	73,396	168,060	18,673	9	3
Dellwood	290346	12,408	4,099	16,506	2,751	6	3
Des Peres	290347	201,461	4,035	205,495	15,807	13	3
Eureka	290349	96,991	86,547	183,538	22,942	8	3
Fenton	290350	2,171,639	472,900	2,644,539	15,931	166	33
Ferguson	290351	190,539	16,083	206,622	3,387	61	28
Florissant	290352	171,203	75,271	246,374	7,466	33	12
Frontenac	290353	102,702	851,508	954,210	86,746	11	4
Hazelwood	290357	5,379,512	2,107,699	7,487,210	60,381	124	38
Jennings	290360	24,188	1,379	25,566	6,392	4	2
Kirkwood	290362	377,875	132,390	510,266	15,463	33	6
Ladue	290363	1,558,884	645,995	2,204,879	43,233	51	12
Mackenzie	290365	30,354	23,408	53,763	10,753	5	1
Manchester	290366	252,633	77,125	329,759	20,610	16	5
Maplewood	295266	49,861	22,800	72,662	3,633	20	6
Maryland Heights	290889	241,754	30,657	272,411	13,621	20	7
Moline Acres	290370	36,779	15,574	52,353	4,027	13	4
Northwoods	290372	212,352	20,942	233,294	9,721	24	10
Oakland	290373	3,583	0	3,583	1,792	2	1

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Community		Payments (Rounded in Dollars)				Losses	Properties
Name	Number	Buildings	Contents	Total	Average		
Olivette	290374	21,796	16,311	38,107	5,444	7	2
Overland	290375	42,835	27,646	70,481	4,146	17	7
Riverview	290381	20,492	3,999	24,492	6,123	4	1
Rock Hill	290382	207,485	3,887,996	4,095,481	136,516	30	5
St. Ann	290383	28,745	18,682	47,427	3,648	13	6
St. John	290384	33,639	15,856	49,495	4,949	10	3
Sunset Hills	290387	745,863	227,916	973,779	15,215	64	16
University City	290390	3,783,554	694,305	4,477,859	14,306	313	66
Valley Park	290391	1,065,506	264,437	1,329,943	20,461	65	14
Velda Village Hills	290857	4,232	51	4,283	2,141	2	1
Warson Woods	290393	7,500	3,355	10,855	5,428	2	1
Webster Groves	290394	68,939	7,788	76,727	9,591	8	3
Wellston	290395	0	51,611	51,611	12,903	4	2
Wildwood	290922	189,768	116,536	306,304	34,034	9	3
St. Louis County	290327	4,580,949	1,518,398	6,099,346	13,117	465	127
<b>City of St. Louis</b>							
City		1,316,500	Not Available	1,316,500	13,714	96	28

Source – State Emergency Management Agency, Repetitive Loss County Summary

Listed below are those jurisdictions which have had repetitive losses since 2009.

Franklin County

Berger  
St. Clair  
Pacific

Jefferson County

Arnold  
Festus  
Crystal City  
DeSoto  
Unincorporated Jefferson County

St. Charles County

West Alton  
Portage des Sioux  
Unincorporated St. Charles County

St. Louis County

Fenton

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University City  
Brentwood  
Ladue  
Rock Hill  
Hazelwood  
Manchester  
Maryland Heights  
Breckenridge Hills  
Northwoods  
Frontenac  
Ferguson  
St. Ann  
Unincorporated St. Louis County

Consequences from riverine and flash flooding could be catastrophic in terms of safety of lives and property. Riverine flooding is considered a primary hazard for the five county area due to the floodplains of major rivers located within the five county area.

### **Flood Mitigation Efforts - Community Rating System**

The Community Rating System (CRS) is a voluntary program for communities participating in the National Flood Insurance Program (NFIP). The CRS was developed to provide incentives, in the form of NFIP insurance premium discounts, for those communities which go beyond minimum floodplain management requirements and implement activities to reduce or eliminate exposure to floods. Under the CRS, communities or counties are rated on a scale of one to 10; the lower the class, the better the rating. These communities conduct advanced elements of hazard mitigation to meet FEMA guidelines.

St. Charles County was awarded a National Flood Insurance Program's CRS Class 7 rating for its efforts to reduce loss of lives and mitigate property damage from floods in its quest to bring the county to being disaster resistant. A Class 7 rating enables residents in unincorporated sections of St. Charles County who have flood insurance and live in a Special Flood Hazard Area to receive a 15 percent discount on their flood insurance premiums. Those who do not live in a SFHA can receive a 10 percent reduction. For more information, go to [www.sccmo.org/203/community-development](http://www.sccmo.org/203/community-development).

The City of Maryland Heights in St. Louis County was given a National Flood Insurance Program's CRS Class 9 rating for its efforts to reduce loss of lives and mitigate property damage from floods in its quest to bring the city to being disaster resistant. A Class 9 rating enables residents of Maryland Heights who have flood insurance and live in a Special Flood Hazard Area to receive a five percent discount on their flood insurance premiums. Those who do not live in a SFHA can receive a five percent reduction. For additional information on CRS activities in Maryland Heights, go to the Community Development department at [www.marylandheights.com](http://www.marylandheights.com).

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The City of Florissant in St. Louis County received a National Flood Insurance Program’s CRS Class 8 rating for its efforts to reduce loss of lives and mitigate property damage from floods in its quest to bring the city to being disaster resistant. A Class 8 rating enables residents of Florissant who have flood insurance and live in a Special Flood Hazard Area to receive a 10 percent discount on their flood insurance premiums. Those who do not live in a SFHA can receive a five percent reduction. For more information, go to the Engineering Division of Florissant Public Works Department at [www.florissantmo.com](http://www.florissantmo.com).

**NFIP Strategy**

The following tables identify the NFIP strategies of the communities participating in the NFIP. Also listed, are those communities which are not part of the NFIP. The 2014 municipal survey responses, which list the specific actions communities are undertaking in regards to hazard mitigation and preparedness , are found in Table 3-17.

Table 3-15 NFIP Strategies – Communities Participating in National Flood Insurance Program

Community	Special Flood Hazard Area	Adopted Most Recent FIRM by Amending/Updating Floodplain Management Ordinance	NFIP Community Rating System
<b>Franklin County</b>		<b>October 2011 FIRM</b>	
Berger	Yes	Yes	No
Gerald	NSFHA	Yes	No
New Haven	Yes	Yes	No
Pacific	Yes	Yes	No
St. Clair	NSFHA	Yes	No
Sullivan	Yes	Yes	No
Union	Yes	Yes	No
Washington	Yes	Yes	No
Franklin County	Yes	Yes	No
<b>Jefferson County</b>		<b>April 2006 FIRM</b>	
Arnold	Yes	Yes	No
Byrnes Mill	NSFHA	Yes	No
Crystal City	Yes	Yes	No
DeSoto	Yes	Yes	No
Festus	NSFHA	Yes	No
Herculaneum	Yes	Yes	No
Hillsboro	Yes	Yes	No
Kimmswick	Yes	Yes	No
Pevely	Yes No elevation determined – All Zone A, C and Z	Yes	No
Scotsdale	Yes	Yes	No
Jefferson County	Yes	Yes	No

*St. Louis Regional Hazard Mitigation Plan*

<b>Community</b>	<b>Special Flood Hazard Area</b>	<b>Adopted Most Recent FIRM by Amending/Updating Floodplain Management Ordinance</b>	<b>NFIP Community Rating System</b>
<b>St. Charles County</b>		<b>August 1996 FIRM</b>	
Augusta	Yes	Yes	No
Cottleville	Yes	Yes	No
Dardenne Prairie	Yes	Yes	No
Flint Hill	Yes	Yes	No
Lake St. Louis	Yes	Yes	No
New Melle	NSFHA	Yes	No
O'Fallon	Yes	Yes	No
Portage des Sioux	Yes	Yes	No
St. Charles	Yes	Yes	No
St. Paul	Yes	Yes	No
St. Peters	Yes	Yes	No St. Peters is working on CRS application
Weldon Spring	Yes	Yes	No
Wentzville	Yes	Yes	No
West Alton	Yes	Yes	No
St. Charles County	Yes	Yes	Yes
<b>St. Louis County</b>		<b>February 2015 FIRM</b>	
Ballwin	Yes	Yes	No
Bella Villa	Yes	Yes	No
Bellefontaine Neighbors	Yes	Yes	No
Bel-Nor	NSFHA	Yes	No
Bel-Ridge	Yes	Yes	No
Berkeley	Yes	Yes	No
Black Jack	Yes	Yes	No
Breckenridge Hills	Yes	Yes	No
Brentwood	Yes	Yes	No
Bridgeton	Yes	Yes	No
Charlack	NSFHA	Yes	No
Chesterfield	Yes	Yes	No
Clarkson Valley	Yes	Yes	No
Clayton	Yes	Yes	No
Cool Valley	Yes	Yes	No
Country Club Hills	NSFHA	Yes	No
Crestwood	Yes	Yes	No
Creve Coeur	Yes	Yes	No
Crystal Lake Park	NSFHA	Yes	No
Dellwood	Yes	Yes	No
Des Peres	Yes	Yes	No

*St. Louis Regional Hazard Mitigation Plan*

<b>Community</b>	<b>Special Flood Hazard Area</b>	<b>Adopted Most Recent FIRM by Amending/Updating Floodplain Management Ordinance</b>	<b>NFIP Community Rating System</b>
Edmundson	NSFHA	Yes	No
Ellisville	Yes	Yes	No
Eureka	Yes	Yes	No
Fenton	Yes	Yes	No
Ferguson	Yes	Yes	No
Flordell Hills	NSFHA	Yes	No
Florissant	Yes	Yes	Yes
Frontenac	Yes	Yes	No
Glendale	NSFHA	Yes	No
Grantwood Village	Yes	Yes	No
Green Park	Yes	Yes	No
Hanley Hills	Yes	Yes	No
Hazelwood	Yes	Yes	No
Hillsdale	Yes	Yes	No
Huntleigh	Yes	Yes	No
Jennings	Yes	Yes	No
Kirkwood	Yes	Yes	No
Ladue	Yes	Yes	No
Lakeshire	Yes	Yes	No
Mackenzie	Yes	Yes	No
Maplewood	Yes	Yes	No
Marlborough	Yes	Yes	No
Maryland Heights	Yes	Yes	Yes
Moline Acres	Yes	Yes	No
Normandy	NSFHA	Yes	No
Northwoods	Yes	Yes	No
Norwood Court	Yes	Yes	No
Oakland	Yes	Yes	No
Olivette	Yes	Yes	No
Overland	Yes	Yes	No
Pagedale	Yes	Yes	No
Pasadena Hills	NSFHA	Yes	No
Pine Lawn	Yes	Yes	No
Richmond Heights	Yes	Yes	No
Riverview	Yes	Yes	No
Rock Hill	Yes	Yes	No
St. Ann	Yes	Yes	No
St. George	Yes	Yes	No
St. John	Yes	Yes	No
Shrewsbury	Yes	Yes	No
Sunset Hills	Yes	Yes	No

*St. Louis Regional Hazard Mitigation Plan*

<b>Community</b>	<b>Special Flood Hazard Area</b>	<b>Adopted Most Recent FIRM by Amending/Updating Floodplain Management Ordinance</b>	<b>NFIP Community Rating System</b>
Sycamore Hills	NSFHA	Yes	No
Town and Country	Yes	Yes	No
Twin Oaks	Yes	Yes	No
University City	Yes	Yes	No
Valley Park	Yes	Yes	No
Velda City	NSFHA	Yes	No
Velda Village Hills	Yes	Yes	No
Vinita Park	NSFHA	Yes	No
Wason Woods	Yes	Yes	No
Webster Groves	Yes	Yes	No
Wellston	Yes	Yes	No
Westwood	Yes	Yes	No
Wilbur Park	Yes	Yes	No
Wildwood	Yes	Yes	No
	Yes	Yes	No
Winchester	Yes	Yes	No
Woodson Terrace	Yes	Yes	No
St. Louis County	Yes	Yes	No
<b>City of St. Louis</b>		<b>May 2011 FIRM</b>	
St. Louis	Yes	Yes	No

Source – SEMA and FEMA NFIP Community Status Book

NFIP – National Flood Insurance Program

FIRM – Flood Insurance Rate Map

CRS – NFIP Community Rating System program

NSFHA – No Special Flood Hazard Area – No need to pass ordinance adopting FIRM as there is no special flood hazard areas and no high-risk floodplain to regulate.

Table 3-16 NFIP Strategies – Communities Not Participating in National Flood Insurance Program

<b>Community</b>	<b>NFIP Status</b>	<b>Reason</b>
<b>Franklin County</b>		
Leslie	Not in NFIP	NSFHA
Miramiguoa Park	Sanction since 2012	No capacity to implement
Oak Grove Village	Sanction since 1978	No capacity to implement; limited flood impact
Parkway	Not in NFIP	NSFHA

**St. Louis Regional Hazard Mitigation Plan**

<b>Community</b>	<b>NFIP Status</b>	<b>Reason</b>
<b>Jefferson County</b>		
Cedar Hill Lakes	Sanction since 1977	No capacity to implement Man-made lake is identified as flood hazard
<b>St. Louis County</b>		
Bellerive	Sanction since 1977	No capacity to implement; limited flood impact
Beverly Hills	Not in NFIP	NSFHA
Calverton Park	In process of joining NFIP	NSFHA
Champ	Sanction since 1996	No capacity to implement; limited flood impact Population 13
Country Life Acres	Not in NFIP	NSFHA
Glen Echo Park	Not in NFIP	NSFHA
Greendale	Has joined NFIP	NSFHA
Uplands Park	Not in NFIP	NSFHA
Vinita Terrace	Not in NFIP	NSFHA
Kinloch	Suspended in 1989 for failure to adopt regulations	No capacity to implement; limited flood impact

Source – SEMA and FEMA NFIP Community Status Book

NFIP – National Flood Insurance Program

FIRM – Flood Insurance Rate Map

NSFHA – No Special Flood Hazard Area – No need to pass ordinance adopting FIRM as there is no special flood hazard areas and no high-risk floodplain to regulate.

Table 3-17 NFIP-Related Actions by Local Communities (Based on 2014 Municipal All Hazard Survey Responses)

<b>Community</b>	<b>Have Floodplain Manager</b>	<b>Plans in Place</b>	<b>Ordinances related to Natural Hazard Mitigation</b>	<b>Participate AllReady STL Program</b>	<b>NWS StormReady Community</b>	<b>Involve with COAD</b>	<b>Educate Public on Mitigation &amp; Preparedness</b>
<b>Franklin County</b>							
Oak Grove Village	No	Natural Hazard Mitigation; Land Use	Yes	No	Yes	No	No
Parkway	Yes	No	No	No	Yes	No	Yes
Union	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	Yes	NR	NR	No
<b>Jefferson County</b>							
Arnold	Yes	Land Use; Development	No	No	Yes	No	Yes

*St. Louis Regional Hazard Mitigation Plan*

<b>Community</b>	<b>Have Floodplain Manager</b>	<b>Plans in Place</b>	<b>Ordinances related to Natural Hazard Mitigation</b>	<b>Participate AllReady STL Program</b>	<b>NWS StormReady Community</b>	<b>Involve with COAD</b>	<b>Educate Public on Mitigation &amp; Preparedness</b>
DeSoto	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	Yes	Yes	Yes	Yes
Festus	Yes	Land Use; Development	No	No	No	No	No
<b>St. Charles County</b>							
Lake St. Louis	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	No	No	No	No
O'Fallon	Yes	No	No	Yes	Yes	Yes	Yes
St. Charles	Yes	Land Use; Development	No	No	Yes	No	Yes
St. Peters	Yes	Natural Hazard Mitigation; Land Use; Development	NR	No	Yes	Yes	Yes
West Alton	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	No	No	No	Yes
St. Charles County	Yes	Natural Hazard Mitigation; Land Use; Development	No	Yes	Yes	Yes	Yes
<b>St. Louis County</b>							
Ballwin	Yes	Land Use; Development	No	NR	Yes	No	No
Bellefontaine Neighbors	Yes	Natural Hazard Mitigation; Land Use; Development	Plan form only	No	Yes	No	Yes
Beverly Hills	No	No	NR	NR	Yes	Yes	Yes
Brentwood	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	No	No	No	Yes
Chesterfield	Yes	Natural	Yes	No	Yes	No	Yes

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Community	Have Floodplain Manager	Plans in Place	Ordinances related to Natural Hazard Mitigation	Participate AllReady STL Program	NWS StormReady Community	Involve with COAD	Educate Public on Mitigation & Preparedness
		Hazard Mitigation; Land Use; Development					
Country Club Hills	No	No	NR	No	No	No	No
Crestwood	Yes	Land Use; Development	No	Yes	No	Yes	Yes
Creve Coeur	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	No	No	No	Yes
Fenton	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	NR	NR	NR	Yes
Glen Echo Park	NR	Natural Hazard Mitigation; Land Use; Development	No	NR	NR	NR	NR
Greendale	No	No	Yes	NR	NR	NR	NR
Green Park	NR	No	No	NR	NR	NR	NR
Huntleigh	NR	No	NR	NR	NR	NR	NR
Ladue	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	No	No	No	No
Maryland Heights	Yes	Natural Hazard Mitigation; Land Use; Development	Yes	No	No	No	No
Overland	Yes	Land Use; Development	No	No	No	No	Yes
Pagedale	Yes	Natural Hazard Mitigation; Land Use; Development	Contract County	Yes	Yes	No	Yes
Pasadena Hills	No	No	No	No	No	No	No
Rock Hill	Yes	Natural Hazard Mitigation;	Yes	No	No	No	No

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Community	Have Floodplain Manager	Plans in Place	Ordinances related to Natural Hazard Mitigation	Participate AllReady STL Program	NWS StormReady Community	Involve with COAD	Educate Public on Mitigation & Preparedness
		Land Use; Development					
Sunset Hills	Yes	Land Use; Development	NR	No	NR	NR	NR
Town and Country	NR	No	NR	NR	NR	NR	NR
Velda Village Hills	No	Natural Hazard Mitigation	Yes	No	Yes	Yes	Yes
Webster Groves	No	Land Use; Development	Yes	No	No	No	Yes
Winchester	Yes	Land Use; Development	No	No	No	No	Yes
Woodson Terrace	Yes	Land Use; Development	No	No	No	No	No
St. Louis County	Yes	Natural Hazard Mitigation; Land Use; Development	No	Yes	Yes	Yes	Yes

Source – 2014 Municipal All Hazard Survey

NR – No response provided

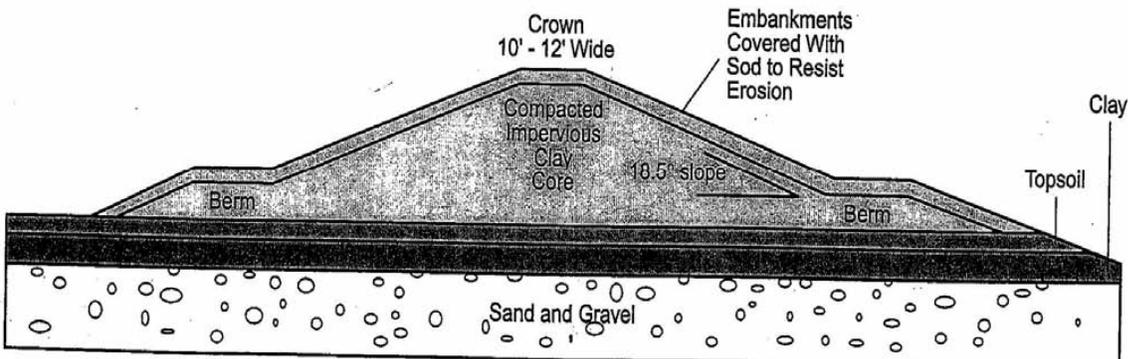
COAD – Community Organizations Active in Disaster

**LEVEES**

Man-made levee systems usually consist of earthen embankments and wall structures which are designed and constructed to contain, control, or divert the rising flow of water so as to protect low lying areas from periodic flooding. For stability, an earthen levee is constructed in pyramid fashion so that its bottom width is several times its height. Therefore, constructed levees have a large footprint requiring considerable land area. Also, earthen levees are generally constructed with compacted clay materials and an impervious clay base to prevent water infiltration (see Figure 3-2). In urban areas where land is limited, a combination of earthen levees and concrete and masonry floodwalls are often used.

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FIGURE 3-2 Cross Section View of an Earthen Levee



Generally, levees are specifically designed and constructed to withstand a certain flood frequency. A ten to a fifty-year levee is usually considered to be an *agricultural* levee designed to protect floodplain in agricultural areas (and agribusinesses) from floods that may occur once every ten or fifty years. These areas will experience flooding during major flood events (e.g., 100-year flood events). *Urban* levees protect floodplains with residences, public or commercial buildings, industrial facilities and related structures from 100-year floods or higher. Other levee structures in the system include *tie back* or *lateral* levees, which extend from the main stem levee to bluff lines (high ground) and are part of the line of protection against backflow during periods of high water. Other key components of a levee system include pumping stations, gravity drains or outlets, street closure gates and relief wells.

The four general ways a levee may fail include: overtopping; piping (internal levee erosion) saturation with floodwaters; and underseepage. During an extreme flood situation, floodwaters may actually exceed the designed water level of the levee and overtop it.

The size and height of the St. Louis urban levee system has grown over the years to its current configuration to protect from the 500-year flood, a flood that has 0.2 percent chance of occurring in any given year. Major levee improvements were completed with the passage of the Flood Control Act of 1938. Today's urban levee system consists of riverside levees and tie back or wing-levees, canals, conduits, pumping stations, gravity drains and seepage relief wells. The urban levee system has proven effective in protecting the American Bottoms in Illinois from major flooding events, including the flood of record in 1993 (a 300-year flood) and a 200-year flood in 1995.

Public Law 84-99 is the authority by which the Army Corps of Engineers responds to emergencies within the District boundary. Under PL 84-99 authorities are delegated to the Corps Districts for disaster preparedness, emergency operations, rehabilitations, emergency water supplies and drought assistance, advance measures and hazard mitigation. The St. Louis District encompasses approximately 28,000 square miles, almost equally divided between Illinois and Missouri, and ten riverine watersheds.

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The St. Louis District’s flood risk management system is comprised of three major components: urban levees or floodwalls, agricultural levees and multi-purpose reservoirs. Eighty-nine levees in the St. Louis District participate in the PL 84-99 program. Inclusion in the program requires submittal of as-built drawings and current geotechnical and survey information, as well as an onsite inspection by Army Corps engineers and specialists. Once accepted into the program, levee districts must pass annual operation and maintenance inspections with an acceptable or minimum acceptable rating. If the levee district maintains its eligibility, the levee district qualifies for federal funds to repair damages that occur to the levee during a declared federal emergency.

When performance of a flood damage reduction system is evaluated, all components must be considered and evaluated as a whole system and not as separate features. Since 1960 the overall system has prevented more than \$11 billion in damages within the St. Louis District.

### Levee Location

The following table delineates the levee systems in the five county area and their inspection rating by the US Army Corp of Engineers (USACE). They are primarily found adjacent to either the Missouri River or the Mississippi River. There are also USACE-developed maps depicting levee location in the St. Louis District of the USACE. USACE conducts an annual visual inspection of the levee systems to verify and rate levee system operation and maintenance. Each segment of the system is reviewed and rated as Acceptable (all items are acceptable), Minimally Acceptable or Unacceptable. One levee system, Berger Levee District in Franklin County, in the five county area has been rated as Acceptable. The remaining levee systems have been rated as Minimally Acceptable. According to USACE, Minimally Acceptable means that one or more inspection items are rated as Minimally Acceptable or one 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. This information is for planning purposes only and will need to be validated at the local level.

Table 3-18 Levee Systems in the Five County Area

Levee System	Leveed Type Area	Protection	Length in Miles	Acres Protected
Franklin County				
Labadie Bottom Levee, Sect 4	Agricultural	10 Year	4.87	927
St. Albans/Labadie Bottoms Levee District, Sect 5, 6	Agricultural	10 Year	9.49	3157
Holtmeier Levee Association, Inc.	Agricultural	10 Year	2.16	259
St. Johns Bottom Levee Association, Inc.	Agricultural	10 Year	5.15	860
New Haven	Urban	10 Year	0.43	14
Berger Levee District	Agricultural	10 Year	17.14	7,514
Jefferson County				
Festus/Crystal City	Urban	500 Year	3.2	365

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Levee System	Leveed Type Area	Protection	Length in Miles	Acres Protected
St. Charles County				
Missouri University Levee System	Agricultural	10 Year	2.77	514
St. Peters MO Old Town Levee System	Urban	100 Year	3.37	668
Dutzow/Augusta Levee System	Agricultural			
Consolidated North County Levee System	Rural	20 Year	40.45	35,408
Darst Levee System	Agricultural	100 Year	6.87	3295
Elm Point Levee System	Urban	25 Year	4.26	1343
Greens Bottom Levee System	Agricultural	5 Year	7.38	3211
Greens Bottom Levee System, Sect 1	Urban	5 Year	1.21	93
St. Peters No. 1 Levee System	Urban	10 Year	0.47	46
Kuhs Levee System	Agricultural	10 Year	7.17	1905
Lakeside 370 Levee System	Rural	500 Year	4.12	1398
St. Louis County				
Missouri Bottom Levee System	Agricultural	10 Year	5.96	2678
Valley Park Levee System	Urban	100 Year	3.1	380
Howard Bend Levee System	Urban	500 Year	8.16	6044
Riverport Levee District System	Agricultural	500 Year	2.58	503
Monarch Chesterfield Levee District System	Rural	500 Year	12.03	4424
Earth City Levee District System	Agricultural	500 Year	2.51	2125
Columbia Bottoms Levee System	Agricultural	5 Year	7.84	4190
City of St. Louis				
St. Louis Flood Protection Project System	Urban	500 Year	11.4	2928

Source - National Levee Database, US Army Corps of Engineers

**Urban Levee Protection Projects**

The following levee projects represent the two major 500 year projects in the St. Louis area. According to the US Army Corps of Engineers, the St. Louis urban levee Flood Protection Project and the Monarch Chesterfield Levee District project provide 500 year levee protection for over 7,400 acres of developed floodplain.

**St. Louis Flood Protection Project**

Authorized level of protection: 500 year Length: 10.67 miles Protects: 3,160 acres of industrial and commercial development, and residential areas

Concern: Inadequate seepage controls and deteriorated metal closure gates

Solution:

- Replace swing gates at 20 closure structures and permanently close openings at 13 closure structures
- Install 70 new relief wells, replace 103 existing relief wells Status: Nearing completion of preconstruction engineering and design City of St. Louis has its cost share. Require Construction General funds to begin relief wells and closure structures construction

**Monarch Chesterfield Levee District**

Authorized level of protection: 500 year Length: 11.5 miles Protects: 4,240 acres; \$660 million in economic value

Concern: Ensure levee provides 500 year level of protection

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Project: Levee raise, installation of relief wells and sheet pile cutoff, and construction of berms

Status:

Project Cooperation Agreement is being executed between USACE and sponsor. USACE initial construction contract expected to be Baxter Road closure structure. Sponsor-constructed levee raise completed. Sponsor constructing berm to address underseepage issue along 7,500 feet of levee.

Table 3-19 Urban Areas Protected by Levee Systems

Levee System	Protects All/Portion of Incorporated Area
<b>Franklin</b>	
New Haven	New Haven
<b>Jefferson</b>	
Festus-Crystal City	Festus, Crystal City
<b>St. Charles</b>	
St. Peters MO Old Town Levee System	St. Peters
Consolidated North County Levee System	St. Charles, Portage des Sioux, West Alton
Elm Point Levee System	St. Peters, St. Charles
St. Peters No. 1 Levee System	St. Peters
Lakeside 370 Levee System	St. Peters
<b>St. Louis County</b>	
Missouri Bottoms Levee System	Bridgeton, Hazelwood
Valley Park Levee System	Valley Park
Howard Bend Levee System	Maryland Heights
Riverport Levee System	Maryland Heights
Monarch Chesterfield Levee System	Wildwood, Chesterfield
Earth City Levee District System	Bridgeton
<b>City of St. Louis</b>	
St. Louis Flood Protection Project System	St. Louis

Source -National Levee Database, US Army Corps of Engineers

**Levee Hazard Event History**

In the last ten years there have been cases of flood waters overtopping agricultural levees in St. Charles County in 2008 and 2013. According to the US Army Corps of Engineers (USACE), there have been no cases of a federal urban levee failure within the region.

**Levee Failure Probability**

Flood risk is high but more predictable. Floods along the Missouri and Mississippi river tend to be the result of significant precipitation over large areas of land, and as a result there is usually ample time to prepare for the arrival of the floodwaters. Therefore risk of loss of human life is relatively low. The exception to this low level risk would occur in the case of an unexpected levee failure which could send flood waters rushing into land that people believe is protected. The USACE regularly inspects levees and levee districts work to maintain them, so the risk of levee failure is low. Nevertheless, the recent development of

## *St. Louis Regional Hazard Mitigation Plan*

new levees and the significant increase in investment in floodplains protected by levees does make levee failure a risk to consider.

### **Levee Failure Severity**

Flooding is the most common hazard associated with levee failure. The failure of a levee can result in property damage, agricultural loss and interruption of economic activity. The St. Louis District has seven flood fight teams assigned to watershed sectors within the District's area of responsibility. Flood fight teams are activated once river stages reach a pre-determined level. They provide technical assistance to effected levee districts and act as a liaison between the District's emergency operations center and impacted communities. The District's Readiness Branch ensures that the teams remain properly staffed and ready for emergency response.

Flooding is the most common hazard associated with levee failure, breach or overtopping. Levee failure, breach, or overtopping can result not only in loss of life, but also considerable loss of capital investment, loss of income, and property damage. SEMA 2010 plan.

No levee can completely reduce flood risk.

### **Levee Failure Vulnerability**

Over time the ability for a levee to reduce the risk of flooding can change. Efforts to improve various levee systems may be underway. When discussing levee failure vulnerability, only those levees which offer protection from 100 year or higher base flood levels are considered. Levees that provide protection from more frequent flooding would be overtopped in a 100 year flood event. The 2010 Missouri State Hazard Mitigation Plan contains the best available data on vulnerability to levee failure. For the 100 year flood protection levees in the USACE Levee Safety Program, the populations exposed to levee failure was estimated by county (Table 3-20).

Table 3-20 Population Exposure to Levee Failure: Missouri Levees in USACE Levee Safety Program

County	Population at Risk
Franklin	2
Jefferson	208
St. Charles	5,384
St. Louis	No Data
City of St. Louis	No Data

Source -July 2010 Missouri State Hazard Mitigation Plan

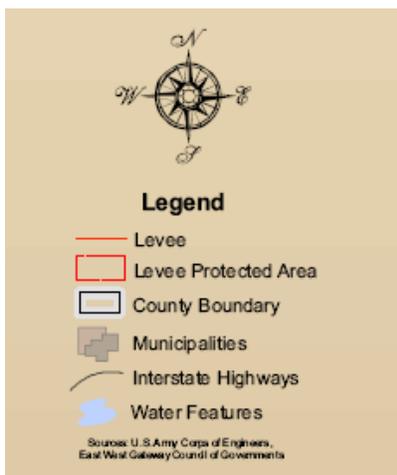
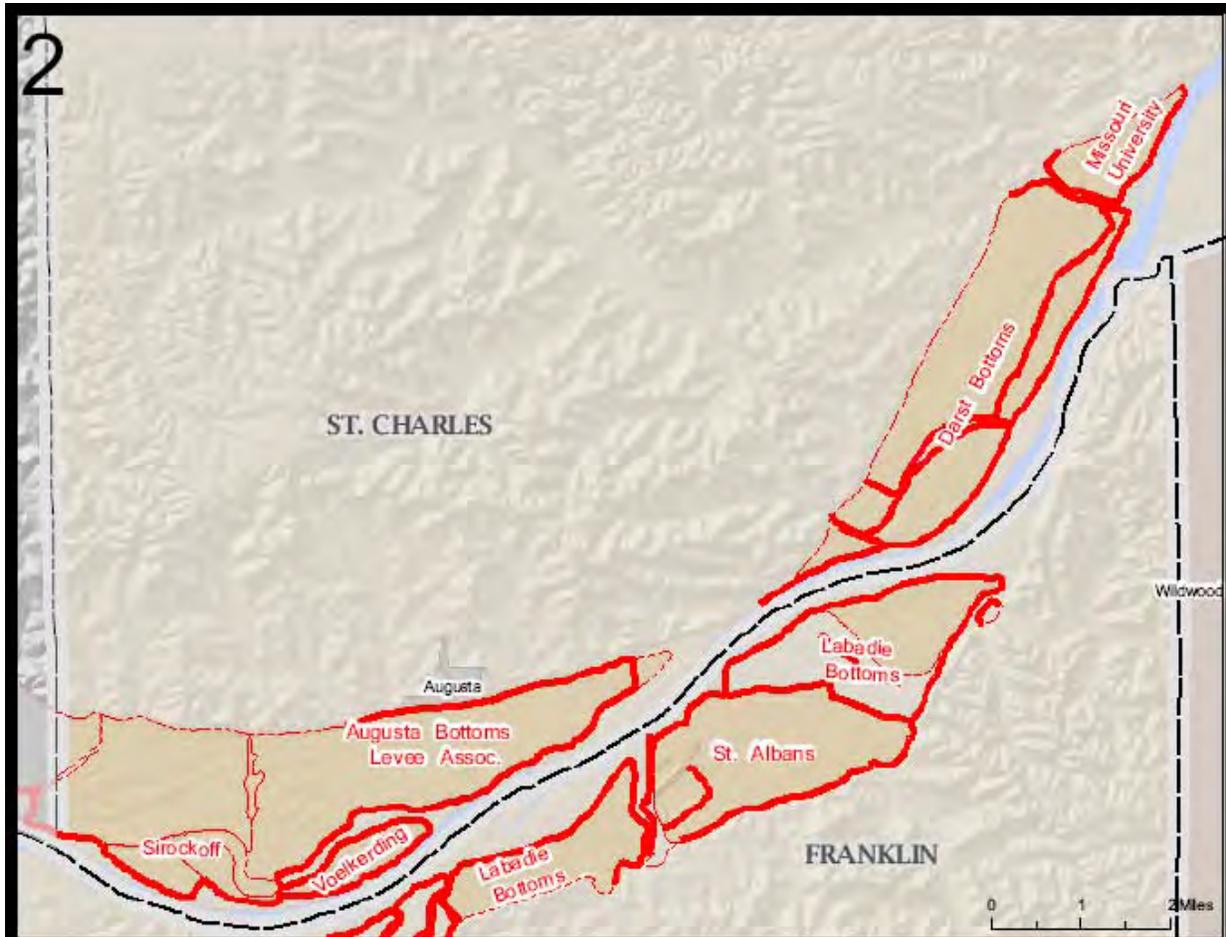
### **Problem Statement**

Because flood risk areas are easily identified, communities can move to reduce risk both for humans and property by effective advance planning. In addition to mapping flood risk

## *St. Louis Regional Hazard Mitigation Plan*

areas, educating citizens about the nature of the risk and the appropriate actions to reduce risk is a critical part of the plan. An area that is flood prone, but where a flood has not occurred in recent years can be especially high risk because property owners can become complacent and unprepared should a flood occur. Flash flooding on small streams is a serious risk, because there are many properties next to streams where development has already taken place and where flood waters are rarely seen. Another risk lies in areas protected by dams or levees, where the public assumes property is safe because it is protected by these structures. Failure of a dam or levee can create a very high hazard, due to the speed with which water can inundate a previously protected area.

FIGURE 3-3 St. Albans & Augusta Bottoms Levee System



FIGURES 3-4 St. Peters & Chesterfield Valley Levee Systems

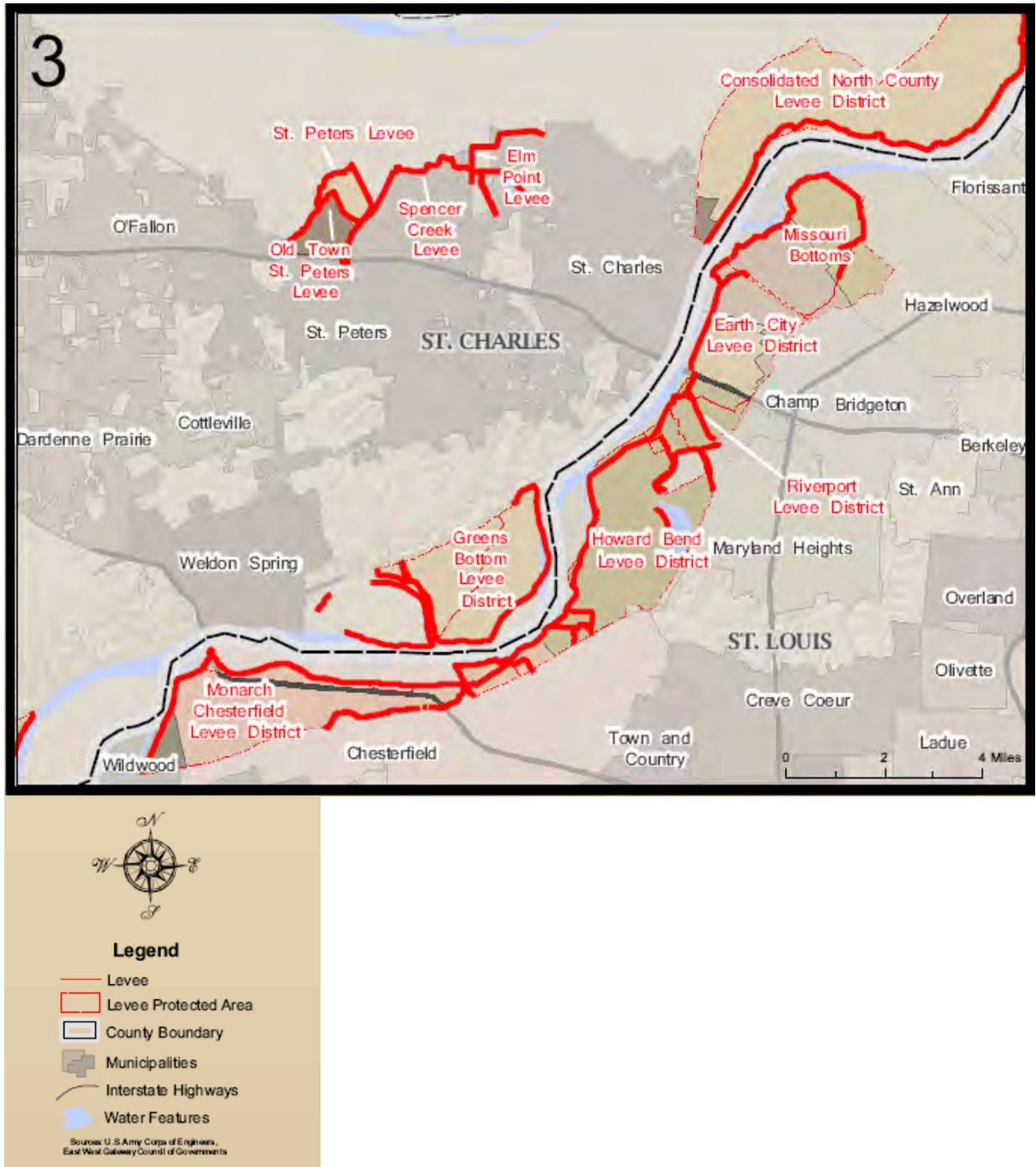
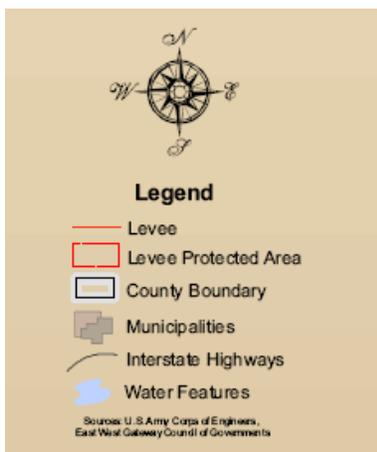
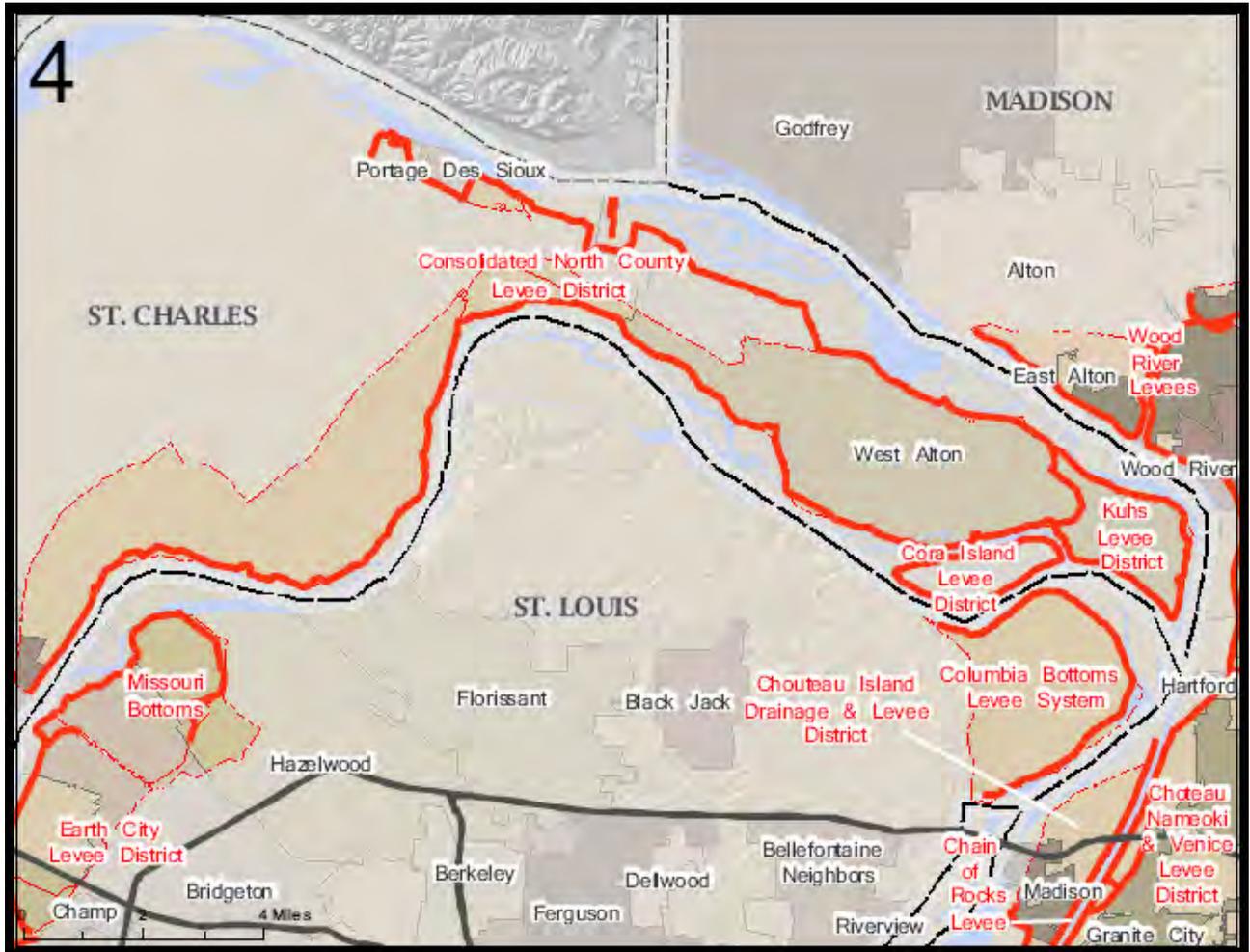
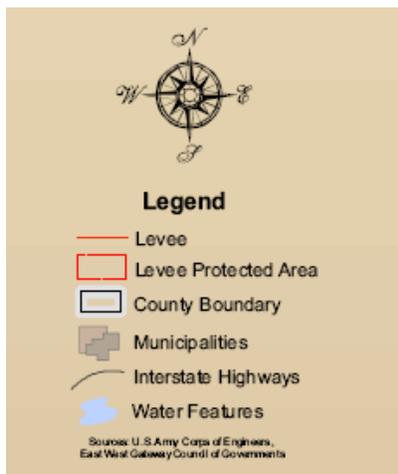
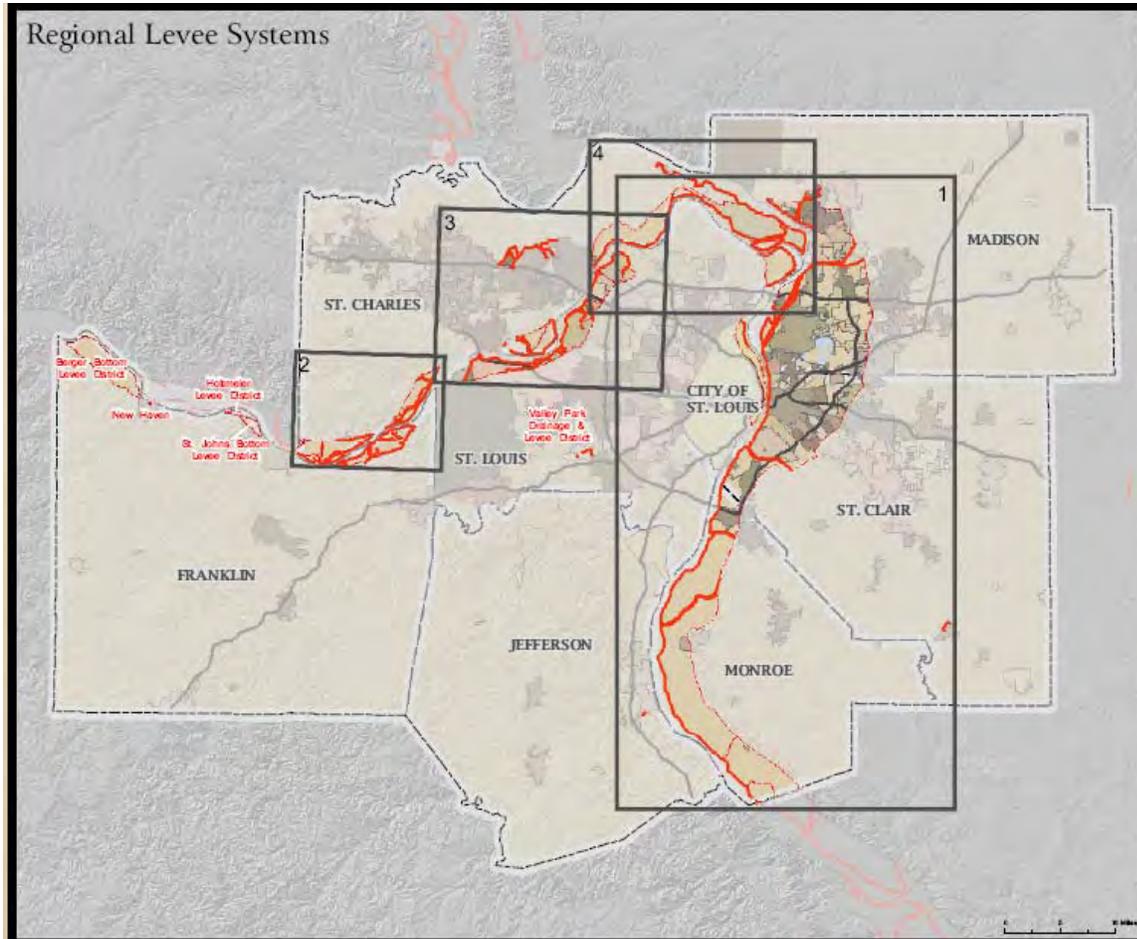


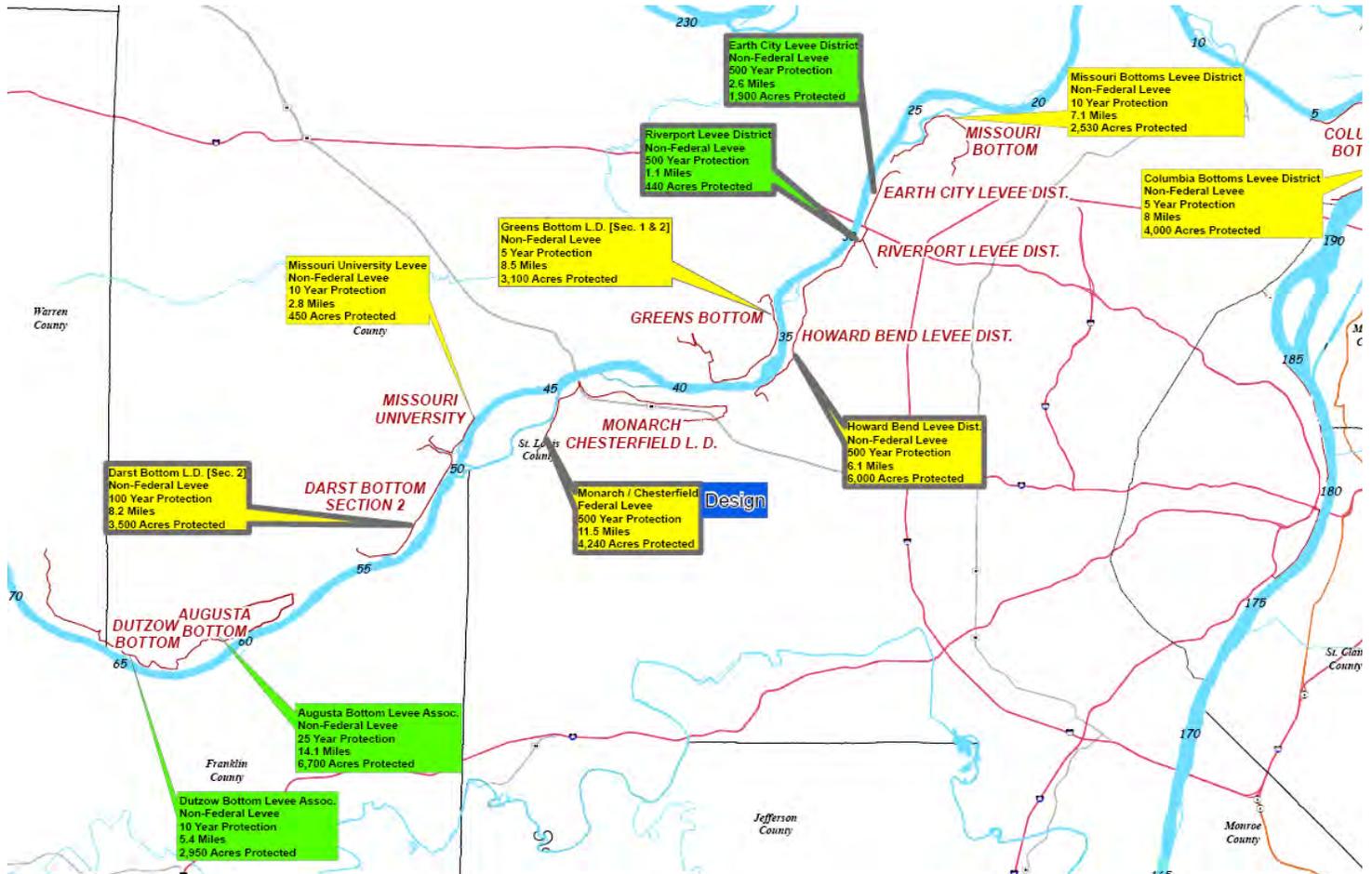
FIGURE 3-5 Confluence Levee System



**FIGURE 3-6 St. Louis Regional Map of Levees**



**FIGURE 3-7 St. Louis and St. Charles County Levee Map**



Source - US Army Corps of Engineers

## 2. Earthquake Hazard Profile

### Background

Earthquake is a term used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth. The Earth's crust is made up of large, relatively rigid tectonic plates which move relative to one another on the outer surface of the Earth. Plate tectonics involves the formation, lateral movement, interaction, and destruction of these plates. The lithosphere is the outer solid part of the earth made up of the crust and mantle. Much of Earth's internal heat is relieved through this process and

## *St. Louis Regional Hazard Mitigation Plan*

many of Earth's large structural and topographic features are consequently formed. Plates collide and are destroyed as they descend at subduction zones to produce deep ocean trenches, strings of volcanoes, extensive faults, broad linear rises, and folded mountain belts. Earth's lithosphere presently is divided into eight large plates with about two dozen smaller ones that are drifting above the mantle at the rate of 5 to 10 centimeters (2 to 4 inches) per year. There are eight large plates; the New Madrid Seismic Zone (NMSZ) is located in the North American Plate. Earthquakes occur all the time all over the world, both along plate edges and along faults. Most earthquakes occur along the edge of the oceanic and continental plates. Most of the earthquakes in the central U.S. occur in the shallow part of the crust at 5-10 km depth (3-6 miles). The five county area is a region which can experience earthquake hazard from earthquakes close and far away. The highest hazard is, and the largest magnitude earthquakes are most likely, from the NMSZ. The approximate middle of the five county area is about 150 miles from the northern end of the NMSZ and about 200 miles from the southern end. Other seismic areas which may impact Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis include the Wabash Valley Seismic Zone in southeastern Illinois and the Big River and Ste. Genevieve faults south of Jefferson County.

The characteristics of earthquakes include the rolling or shaking of the surface of the ground, landslides, liquefaction and amplification. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault and earthquake magnitude. Earthquakes have the potential to destroy roads, bridges, buildings (especially older buildings constructed of masonry or those buildings that are not designed to seismic standards), utilities (including those that are not designed to seismic standards) and other critical facilities.

The State of Missouri established the Missouri Seismic Safety Commission (MSSC) through the authority of the Seismic Safety Commission Act also known as (RSMo) Sections 44.225 through 44.237, the main office being within SEMA. The purpose of MSSC is to review Missouri's current preparedness for major earthquakes and to make recommendations to mitigate their impact. MSSC developed a 1997 plan titled *A Strategic Plan for Earthquake Safety* that documented successes, opportunities and concerns.

The MSSC prepared the *A Strategic Plan for Earthquake Safety* as the result of a legislative mandate, Senate Bill No. 142 in 1993. This plan will aid in identifying goals, initiatives and priorities. It was produced in 1997 and updated in 2007. The MSSC notes that following the Strategic Plan will yield significant reduction in fatalities, casualties, damaged structures, business failures and state infrastructure losses from earthquakes and will reduce the impact from other hazards. Key issues identified by MSSC are: 1) earthquake threat is real and addressing problem now will yield significant long-term benefits, 2) reduction of earthquake risk requires combined efforts of individuals, businesses, industry, professional and volunteer organizations and all levels of government, and 3) strategies identified in the report for reducing earthquake risk can be implemented through proactive, voluntary community participation; others will require legislation or funding. Objectives include: 1) increase earthquake awareness and education, 2) reduce earthquake

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hazard through mitigation, 3) improve emergency response, 4) improve recovery, and 5) assess earthquake hazards.

### **Location**

The five county area is a region which can experience earthquake hazard from earthquakes close and far away. The highest hazard is, and the largest magnitude earthquakes are most likely, from the NMSZ. The approximate middle of the five county area is about 150 miles from the northern end of the NMSZ and about 200 miles from the southern end. Other seismic areas which may impact Franklin, Jefferson, St. Charles and St. Louis counties and the City of St. Louis include the Wabash Valley Seismic Zone in southeastern Illinois and the Big River and Ste. Genevieve faults south of Jefferson County.

If an earthquake of Richter scale magnitude 6.6 or so occurred in the NMSZ, the five county area would be impacted; a lot of the damage would be minor, and not many collapses. If there was an earthquake of Richter scale magnitude 7.0 to 7.8, there would be widespread damage. Risk of hazard is regionwide.

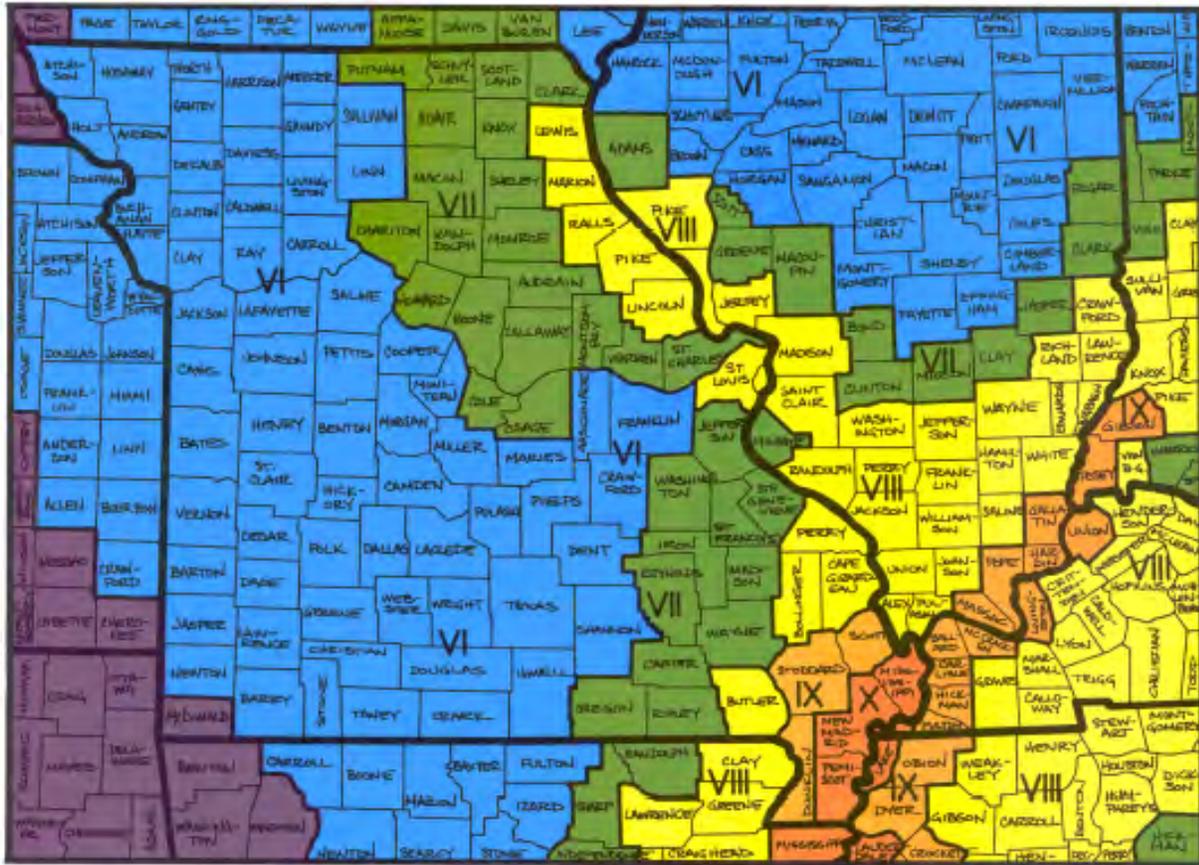
According to Figure 3-8 (Projected Earthquake Intensities of New Madrid Seismic Zone Earthquake), Franklin County is at risk for a Modified Mercalli Intensity (MMI) Level V impact from an earthquake of 6.7 Richter scale magnitude and Level VI effects from a 7.6 Richter scale magnitude earthquake. See Table 3-24 for a description of the different impact levels making up the MMI scale. Jefferson County is at risk for Level VIII impact from a 7.6 Richter scale magnitude earthquake. For St. Charles County there is the risk of the Level VI impacts for a 7.6 Richter scale magnitude earthquake. St. Louis County has risk of a Level VII impact from an earthquake of 6.7 Richter scale magnitude and Level VIII from a 7.6 Richter scale magnitude earthquake. The City of St. Louis is at a risk for a Level VIII impact on the MMI Scale from a 7.6 Richter scale magnitude earthquake. Secondary effects of such an earthquake could include fire, building collapse, utility disruption, flooding, hazardous materials release, environmental impacts and economic disruptions and losses. Based on the projected Earthquake Intensities map and the Modified Mercalli damage scale, the future probable severity for each level is shown below.

<u>Intensity</u>	<u>Severity</u>
Modified Mercalli Levels I-V	Negligible
Modified Mercalli Levels VI	Limited
Modified Mercalli Levels VII	Critical
Modified Mercalli Levels VII-XIII	Catastrophic

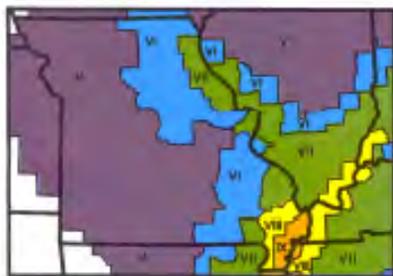
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FIGURE 3-8 Projected Earthquake Intensities of New Madrid Fault Earthquake

PROJECTED EARTHQUAKE INTENSITIES



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.

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Figure 3-9 presents the Peak Acceleration (expressed as a percentage of standard gravity %g) with a two percent probability of exceedance within 50 years within the five county area. This map displays different ground motions for various probability levels. The higher the percentage range, the more severe the horizontal shaking is estimated to be. This information is used in the seismic provisions of building codes, insurance evaluations, risk assessments and other types of public policy.

There are two peak acceleration zones in Jefferson County. The majority of the county is in the 20-30 %g zone and a small area at its southeast boundary is in the 30-40 %g severity zone.

Franklin County contains three peak acceleration zones running northeast to southwest ranging from a high of 20-30 %g in the southeastern corner to a low of 10-14%g of severity in the northwestern corner. The majority of the county is in the 14-20 %g zone.

St. Charles County has within it three peak acceleration zones running northeast to southwest ranging from a high of 20-30 %g in the far east section of the county to a low of about 10-14%g severity in the northwestern corner of the county. The majority of the county is located in the 14-20 %g zone

Two peak acceleration zones can be found in St. Louis County, running northeast to southwest ranging from a high of 20-30%g across most of the county to a low of about 14-20%g in the far west portion of the county.

The City of St. Louis is in one peak acceleration zone ranging between 20-30 %g severity.

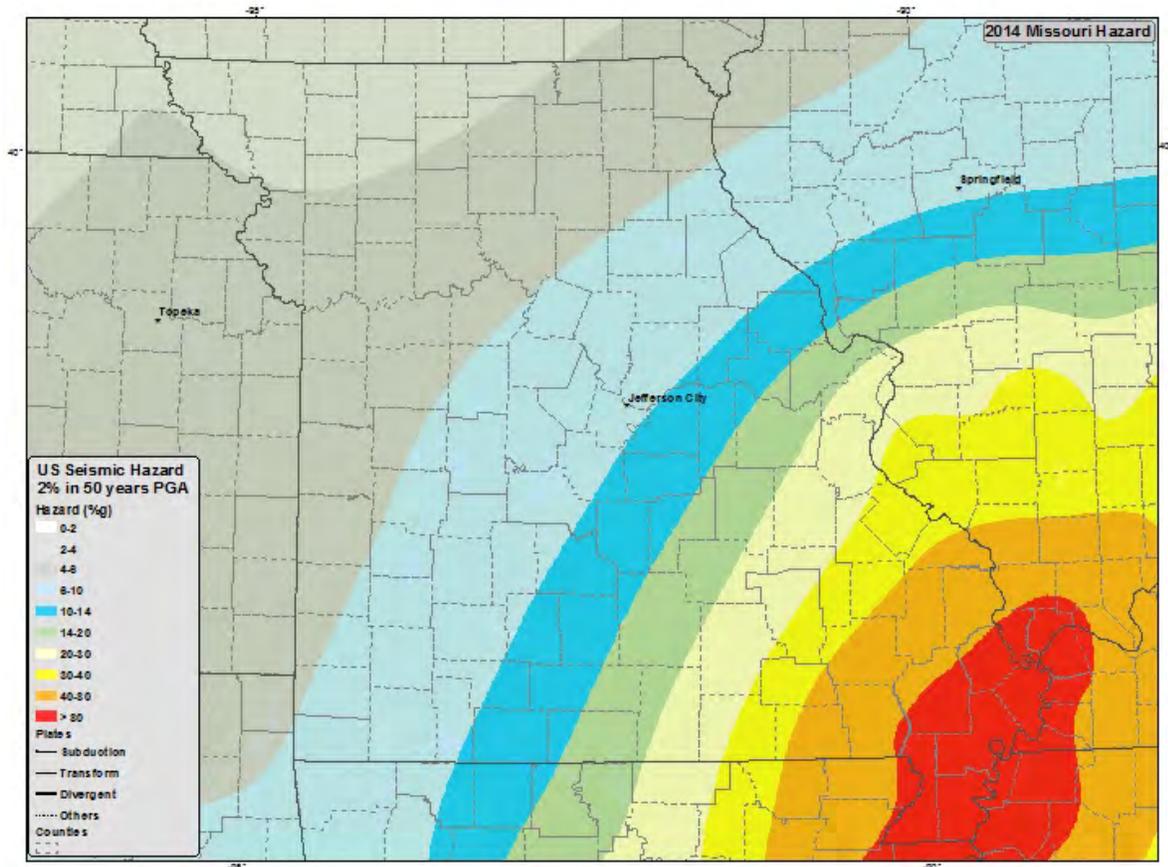
### **Hazard Event History**

Prior to 2014, the NMSZ in the Central Mississippi Valley was the most active seismic area in the U.S. east of the Rocky Mountains. Since then Oklahoma has been the active area in the continental U.S. The region was struck by three of the most powerful earthquakes in United States history. These Richter scale magnitude 7.3 – 7.5 quakes, centered near the town of New Madrid, Missouri and northeast Arkansas, devastated the surrounding region. These earthquakes changed the course of the Mississippi River and created Reelfoot Lake, which covers an area of more than 10 square miles in northwestern Tennessee. In recent decades, earth scientists have collected evidence that strong earthquakes in the central Mississippi Valley have occurred repeatedly in the geologic past. Small earthquakes occur in the region frequently. The NMSZ lies within the central Mississippi Valley, extending from northeast Arkansas, through southeast Missouri, western Tennessee, and western Kentucky to southern Illinois. Historically, this area has been the site of some of the largest earthquakes in North America. Between 1811 and 1812, four catastrophic earthquakes, with Richter scale magnitude estimates greater than 7.0, occurred during a three month period. Hundreds of aftershocks followed over a period of several years. Two earthquakes,

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estimated to measure above 6.0 on the Richter scale, occurred on January 4, 1843 and October 31, 1895. In addition to these events, seven events of Richter scale magnitude 5.0

Figure 3-9 2014 Peak Acceleration (%g) with 2 Percent Probability of Exceedance in 50 Years - Seismic Hazard



Source - U.S. Geological Survey

and greater have occurred in the area. Instruments were installed in and around this area in 1974 to closely monitor seismic activity. According to the Center for Earthquake Research at the University of Memphis, since then 96 earthquakes of magnitude 3 or greater have been recorded, between latitude 36° – 40° north and longitude 88° – 92° west. On average one earthquake per year will be large enough to be felt in the area.

The most recent earthquake event affecting the five county area was on February 3, 2014. The epicenter of the 2.6 Richter scale magnitude earthquake was 11 miles northwest of Potosi in Washington County. While impacts of this quake were inconsequential, Missouri has had three of the largest earthquakes in the contiguous United States; the three ranking #4, #5 and #6 in magnitude ranging from 7.5 to 7.7 on the Richter scale. Projected losses, based on losses from the 1989 Loma Prieta, California earthquake activity, exceeded

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\$6 billion dollars with over 28,000 homes and businesses destroyed and 63 lives lost and 3800 injuries. Earthquakes pose a serious threat to many Missouri communities. Identifying locations susceptible to seismic activity generated by nearby faults, adopting strong policies and implementing measures and using other mitigation techniques are essential to reducing risk from seismic hazards in the five county area. Table 3-21 below depicts the history of the large earthquakes in the continental U.S.

TABLE 3-21 LARGEST EARTHQUAKES IN CONTINENTAL UNITED STATES			
	Location	Date Time UTC	Richter Scale Magnitude
1	<a href="#">Fort Tejon, California</a>	1857 01 09 16:24 UTC	7.9
2	<a href="#">San Francisco, California</a>	1906 04 18 13:12 UTC	7.8
3	<a href="#">Imperial Valley, California</a>	1892 02 24 07:20 UTC	7.8
4	<a href="#">New Madrid, Missouri</a>	1812 02 07 09:45 UTC	7.7
5	<a href="#">New Madrid, Missouri</a>	1811 12 16 08:15 UTC	7.7
6	<a href="#">New Madrid, Missouri</a>	1812 01 23 15:00 UTC	7.5
7	<a href="#">Owens Valley, California</a>	1872 03 26 10:30 UTC	7.4
8	<a href="#">Hebgen Lake, Montana</a>	1959 08 18 06:37 UTC	7.3
9	<a href="#">Kern County, California</a>	1952 07 21 11:52 UTC	7.3
10	<a href="#">West of Eureka, California</a>	1922 01 31 13:17 UTC	7.3
11	<a href="#">California - Oregon Coast</a>	1873 11 23 05:00 UTC	7.3
12	<a href="#">Charleston, South Carolina</a>	1886 09 01 02:51 UTC	7.3

USGS – Historic Earthquakes in the United States and Its Territories

The Table below illustrates seismic events in the five county area and adjacent counties in Missouri and Illinois from 2005 to November 4, 2014 as documented by the U.S. Geological Survey (USGS). In the five county area, there have been three earthquakes with a maximum 2.9 Richter scale. No earthquakes with 5 or greater magnitude. To better understand the earthquake hazard, the scientific community has looked at historical records. Historical earthquake records can be divided into pre-instrumental and the instrumental period. In the absence of instruments, the detection of earthquakes is based on observations and felt reports, and is dependent upon population density and distribution. Newspapers and books from various cities around the nation provide a good source of historical documentation of the earthquakes of 1811-1812. The seismic risk is more severe today than in the past because of increased population and infrastructure design lacking seismic control elements.

Table 3-22 2005 - 2014 Earthquake Events

Date	Location	County	Richter Scale Magnitude
November 23, 2005	Northeast St. Clair County	St. Clair IL	2.5
May 18, 2006	Southern Jefferson County	Jefferson MO	2.9
May 5, 2008	Northeast Jefferson	Jefferson MO	2.8

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Date	Location	County	Richter Scale Magnitude
	County		
March 7, 2009	Northeast Crawford County	Crawford MO	2.6
October 25, 2009	Southern Washington/St. Francois Counties	Washington/St. Francois Counties	2.3
August 11, 2010	Northern Ste. Genevieve County	Ste. Genevieve MO	2.5
January 30, 2011	Central St. Francois County	St. Francois MO	2.0
June 7, 2011	24 km (14.9 mi ) NNW of Potosi	Washington MO	3.9
January 20, 2013	Western Monroe County	Monroe IL	2.4
April 10, 2013	10 km (6.2 mi) WSW of New Haven	Franklin MO	2.3
October 11, 2013	6 km (3.7 mi ) SSW of Columbia	Monroe IL	1.9
November 25, 2013	8 km (4.9 mi ) NE of Bonne Terre	St. Francois MO	2.6
December 4, 2013	7km ( 4.3 mi) SE of Farmington	St. Francois MO	2.1
February 3, 2014	18 km (11 mi) NW of Potosi	Washington MO	2.6

Source - Earthquake Archive Search, Earthquake Hazards Program, U.S. Geological Survey

The map (Figure 3-10) below shows earthquakes that have occurred in the proximity of the St. Louis Metropolitan area from 1973 through 2012.

**Probability of Occurrence - High**

Earthquake scientists cannot predict the frequency of occurrence, although some have tried. While estimates of the recurrence intervals of the large 1811-1812 earthquakes are about 500-1,000 years, smaller earthquakes of magnitude 5.5 to 6.0 are more likely in the region, but would have much smaller areas of damaging shaking. The last such earthquake was in 1895 near Charleston, Missouri.

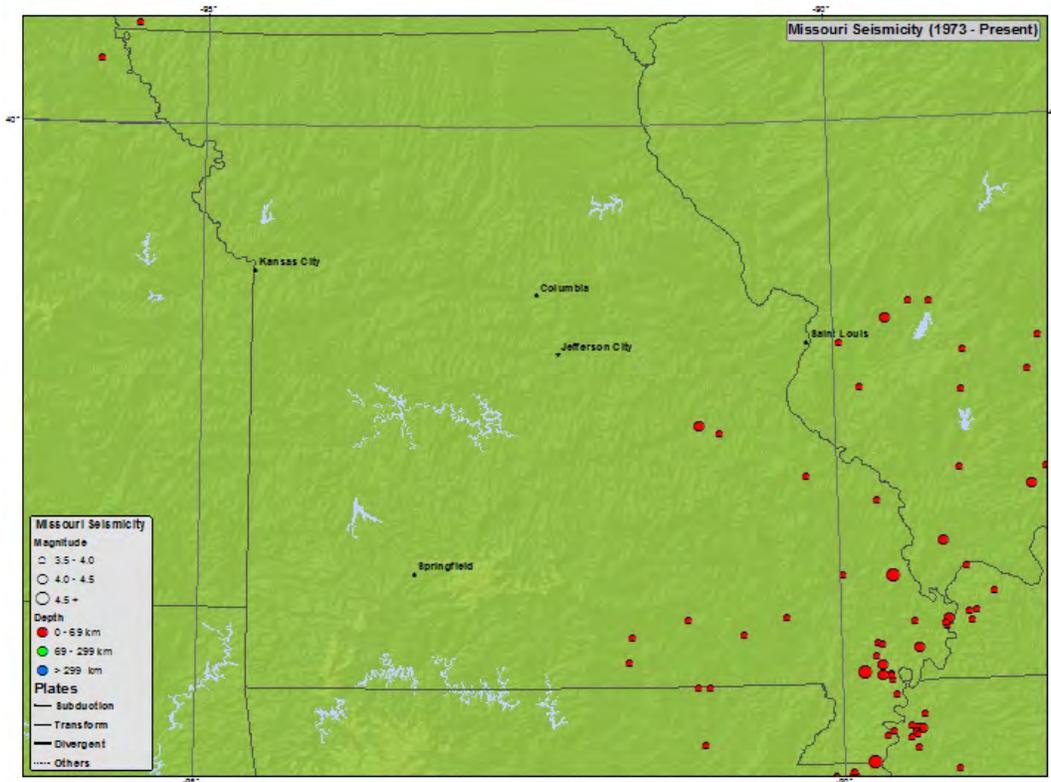
Another earthquake as powerful as the great quakes of 1811-12 may not occur for many years. In 2009, the USGS estimated the chance of an earthquake similar to those of 1811-12 is about seven to ten percent in the next fifty years and the chance of a magnitude 6 Richter scale or larger at 25 to 45 percent in that same time frame. Because of differences in the geology east and west of the Rocky Mountains, the effects of a Richter scale magnitude 7 quake in the mid-continent United States could be far worse than those of the 1989 Richter scale magnitude 6.9 Loma Prieta, California, earthquake.

In response to this threat, the USGS has been leading an effort to understand the causes of earthquakes in the Mississippi Valley. Initiated in the 1980s, this ongoing cooperative endeavor among universities, private agencies, state governments, and Federal agencies has two goals--to evaluate the level of the earthquake hazard and to help reduce the risk

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to lives and property from future quakes in the region. The USGS is currently working with the Missouri and Illinois geological surveys to study soil conditions in and around the St. Louis region. They are utilizing soil samples from borings taken from public construction projects such as highways, bridges and sewers. This study will last about five years.

Figure 3-10 Missouri Seismicity map 1973-2012, USGS



Source - U.S. Geological Survey

The NEIC now locates about 50 earthquakes each day, or about 20,000 a year. Refer to Table 3-23.

TABLE 3-23 FREQUENCY OF EARTHQUAKES WORLDWIDE		
Descriptor	Richter Scale Magnitude	Average Annually
Great	8 and higher	1 <sup>1</sup>
Major	7 - 7.9	15 <sup>1</sup>
Strong	6 - 6.9	134 <sup>2</sup>
Moderate	5 - 5.9	1319 <sup>2</sup>
Light	4 - 4.9	13,000 (estimated)
Minor	3 - 3.9	130,000 (estimated)
Very Minor	2 - 2.9	1,300,000 (estimated)

<sup>1</sup> Based on observations since 1900.

<sup>2</sup> Based on observations since 1990.

Source - Earthquake Hazards Program, U.S. Geological Survey

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Earthquake prediction is a future possibility but far from likely happening in the coming decades. Earthquake research was stepped up after the Alaska shock in 1964. Today, research is being conducted by the USGS and other federal and state agencies, as well as universities and private institutions.

The magnitudes of the historic earthquakes listed above in the New Madrid Seismic Zone range from 2.4 to 7.5 on Richter scale. These most recent earthquakes did not affect the five county area. The USGS and the Center for Earthquake Research and Information at the University of Memphis (CERI) have forecast that the probability of an earthquake event is rated as moderate and the severity is rated as high.

The five county area and the Midwest are located in proximity to the NMSZ. The other fault zones mentioned above including the Wabash Valley in southeastern Illinois and seismicity in the vicinity of Farmington to Cape Girardeau, Missouri are also known to produce earthquakes in recent history. The Wabash Valley Seismic Zone has produced three earthquakes of magnitude 5.0 to magnitude 5.4 since 1968, some of which minor damage in St. Louis. Instruments were installed in and around this area in 1974 to closely monitor seismic activity. On average one earthquake per year will be large enough to be felt in the area.

### **Severity – High**

Percentage of Land Area Affected by Hazard – 25 to 50 percent

The speed of onset is immediate. An earthquake can occur at anytime with most not receiving emergency care for the first 72 to 96 hours.

Buildings on poorly consolidated and thick soils will typically have more damage than buildings located on consolidated soils and bedrock. Soils and soft sedimentary rocks near the earth's surface and landfills can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the size of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk. Earthquakes have the potential to destroy roads, bridges, buildings (especially buildings constructed of masonry or those buildings which are not designed to seismic standards), utilities (including those not designed to seismic standards). Building damage can range from minor foundation cracks to complete leveling of the structure. Refer to Figures 3-11 and 3-12 below. Building contents can be broken from being knocked onto the floor or being crushed by the ceiling, walls and floor failing. Dams and levees have the potential to fail, resulting in the flooding of downstream regions including residentially populated areas.

FIGURE 3-11 INTERIOR



FIGURE 3-12 EXTERIOR

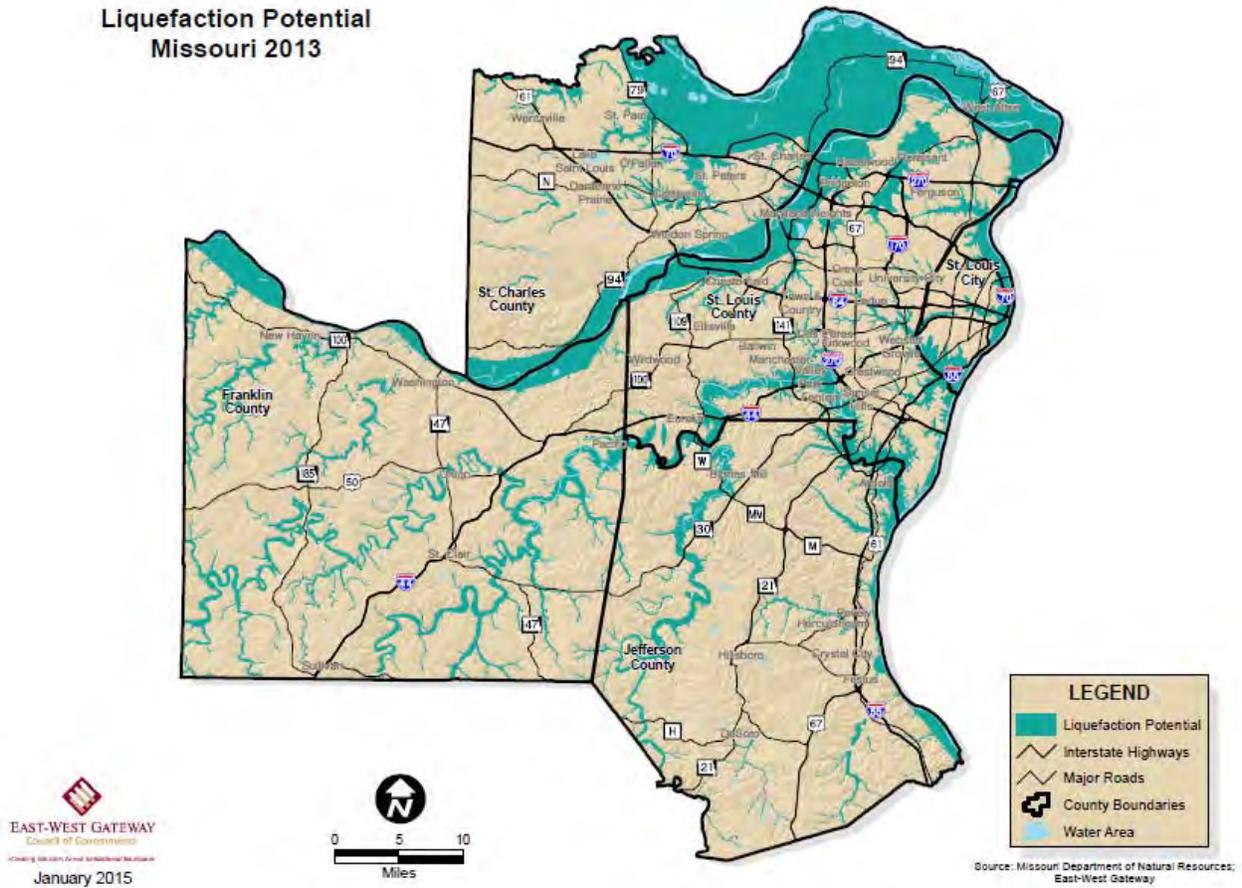


Source for both photographs: United States Geological Survey website

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. (Figure 3-13) This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these structures. Damage from liquefaction can destroy the buildings and the foundations the buildings rest on. Liquefaction has been documented from the New Madrid Fault Zone earthquake activity. Certain portions of the five county area would be predisposed to earth movements including earthquakes due to their position within the soil liquefaction zone found along floodplains of major rivers and streams, as identified by Missouri Department of Natural Resources, Geological Survey Resource Assessment Division. Areas outside of the soil liquefaction zone will most likely be impacted from an earthquake, but probably to a lesser degree.

Earthquakes can be measured by intensity or by magnitude. The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for 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. It measures the size of the earthquake at its source. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value. The Richter Scale is not used to express damage. An earthquake in a densely populated area which results in many

Figure 3-13 Liquefaction Potential



deaths and considerable damage may have the same magnitude as a shock in a remote area that does nothing more than scare the wildlife. Large-magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

The Modified Mercalli Scale is an intensity scale based on observable earthquake damage which can be subjective. It measures the amount of shaking at a particular location. The intensity of an earthquake will vary depending on where you are. From a scientific standpoint, the Richter scale is based on seismic records while the Mercalli is based on observable data that can be subjective. Thus, the Richter scale is considered scientifically more objective and therefore more accurate. For example a level I-V on the Mercalli scale would represent a small amount of observable damage. At this level doors would rattle, dishes break and weak or poor plaster would crack. As the level rises toward the larger numbers, the amount of damage increases. The top number, XII, represents total damage.

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The St. Louis Metropolitan region is approximately 150 miles from the New Madrid Fault Zone. If an earthquake of Richter magnitude 6.6 or so occurred, the five county area would be impacted; a lot of the damage would be minor, and not many collapses. If there was an earthquake of Richter scale magnitude 7, there would be widespread damage.

**Table 3-24 MODIFIED MERCALLI INTENSITY SCALE**

MMI Value	Description
I	People do not feel any earth movement.
II	Felt by persons at rest, on upper floors of tall buildings.
III	Felt by persons indoors. Hanging objects swing back and forth. Vibrations from the earthquake may seem like the passing of light trucks. May not be recognized as an earthquake.
IV	Hanging objects swing. Vibrations may seem like the passing of heavy trucks or a jolt, like heavy ball striking the walls. Parked vehicles may rock noticeably. Windows, dishes, doors may rattle and glasses clink. In the upper range IV, walls of wood frame buildings may creak.
V	Almost everyone feels movement whether inside or outdoors. Sleeping people are awakened. Liquids in containers are disturbed; some are spilled. Small unstable objects are displaced or overturned. Doors swing, close or open. Shutters, pictures on the wall move.
VI	Felt by all; some are frightened and take cover. People have difficulty walking due to motion. Objects fall from shelves and dishes, glassware and ceramics may be broken. Pictures fall off walls. Furniture moves or is overturned. Weak plaster and masonry cracked. Damage slight in poorly constructed buildings. Trees, bushes shaken visibly or are heard rustling.
VII	People have difficulty standing. Drivers on the road feel their cars shaking. Furniture may be overturned and broken. Loose bricks fall from buildings a masonry walls and cracks in plaster and masonry may appear. Weak chimneys may break at the roofline. Damage is slight to moderate in well-built structures; considerable in poorly constructed buildings and facilities.
VIII	Drivers have trouble steering. Tall structures such as towers, monuments may twist and fall. Wood frame houses that are not bolted to their foundations may shift and sustain serious damage. Damage is slight to moderate in well-constructed buildings, considerable in poorly constructed buildings. Branches are broken and fall from trees. Changes occur in flow or temperature of springs and wells. Cracks appear in wet ground and steep slopes.
IX	Masonry structures and poorly constructed buildings suffer serious damage or collapse. Frame structures, if not bolted, shift off foundations. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in the ground. In alluvial areas, sand and mud ejected and sand craters are formed
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations.
XI	Few, if any masonry structures remaining standing. Bridges destroyed. Rails bent greatly. Serious damage to dams, dikes and embankments. Large landslides occur. Water thrown on the banks of canals, rivers and lakes.
XII	Damage total. Line of sight and level are distorted. Objects thrown in air.

**Table 3-25 Richter Magnitude/Mercalli Intensity Comparison**

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

Source - Earthquake Hazards Program, U.S. Geological Survey

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A 1990 FEMA report estimated that if the NMSZ were to quake at a range of 7.6 magnitude on the Richter scale, there would be 260 deaths, 1,060 serious injuries and approximately \$2 billion in damages. According to Col. Mark McCaster the residents would be “on their own” for the first 72 to 96 hours following a major quake. According to Shannon Marquez of IEM, models have shown over 30,000 highway bridges and 86,000 miles of highways could be damaged profoundly disrupting transcontinental commerce. A 25 percent reduction in availability of natural gas just “in the Chicago area alone could be disrupted” (Marquez). Refineries producing over 300,000 barrels of oil a day could also be affected. According to the Mid-America Earthquake Center at the University of Illinois at Urbana Champaign, more than 250,000 buildings would suffer severe damage, 260,000 displaced, and over 60,000 casualties would result.

The next disaster’s likely adverse impact on the five county area could be critical in terms of amount of damage to infrastructure (utilities, communications) buildings, deaths and other cascading disasters including fire and explosions from natural gas and oil pipeline ruptures.

At the time of the New Madrid earthquake in 1811-1812, St. Louis and other major cities in the central U.S. were sparsely settled and there were few man-made structures. Today, this region is home to millions of people, including the populations of large cities, such as St. Louis, Missouri, and Memphis, Tennessee. A repeat today of the earthquakes of 1811-12 would cause widespread loss of life and billions of dollars in property damage. The potential for the recurrence of such earthquakes and their impact today on densely populated cities in and around the seismic zone has generated much research devoted to understanding earthquakes. By closely monitoring the earthquake activity, scientists can hope to understand their causes, recurrence rates, ground motion and disaster mitigation.

Earthquakes pose a serious threat to many Missouri communities. Local governments, planners, and engineers must consider the threat as they seek to balance development and risk. Identifying locations susceptible to seismic activity generated by nearby faults, adopting strong policies and implementing measures and using other mitigation techniques are essential to reducing risk from seismic hazards in the five county area.

Based on January 2003 estimates, Franklin County is at most risk for MMI Level VI likely adverse impacts from an earthquake of 7.6 magnitude on the Richter scale. For planning purposes Level VII should be used due to the geological setting of Franklin County and the alluvial soils along the Missouri River. Jefferson County is at most risk for MMI Level VII likely adverse impacts from a 7.6 Richter scale magnitude earthquake. Due to the alluvial soils along the Mississippi River in Jefferson County, MMI Level VIII should be used for planning purposes. St. Charles County is at most risk for MMI Level VII adverse impacts based on an earthquake of 7.6 Richter scale magnitude. However, due to the geological setting in St. Charles County (alluvial soils along the Missouri and Mississippi Rivers), MMI Level VIII should be used for planning purposes. St. Louis County is at most risk for MMI Level VIII adverse impacts from a 7.6 Richter scale magnitude earthquake. Because of the alluvial soils along the Missouri and Mississippi Rivers, MMI Level IX should be used for

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planning purposes in St. Louis County. The City of St. Louis is at most risk for MMI Level VIII as likely adverse impacts from an 7.6 Richter scale magnitude earthquake. However, due to the geologic setting in the City of St. Louis in terms of alluvial soils along the Mississippi River, Level IX should be used for planning purposes. The possible effects at these different levels are shown below.

### Bridge Integrity/Mitigation Efforts

An earthquake along the New Madrid fault of a 6.7 magnitude on the Richter scale could affect between 230 to 700 counties in eight states. Retrofitting of bridges and buildings are one way to decrease the potential socio-economic costs and lives lost. According to the Missouri Department of Transportation (MoDOT) there is currently no program to address seismic upgrades with the exception of the elevated I-64/U.S. 40 double-decker approach to the interstate Poplar Street bridge over the Mississippi River as there is just no money for that type of program. Since the expenses are too great to address this, it may be cheaper to replace the bridge and meet seismic requirements, than to try and retrofit them. MODOT assesses seismic needs in replacing bridges and in major rehab projects. Located in Appendix G is a list of bridges in the five county area rated by their structural integrity.

### **Vulnerability**

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to earthquake. The HAZUS-MH model was used to estimate by county direct economic building loss and income. The loss ratio is the sum of structural and nonstructural damage divided by the entire building inventory value within a county. This shows the economic impacts an earthquake could have and the challenge for a community to recover. The HAZUS-MH model was also used to estimate building-related losses by county, both structural and non-structural for a two percent probability of peak ground acceleration (shaking). Damage to structural components can affect the length of a disruption and the process to recover. This model also estimated the social impact (casualty, displaced households, shelter needs) by county if this scenario occurred at 2 a.m. when residents would be at home.

Table 3-26 HAZUS-MH Earthquake Loss Estimation Annualized Loss Scenario

County	Building Loss (\$)	Loss Ratio (%)	Income Loss (\$)	Total Loss (\$)
Franklin	1,285,000	0.015	374,000	1,659,000
Jefferson	3,538,000	0.023	904,000	4,442,000
St. Charles	3,581,000	0.013	1,087,000	4,667,000
St. Louis	20,568,000	0.018	5,851,000	26,419,000
City of St. Louis	9,279,000	0.023	3,000,000	12,279,000

Source - July 2010 Missouri State Hazard Mitigation Plan

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Table 3-27 HAZUS-MH Earthquake Loss Estimation 2% Probability of Peak Ground Acceleration Exceedance in 50 Years Scenario

County	Structural Damages (\$)	Non-Structural Damages (\$)	Contents Damage and Inventory Loss (\$)	Loss Ratio (%)*	Income Loss (\$)	Total Economic Loss (\$) **
Franklin	157,351,000	439,710,000	174,438,000	9.08	220,136,000	991,634,000
Jefferson	396,384,000	1,233,043,000	430,121,000	13.08	507,402,000	2,566,950,000
St. Charles	424,992,000	1,257,925,000	457,333,000	7.92	635,200,000	2,775,449,000
St. Louis	2,257,701,000	6,857,154,000	2,626,807,000	10.39	3,255,953,000	14,997,616,000
City of St. Louis	944,521,000	2,062,672,000	1,247,462,000	12.94	1,647,357,000	6,902,013,000

\*Loss Ratio is the sum of structural and nonstructural damage divided by the entire building inventory value within a county

\*\*Total Economic Loss includes inventory loss, relocation loss, capital-related loss, wages lost and rental income loss

Source - July 2010 Missouri State Hazard Mitigation Plan

Table 3-28 HAZUS-MH Social Impact Estimates from the 2% Probability of Peak Ground Acceleration Exceedance in 50 Years Scenario at 2 a.m.

County	MMI Zone*	Level1	Level2	Level3	Level4	Total	Displaced Households	Short-Term Shelter Needs
Franklin	VI	426	98	12	23	559	763	478
Jefferson	VII	1,513	377	48	93	2,030	2,827	1,773
St. Charles	VII	1,080	252	33	65	1,430	2,243	1,259
St. Louis	VIII	2,034	519	76	149	2,778	8,832	6,995
City of St. Louis	VIII	5,216	1,302	187	367	7,072	14,609	8,518

\*Modified Mercalli Index

Source - July 2010 Missouri State Hazard Mitigation Plan

Table 3-29 Casualty Severity, Displaced Households and Short-Term Shelter Needs Descriptions

Term	Description
Level1	Injuries will require medical attention but hospitalization is not needed
Level2	Injuries will require hospitalization but are not considered life-threatening
Level3	Injuries will require hospitalization and can become life-threatening if not promptly treated
Level4	Victims are killed by the earthquake
Displaced Households	The number of households that are expected to be displaced from their homes due to the earthquake
Short-Term Shelter Needs	The number of displaced people that will require accommodations in temporary public shelters

Source - July 2010 Missouri State Hazard Mitigation Plan

## **Problem Statement**

Although there is a low probability in any given year, there is very high potential for severe, widespread damage from a large earthquake. Earthquake damage zones have been identified. What communities can do is to be prepared with effective communications systems in the event of widespread power outages, and with effective construction ordinances that require buildings to be constructed to withstand earthquakes. In addition, the public is generally unaware of the risk and what individuals can do to be prepared in advance as well as immediately after an earthquake.

In 2011, Missouri and seven surrounding states participated in the National Level Exercise 2011. It was a five day training effort focused on a coordinated non-government and government response a 7.7 Richter scale magnitude earthquake in the New Madrid Seismic Zone. The State of Missouri has participated in the Central U.S. Shakeout Earthquake drills over the last several years. Allen Lehmen of the State Emergency Management Agency stated that Missouri is "enormously prepared." He also added that he does not know if we're ever ready for anything. A disaster of this nature needs to be addressed on a National, State, and Local level for local governments to understand "state assets are available to them."

Emergency preparedness is key in all major disasters. The retrofitting of unreinforced masonry buildings (in particular, schools, hospitals and other critical facilities) and transportation routes is a necessity but in the large part not economical. National, state, and local governments must work together to create an annual plan on how the area would respond to a major earthquake.

## **3. Tornado Hazard Profile**

### **Description of Hazard**

When severe storms hit a community, they leave behind a distinctive trail. Toppled trees, damaged buildings and cars, downed power lines crossing roadways and widespread power outages are signs that a storm has struck. After such events, it can take communities weeks to return to normal. These storms result in costly structural damages, personal injury, property damage and death.

A tornado is a vortex of rapidly rotating air that extends from a thunderstorm to the ground. Supercell thunderstorms are often the producers of violent tornadoes. To be a tornado, the swirling winds must be at the surface, capable of doing damage. If there is debris (dust and other objects swirling in the winds), it is definitely a tornado, even if there is no visible funnel cloud. If there is no debris with a funnel cloud, then it might be a tornado but one cannot be certain that it is (or is not). All funnel clouds should be treated as if they are tornadoes, unless one can be certain that they will not touch down and being certain about such things is difficult. Refer to Figure 3-14 below.

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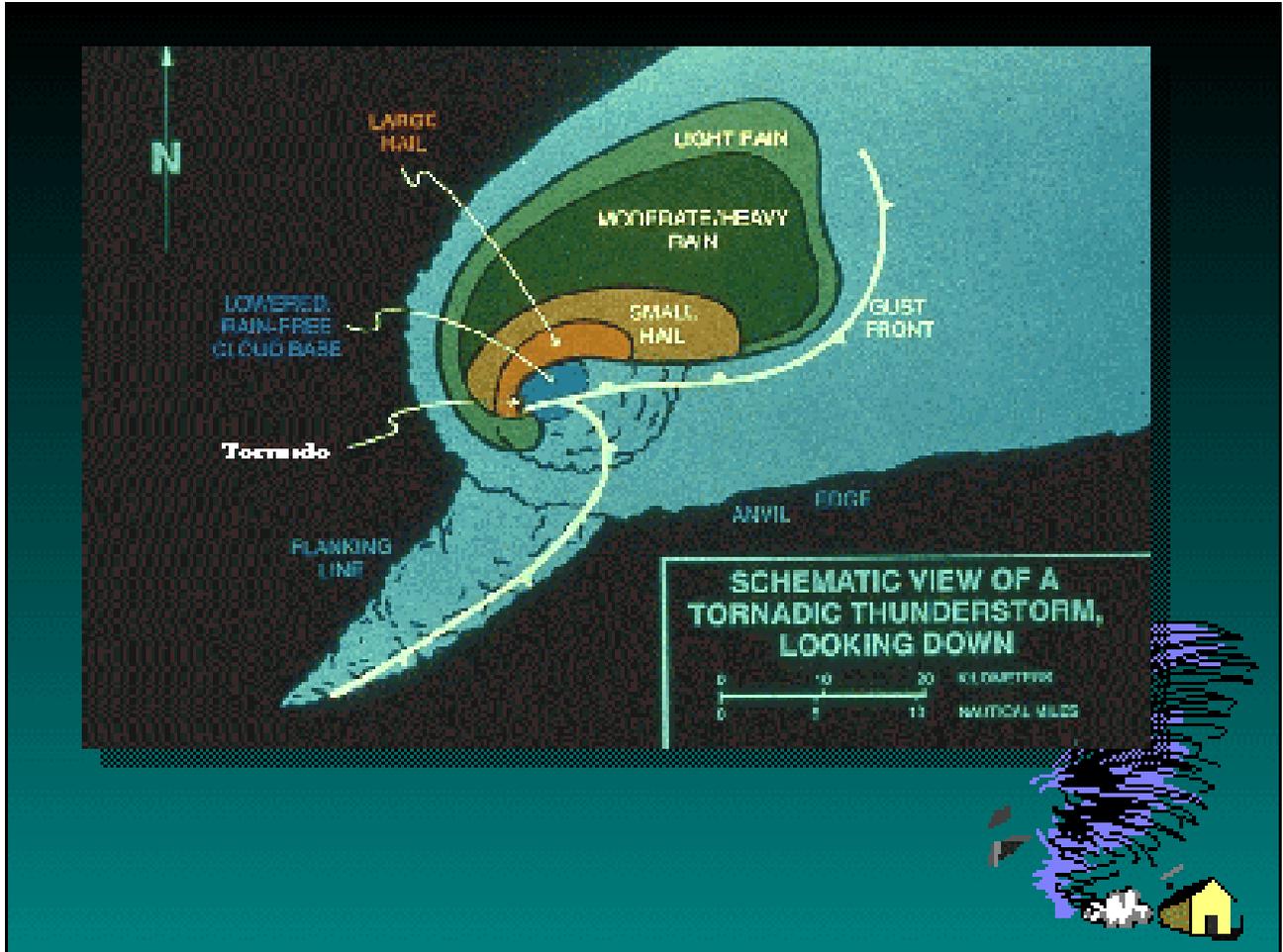
The most threatening situation would be for a very intense convective wind event that also affected a large area. A few times each year in North America, extreme convective wind events of this sort do occur. To date, no such storm has struck a major city during a vulnerable time (e.g., the morning or evening rush hours). However, it is only a matter of time until this actually occurs. Given that the area affected can approach that of a tropical cyclone's damage swath, and certainly far exceeds that affected during a tornado outbreak (while not being as intense, of course), it is uncomfortable to imagine the potential devastation. When such storms are accompanied by large hail (equal to or greater than 1.9 inches in diameter) the damage potential increases exponentially. The occurrence of hail has resulted in some of the costliest storms in United States history; coupling a fall of large hail with winds approaching 112 miles per hour could produce incredible damage in a populated area. Of course, economic losses to agriculture from such storms are already high, but do not attract much public attention, and such losses would be very difficult to mitigate with a 20-30 minute warning. The large area covered by such storms can result in major property losses.

A timely forecast may not be able to do much to mitigate the property loss, but could reduce the casualties. It appears possible to forecast these extreme events with some skill, but further research needs to be done to test the existing hypothesis about the interaction between the convective storm and its environment that produces the extensive swath of high winds.

Convective wind events are a hazard to societies the world over, doing considerable damage and occasionally generating many casualties. Most convection produces some straight-line wind as a result of outflow generated by the convective downdraft, and so anyone living in convection-prone areas of the world has experienced this phenomenon. On rare occasions, the intensity of the wind achieves the potential for doing damage. Although engineered structures typically are quite resistant to wind damage, many homes and outbuildings are quite vulnerable to damage from even relatively modest windstorms. In the United States, it is assumed that the potential for wind damage begins at around 56 miles per hour. Of course, considerable damage occurs in situations where there was no anemometer, and so wind damage is graded according to its character: e.g., damage to tree limbs is considered non-severe, but uprooted trees are considered to represent a severe event.

Various human activities place people at risk from convective winds, notably aircraft operations and recreation. Most casualties from convective windstorms in the United States arise from such situations. Given the high vulnerability of aircraft operations during takeoff and landing procedures (the aircraft are operating on the margins of their flight "envelope" during such times); it does not take a particularly intense event from a meteorological standpoint to create many casualties. Commercial aircraft are less vulnerable than private aircraft, but their high occupancy means that rare events can have a large impact on

FIGURE 3-14 VIEW OF TORNADIC THUNDERSTORM



Source: NOAA

casualty figures. Recreational boating also can account for many casualties in relatively modest windstorms, whereas most commercial craft are unlikely to be affected by marginal convective wind events.

### Location

The risk of a tornado event is the same throughout the five county area.

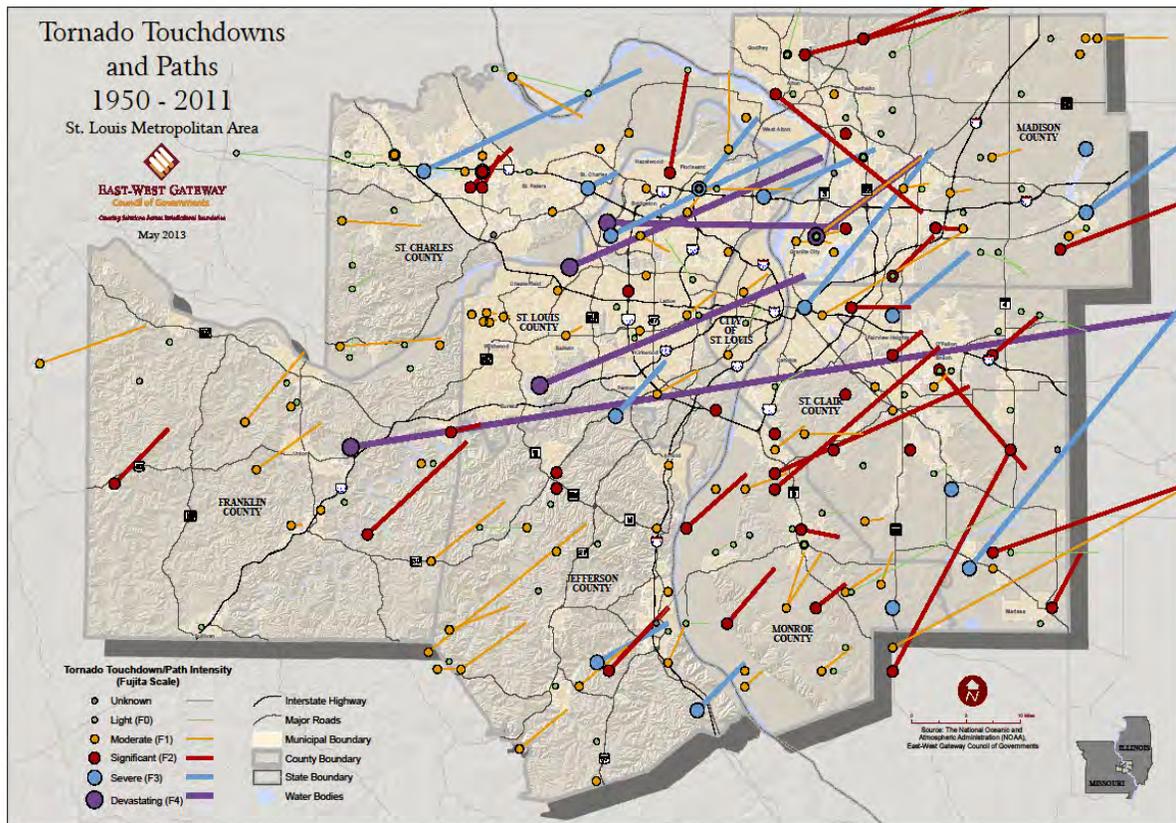
Whenever and wherever conditions are right, tornadoes are possible, but they are most common in the central plains of North America, east of the Rocky Mountains and west of the Appalachian Mountains. The map depicts those areas within the planning region that have experienced tornadoes. Since 1950, St. Charles County with 42 tornadoes has had the most tornado outbreaks, with St. Louis County second with 38. Jefferson County has had 31 tornadoes, Franklin County 25 and St. Louis City the least with six. However, these

## St. Louis Regional Hazard Mitigation Plan

statistics don't necessarily predict future likely locations of tornadoes since St. Louis and St. Charles Counties cover larger areas of land. Whenever and wherever conditions are right, severe thunderstorms are possible.

Based on the available data, there is no predictable pathway for the tornadoes and windstorms to follow. In general, though, these storms run in a southwest to northeast direction. Refer to Figure 3-15 below that depicts the distribution of storms across the bi-state region. One can see that each county has had multiple tornadoes.

### FIGURE 3-15 REGIONAL TORNADO STORM TRACKS



Source: NOAA

Refer to maps in the Appendix – Map Sets – County Natural Hazards which depict the areas and structures that are susceptible to severe windstorms including tornadoes, thunderstorms, and hail. The following tables identify those communities (incorporated and unincorporated) which have concentrations (five percent or greater) of mobile homes. There are no incorporated communities in St. Louis in which mobile homes make up five percent or more of the total residential structures. Mobile homes make up less than one percent of the total residential structures found in the City of St. Louis.

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Table 3-30 Mobile Homes in the Five County Area

County	Total Residential Structures	Number of Mobile Homes	Mobile Homes Percent Share
Franklin	43402	4894	11.3
Jefferson	87,706	10,759	12.3
St. Charles	141,259	4,546	3.2
St. Louis	437,803	1,335	0.3
City of St. Louis	175,855	466	0.3

Source – 2012 5 Year American Community Survey

Table 3-31 Places in Franklin County Where Mobile Homes Make Up 5 Percent or More of Total Residential Structures

Incorporated		Unincorporated	
Community	Mobile Home Percent Share	Census Designated Place	Mobile Home Percent Share
Berger	10.8	Gray Summit	20.4
Gerald	15.4	Villa Ridge	23.8
Leslie	23.4		
Oak Grove Village	54.2		
Parkway	8.5		
St. Clair	10.5		
Union	5.8		

Source – 2012 5 Year American Community Survey

Table 3-32 Places in Jefferson County Where Mobile Homes Make Up 5 Percent or More of Total Residential Structures

Incorporated		Unincorporated	
Community	Mobile Home Percent Share	Census Designated Place	Mobile Home Percent Share
Arnold	9.4	Cedar Hill	14.6
Byrnes Mill	32.9	High Ridge	6.3
Hillsboro	5.4	Horine	10.9
Kimmswick	23.0	Imperial	15.3
Olympian Village	34.2	LaBarque Creek	5.0
Pevely	30.2	Murphy	23.6

Source – 2012 5 Year American Community Survey

Table 3-33 Places in St. Charles County Where Mobile Homes Make Up 5 Percent or More of Total Residential Structures

Incorporated		Unincorporated	
Community	Mobile Home Percent Share	Census Designated Place	Mobile Home Percent Share
Augusta	10.7	Defiance	14.5

Source – 2012 5 Year American Community Survey

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**Hazard Event History**

The tornado categorized as an F-4 occurred on May 27, 1896 in the City of St. Louis was third on the list of 10 top weather events of the century. The May 1896 storm was the ninth costliest storm in the United States, costing over \$285 million dollars (2014 dollars) in property damage and the third deadliest storm in the United States, killing 255 people and injuring 1,000. Tables 3-34 through 3-36 reflect the history of storms that have occurred in the five county area since 1950. Please refer to the 2009 Plan Update and Appendix G for information on severe thunderstorm and wind storm events which occurred prior to 2010.

Tornado events by county and damage estimates are presented in Table 3-31. Since 1950 there have been 136 tornadoes with estimated property damage of \$230 million. The tornado events which have occurred in the five county area from 2005 to October 31, 2014 are listed in Table 3-32. During this period there were 44 tornadoes with one death and 23 injuries. The majority of these tornadoes have been classified as EF-0 and EF-1. Information on EF-1 and greater tornadoes which have occurred since January 2005 can be found in Table 3-36.

Table 3-34 1950 – October 31, 2014 Tornado Events by County

Location	Number	Deaths	Injuries	Property Damage (\$)	Crop Damage (\$)
Franklin	25	0	18	1,928,000	5,500
Jefferson	33	1	0	8,713,000	10,500
St. Charles	33	0	84	90,633,000	0
St. Louis	39	15	425	104,181,000	0
City of St. Louis	6	11	177	25,275,000	0

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

Table 3-35 2005 – October 31, 2014 Tornado Events by County - All F/EF Categories

Dates	Number of Tornado Events					Total
	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis	
November 27, 2005				1		1
January 2, 2006			1	1		2
March 13, 2006		2				2
September 22, 2006		2				2
March 31, 2007					1	1
April 24, 2010				2		2
April 30, 2010		1				1
December 31, 2010	4	3	1	2	1	11
February 27, 2011	1		1	5		7
April 22, 2011			1	1		2
August 31, 2012			1			1
April 10, 2013	1			1	1	3
May 31, 2013	1	1	1	2		5
April 3, 2014				1		1

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Dates	Number of Tornado Events					Total
	Franklin	Jefferson	St. Charles	St. Louis	City of St. Louis	
June 7, 2014			1	1		2
September 1, 2014		1				1
<b>Total</b>	7	10	7	17	3	44

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

Table 3-36 2005 – October 31, 2014 - EF1 and Greater Tornadoes in the Five County Area

Location	County	Magnitude	Length (Miles)	Width (Yards)	Deaths	Injuries	Property Damage (\$)
<b>January 2, 2006</b>							
Creve Coeur	St. Louis	F1	1	50	0	0	0
<b>March 11, 2006</b>							
Unincorporated	Jefferson	F3	3.1	200	0	0	0
<b>September 22, 2006</b>							
Unincorporated	Jefferson	F1	0.1	50	0	0	0
Unincorporated	Jefferson	F1	0.7	100	0	0	0
<b>April 30, 2010</b>							
Unincorporated	Jefferson	EF1	17.6	581	0	0	0
<b>December 31, 2010</b>							
Unincorporated	Franklin	EF1	0.8	100	0	0	40K
Unincorporated	Franklin	EF2	11.38	370	0	0	0
Unincorporated	Jefferson	EF1	6.6	50	0	0	0
Unincorporated	Jefferson	EF1	0.81	150	0	0	0
Ballwin	St. Louis	EF1	1.7	175	0	0	0
Fenton, Sunset Hills, Crestwood	St. Louis	EF3	5.79	440	1	6	1M
City of St. Louis	City of St. Louis	EF1	2.71	100	0	0	0
<b>February 27, 2011</b>							
Unincorporated	Franklin	EF1	3.15	50	0	0	0
Unincorporated, Augusta	St. Charles	EF1	6.2	200	0	0	0
Babler State Park Wildwood	St. Louis	EF1	0.15	50	0	0	0
Babler State Park Wildwood	St. Louis	EF1	0.36	75	0	0	0
Babler State Park Wildwood	St. Louis	EF1	0.91	200	0	0	0
Babler State Park Wildwood	St. Louis	EF1	0.74	50	0	0	0
Wildwood	St. Louis	EF1	0.6	70	0	0	0
<b>April 22, 2011</b>							
Unincorporated	St. Charles	EF1	7.35	250	0	0	0
Maryland Heights, Bridgeton, St. Ann, Lambert St. Louis International Airport, Berkeley, Ferguson, Dellwood, Bellefontaine	St. Louis	EF4	16.2	880	0	5	30M

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Location	County	Magnitude	Length (Miles)	Width (Yards)	Deaths	Injuries	Property Damage (\$)
Neighbors							
<b>April 10, 2013</b>							
Unincorporated	Franklin	EF1	1.32	200	0	0	0
Bridgeton, Hazelwood, Florissant	St. Louis	EF2	6.75	500	0	2	4M
<b>May 31, 2013</b>							
Unincorporated	Franklin	EF1	9.98	550	0	0	0
Unincorporated	Jefferson	EF1	12.41	200	0	0	0
Unincorporated, Weldon Spring, Weldon Spring Heights, O'Fallon, St. Peters, St. Charles	St. Charles	EF3	14.76	950	0	8	50M
Unincorporated, Maryland Heights, Bridgeton, Berkeley, Kinloch, Ferguson, Dellwood, Bellefontaine Neighbors	St. Louis	EF2	16.95	1,760	0	0	10M
Unincorporated	St. Louis	EF1	2.01	50	0	0	0
<b>April 3, 2014</b>							
Olivette, University City	St. Louis	EF1	0.63	100	0	0	0
<b>September 1, 2014</b>							
Unincorporated	Jefferson	EF 1	6.4	60	0	0	0

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

**Probability of Occurrence - High**

Between 2005 and October 2014 (10 years), eight years included tornadoes for an 80 percent chance of a tornado in any given year in the five county area.

Tornadoes occur mostly during the spring and summer; the tornado season comes early in the south and later in the north because spring comes later in the year as one moves northward. By nature, tornadoes occur at random. They usually occur during the late afternoon and early evening. However, they have been known to occur in every state in the United States, on any day of the year, and at any hour.

The occurrence of tornadoes in the five county area ranges from fairly low in the City of St. Louis to fairly high in the other counties. Based on information from the National Oceanic and Atmospheric Administration, tornadoes occur between five to seven times per 10,000 square miles per year in the five county area. FEMA indicates that there are between six to ten tornadoes per 1,000 square miles in the five county area.

Ostby (1993) found that the occurrence of weak tornadoes (F0-F1) has shown a dramatic increase since 1980, while the number of strong and a violent tornado have either remained steady or decreased. Reasons for this include improved verification efforts by local NWS offices and the marked increase in storm chasing and tornado reports. Since

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strong and violent tornadoes produce a more stable long-term data set, these categories were the main focus of this study.

### **Severity - High**

Percentage of Land Area Affected by Hazard – Less than 10 percent

Severe windstorms range in type from downdrafts to tornadoes. The most frequent surface winds in Missouri originate from the west and southwest. These winds are associated with storms moving into the region from Kansas and Oklahoma. Tornadoes range in size and severity. The dimensions of the storm can be measured by the size of the damage path. It is important to note that the "average" can be misleading, since most tornadoes are small. The typical tornado damage path is about one or two miles, with a width of about 50 yards. The largest tornado widths can exceed one mile, and the smallest widths can be less than 10 yards. Widths can vary considerably during a single tornado, because the size of the tornado can change considerably during its lifetime. Path lengths can vary from what is basically a single point to more than 100 miles. Tornado intensity (the peak windspeeds) is not necessarily related to the tornado size. Detailed statistics about the time a tornado is on the ground are not available. This time can range from an instant to several hours. What is typical is roughly 5 minutes. Detailed statistics about forward speed of tornadoes are not available. Movement can range from virtually stationary to more than 60 miles per hour, typical storms move at roughly 10-20 miles per hour.

The damage from tornadoes comes from the strong winds they contain. It is generally believed that tornadic wind speeds can go over 200 mph in the most violent tornadoes. Wind speeds that high can cause automobiles to become airborne, rip ordinary homes to shreds, and turn broken glass and other debris into lethal missiles. The biggest threat to living creatures (including humans) from tornadoes is from flying debris and from being tossed about in the wind. It used to be believed that the low pressure in a tornado contributed to the damage by making buildings "explode" but this is no longer believed to be true. Tornado intensity is classified according to the Fujita (F) Scale first developed by Theodore Fujita. The F-scale ranks tornadoes according to wind speed, and the severity of damage caused within the wind speed ranges. In 2007 the Enhanced Fujita (EF) Scale went into effect. It takes into account the quality of construction and different kinds of structures were standardized. Table 3-37 shows the Enhanced Fujita Tornado Measurement Scale from the Storm Prediction Center, National Weather Service.

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TABLE 3-37 ENHANCED FUJITA TORNADO MEASUREMENT SCALE		
<b>Category EF0</b>	Light (65-85 mph)	Minor damage. Shingles or parts of roof peeled off; damage to gutters/siding; branches broken off; shallow rooted trees toppled.
<b>Category EF1</b>	Moderate (86-110 mph)	Moderate damage. More significant roof damage; windows broken; exterior doors damaged or lost; mobile homes badly damaged or overturned.
<b>Category EF2</b>	Considerable (111-135 mph)	Considerable damage. Roofs torn off well-constructed houses; homes shifted off their foundation; mobile homes completely destroyed; large trees snapped or uprooted; cars may be tossed.
<b>Category EF3</b>	Severe (136-165 mph)	Severe damage. Entire stories of well-constructed houses destroyed; significant damage to large buildings; homes with weak foundations may be blown away; trees begin to lose bark..
<b>Category EF4</b>	Devastating (166-200 mph)	Extreme damage. Well-constructed houses leveled; cars thrown significant distances; top story exterior walls of masonry buildings likely collapse.
<b>Category EF5</b>	Incredible tornado (200+ mph)	Incredible damage. Well-constructed homes swept away; steel-reinforced concrete structures critically damaged; high-rise buildings sustain severe structural damage; trees usually completely debarked, stripped off branches and snapped..

The photographs below in Figures 3-16- 3-20 depict damage according to the original Fujita Scale.

FIGURE 3-16



F-1

F1

FIGURE 3-17



F-2

F2

FIGURE 3-18



F-3

F3

FIGURE 3-19



F-4

F4

FIGURE 3-20



F-5

F5

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According to the National Climatic Data Center, since 1950 the five county area has been struck by 136 tornadoes. Tables 3-38 and 3-39 summarize the region’s tornadoes by their intensity. There have been no recorded F or EF5 events.

Table 3-38 1950 – 2006 Tornadoes and Intensities

County	F0	F1	F2	F3	F4	Total
Franklin	8	6	3	0	1	18
Jefferson	10	13	2	2	0	27
St. Charles	8	9	5	5	0	27
St. Louis	4	11	4	3	2	24
City of St. Louis	0	1	0	1	1	3
<b>Total</b>	<b>30</b>	<b>40</b>	<b>14</b>	<b>11</b>	<b>4</b>	<b>99</b>

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

Table 3-39 2005 – October 31, 2014 Tornadoes and Intensities

County	EF0	EF1	EF2	EF3	EF4	Total
Franklin	2	4	1	0	0	7
Jefferson	1	5				6
St. Charles	3	2	0	1	0	6
St. Louis	3	8	2	1	1	15
City of St. Louis	2	1				3
<b>Total</b>	<b>11</b>	<b>20</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>37</b>

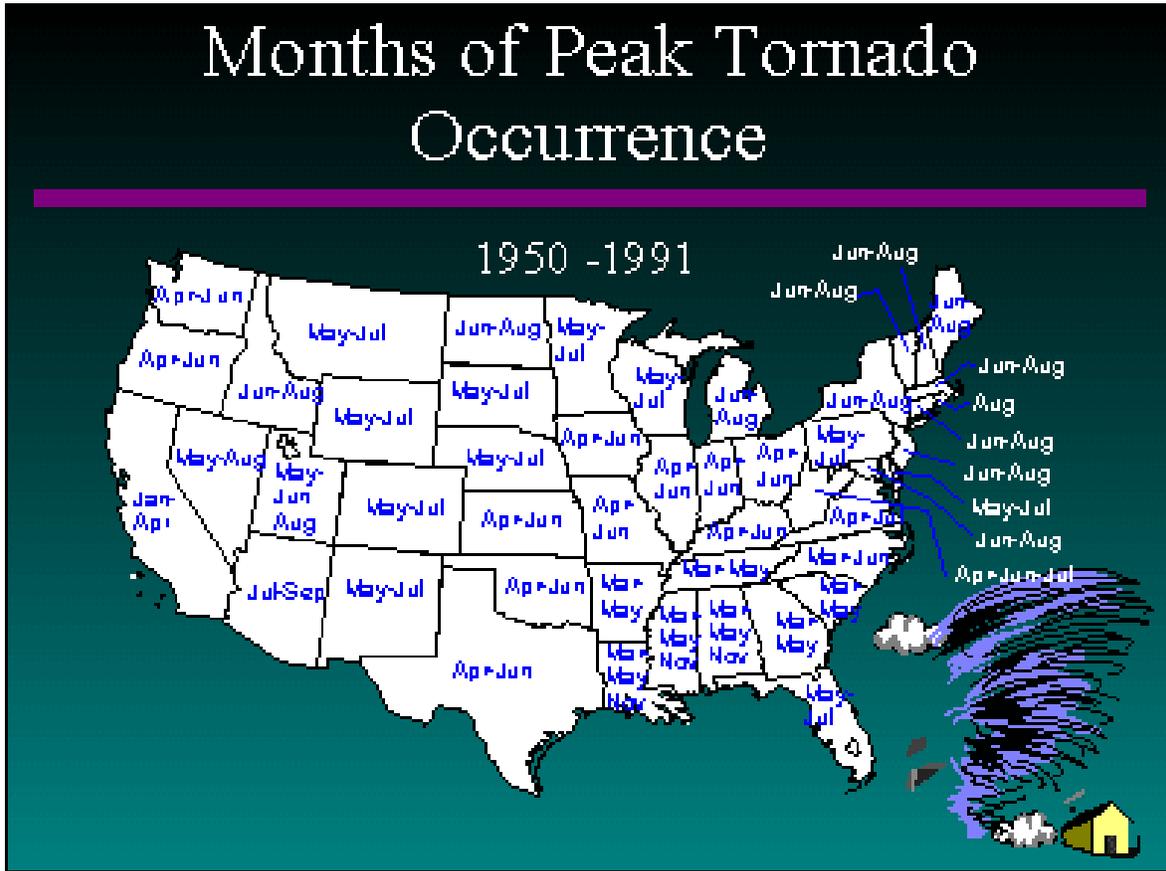
Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

The May 27, 1896 tornado, categorized as an F-4, that hit St. Louis was third on the list of 10 top weather events of the century. This storm killed 255 people and injured 1,000. The May 1986 storm was the ninth costliest storm in the United States, costing over \$285 million dollars (2014 dollars) in property damage and the third deadliest storm in the United States, killing 255 people.

Even though only about 10 percent of tornadoes are significant, these tornadoes are responsible for the majority of deaths caused by tornadoes in the country, with violent tornadoes claiming 67 percent of the total. Furthermore, with the aftermath of such events, the US suffers millions of dollars in damage costs, an important consideration for the insurance industry.

Tornadoes occur mostly during the spring and summer; the tornado season comes early in the south and later in the north because spring comes later in the year further north. They usually occur during the late afternoon and early evening but can occur at any time of the day and any time of the year. Refer to Figure 3-21 that depicts the regional seasonal pattern of tornadoes.

FIGURE 3-21 TORNADO SEASONAL PATTERN



Source: NOAA

Tornadoes and other severe windstorms can occur without warning. The National Oceanic and Atmospheric Agency and other agencies (National Weather Service) have prioritized the research and understanding of the development of these types of storms in order to protect citizens and their property. As a result of this research, Doppler Radar was developed in the 1950s by the Weather Radar Laboratory. The new Radar, or NEXRAD for Next Generation Radar (officially WSR-88D), provides forecasters with a detailed look at storms through reflectivity and velocity displays. Reflectivity indicates rainfall or precipitation intensity and velocity displays the speed and direction of the winds within the storm.

Through the Doppler Effect, a physical phenomenon marked by a change in frequency depending on the motion of an object toward or away from a point, the radar can give a picture of the winds within a storm. If, within a small area, high winds toward the radar are adjacent to high winds away from the radar, a circulation has developed and forecasters prepare to issue a warning. With this capability, tornado warning lead times have increased in the last 10 years from less than 5 minutes to nearly 12 minutes (NWS).

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Tornadoes have enormous power and destructive ability. Injuries, property damage of risk of death remains high. Technological advances will facilitate earlier warning than previously available. This combined with public education and improved construction techniques, provides the opportunity for reductions in the number of injuries, reduction in property damage and loss of life. Based on past history, the likely adverse impact of future tornado and thunderstorm events is shown below. The next tornado or severe windstorm will most likely have a detrimental impact on the community in terms of injuries, property damage (up to millions dollars in damages from property damage) and death, based upon the past historic storm events.

### Vulnerability

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to tornadoes and severe thunderstorms (wind/lightning/hail). The tornado vulnerability analysis examined the likelihood of future tornado impacts, average annual property loss ratio (building exposure/average annual historic losses), population change and housing unit change. These factors were scored: 1 (moderate); 2 (high); or 3 (very high). The sum of these scores would help to identify where tornadoes would have the greatest impact. Table 3-40 presents the factors and ranges considered in the 2010 analysis and Table 3-41 contains the probability and total vulnerability.

Table 3-40 Factors and Ranges considered in Tornado Vulnerability Analysis

Factors and Considered	Moderate (1)	High (2)	Very High (3)
Likelihood of future occurrence (#events/yr of data)	6 – 24	25 – 49	50 – 68
Loss ratio %	0 – 0.113	0.114 – 0.226	0.227 – 0.340
Population % change from 2000 - 2008	Below 6	7 – 22	23 – 39
Housing % change from 2000 – 2008	Below 12	13 – 25	16 – 39
<b>Overall vulnerability rating</b>	4 and 5 rating	6 and 7 rating	8 and 9 rating

Source - July 2010 Missouri State Hazard Mitigation Plan

Table 3-41 Tornado Probability, Potential Loss and Risk Summary – Based on 1950 – 2009 Data

#### A. Tornado Events 1950 – 2009

County	# of Tornadoes	Likelihood of Occurrence	Probability Rating
Franklin	19	32.43	2
Jefferson	25	42.68	2
St. Charles	28	47.80	2
St. Louis	25	42.68	2
City of St. Louis	4	6.83	1

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B. Average Annual Property Loss Rating 1950 – 2009

County	Total Building Exposure Value (\$)	Annualized Historic Loss (\$)	Loss Ratio (%)	Loss Ratio Ranking
Franklin	6,572,848,000	344,315	0.005	1
Jefferson	12,461,247,000	303,882	0.002	1
St. Charles	21,256,403,000	455,346	0.002	1
St. Louis	87,726,058,000	458,464	0.001	1
City of St. Louis	30,968,356,000	459,504	0.001	1

C. Population Change and Housing Change 2000 – 2008

County	Population Growth Change (%)	Population Change Ratio	Housing Unit Change (%)	Housing Ratio Rating
Franklin	11.9	2	13.15	2
Jefferson	16.3	2	15.79	2
St. Charles	31.5	3	29.99	3
St. Louis	32.5	3	2.89	1
City of St. Louis	1.80	1	2.58	1

D. Total Vulnerability

County	Total Vulnerability
Franklin	High
Jefferson	High
St. Charles	Very High
St. Louis	High
City of St. Louis	Moderate

Source - July 2010 Missouri State Hazard Mitigation Plan

**Problem Statement**

Because Tornados can strike quickly and unexpectedly, communities must be prepared in advance with emergency shelter both to provide protection to school populations and other groups that might be at greater risk in a tornado event and also to provide shelter immediately following a severe event, where people may have lost their homes or where homes have been made unsafe. Communication is also important to help citizens to know when to take shelter and how to shelter.

The 2010 State Hazard Mitigation Plan also suggests that future development should consider tornado hazards at the planning engineering and architectural design stages of any new construction.

## **4. Thunderstorm/Hail/Lightning Hazard Profile**

### **Description of Hazard**

When severe storms hit a community, they leave behind a distinctive trail. Toppled trees, damaged buildings and cars, downed power lines crossing roadways and widespread power outages are signs that a storm has struck. After such events, it can take communities weeks to return to normal. These storms result in costly structural damages, personal injury, property damage and death.

A thunderstorm is a rain shower produced by a cumulonimbus cloud during which thunder is heard. Thunder is a direct result of lightning. Thunderstorms may occur singly, in groups or in lines. Lightning is a sudden visible electrical discharge produced by a thunderstorm. Lightning often takes place outside of heavy rain and may be as far as 10 miles away from rainfall. Supercell thunderstorms are often the producers of violent tornadoes. These thunderstorms can also produce other dangerous weather conditions such as large hail, severe wind, lightning and heavy rainfall causing flash floods. Hail is frozen precipitation falling to the ground in the form of irregular pellets more than 0.2 inches in diameter. The National Weather Service considers a thunderstorm to be severe if has winds gusting in excess of 58 miles per hour (50 knots) or hail at least 0.75 inches in diameter (dime size).

The most threatening situation would be for a very intense convective wind event that also affected a large area. A few times each year in North America, extreme convective wind events of this sort do occur. When such storms are accompanied by large hail (equal to or greater than 1.9 inches in diameter) the damage potential increases exponentially. The occurrence of hail has resulted in some of the costliest storms in United States history; coupling a fall of large hail with winds approaching 112 miles per hour could produce incredible damage in a populated area. Of course, economic losses to agriculture from such storms are already high, but do not attract much public attention, and such losses would be very difficult to mitigate with a 20-30 minute warning. The large area covered by such storms can result in major property losses.

Convective wind events are a hazard to societies the world over, doing considerable damage and occasionally generating many casualties. Most convection produces some straight-line wind as a result of outflow generated by the convective downdraft, and so anyone living in convection-prone areas of the world has experienced this phenomenon. On rare occasions, the intensity of the wind achieves the potential for doing damage. Although engineered structures typically are quite resistant to wind damage, many homes and outbuildings are quite vulnerable to damage from even relatively modest windstorms. In the United States, it is assumed that the potential for wind damage begins at around 56 miles per hour. Of course, considerable damage occurs in situations where there was no anemometer, and so wind damage is graded according to its character: e.g., damage to

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tree limbs is considered non-severe, but uprooted trees are considered to represent a severe event. Damaging winds of a thunderstorm can cause as much damage as a weak tornado.

**Location**

The risk of a thunderstorm event is the same throughout the five county area. Based on the available data, there is no predictable pathway for the tornadoes and windstorms to follow.

Refer to maps in the Appendix – Map Sets – County Natural Hazards which depict the areas and structures that are susceptible to thunderstorms, hail and lightning.

**Hazard Event History**

Thunderstorm wind, hail and lightning events by county and damage estimates are presented in the following Tables. From 2005 through October 31, 2014, there have been 511 thunderstorm wind events with estimated property damage of \$549,000. Of these events, 131 were identified as severe thunderstorms. During this period in the five county area there were two deaths and 158 injuries from thunderstorm wind events, four deaths and 10 injuries associated with lightning events and one injury from hail events.

Table 3-42 2005 – October 31, 2014 Thunderstorm Wind Events (wind speed 58 miles per hour or greater) by County

County	Years	Events	Deaths	Injuries	Property Damage (\$)
Franklin	All	96	0	17	0
Jefferson	All	52	0	2	5K
St. Charles	All	127	0	2	200K
St. Louis	All	201	1	5	85K
City of St. Louis	All	35	1	132	259K
<b>Total</b>		511	2	158	

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

Table 3-43 2005 – October 31, 2014 Severe Thunderstorm Wind Events (wind speed 67 miles per hour or greater) by County

County	Years	Events	Deaths	Injuries	Property Damage (\$)
Franklin	2006, 2007, 2009, 2011, 2012, 2013	26	0	14	0
Jefferson	2006, 2009, 2010, 2011	6	0	2	0
St. Charles	2005, 2006, 2007, 2010, 2011, 2012,	22	0	2	200K

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County	Years	Events	Deaths	Injuries	Property Damage (\$)
	2013, 2014				
St. Louis	2005, 2006, 2007, 2009, 2011, 2012, 2013, 2014	69	1	1	25K
City of St. Louis	2006, 2013	8	0	32	259K
<b>Total</b>		131	1	51	464K

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

Table 3-44 2005 – October 31, 2014 Lightning Events by County

County	Years	Events	Deaths	Injuries	Property Damage
Franklin	2005	1	0	0	0
Jefferson	2005, 2006	3	0	0	2K
St. Charles	2008, 2010, 2011, 2014	4	0	3	497K
St. Louis	2005, 2007, 2010, 2014	6	4	3	0
City of St. Louis	2010	3	0	4	0
<b>Total</b>		17	4	10	

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

Table 3-45 2005 – October 31, 2014 Hail (0.75 inch or greater) Events by County

County	Years	Events	Deaths	Injuries	Property Damage
Franklin	All	106	0	0	0
Jefferson	All	115	0	0	34K
St. Charles	All	136	0	0	5K
St. Louis	All	183	0	1	855K
City of St. Louis	All	31	0	0	0
<b>Total</b>		571	0	1	

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

**Probability of Occurrence - High**

Between 2005 and October 2014, nine years had thunderstorm winds/severe thunderstorm events for a 90 percent chance of severe thunderstorm winds in any given year in the five county area. Severe thunderstorms are a common event in the five county area.

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Hail events occurred each year in the five county area between 2005 and October 31, 2014 for a 100 percent chance in any year. Lightning events in the five county area took place in seven of the ten years (2005-2014) for a 70 percent chance of occurrence in any year.

### **Severity - High**

Percentage of Land Area Affected by Hazard – Less than 10 percent

Severe windstorms range in type from downdrafts to tornadoes. The most frequent surface winds in Missouri originate from the west and southwest. These winds are associated with storms moving into the region from Kansas and Oklahoma. Tornadoes range in size and severity. The dimensions of the storm can be measured by the size of the damage path.

Thunderstorms normally occur on 40 to 50 days per years in the five county area and can occur at any time during the year. During a year some of these storms are severe and produce damaging winds, large hail and heavy rains. Severe event can cause death by either flying debris, heavy objects blown over or lightning. Thunderstorms can also disrupt the power supply.

Figure 3-22 shows the wind zones in the U.S. The five county area is in the center of the map in zone IV.

Various human activities place people at risk from convective winds, notably aircraft operations and recreation. Most casualties from convective windstorms in the United States arise from such situations. Given the high vulnerability of aircraft operations during takeoff and landing procedures (the aircraft are operating on the margins of their flight "envelope" during such times); it does not take a particularly intense event from a meteorological standpoint to create many casualties. Commercial aircraft are less vulnerable than private aircraft, but their high occupancy means that rare events can have a large impact on casualty figures. Recreational boating also can account for many casualties in relatively modest windstorms, whereas most commercial craft are unlikely to be affected by marginal convective wind events.

Tornadoes and other severe windstorms can occur without warning. The National Oceanic and Atmospheric Agency and other agencies (National Weather Service) have prioritized the research and understanding of the development of these types of storms in order to protect citizens and their property. As a result of this research, Doppler Radar was developed in the 1950s by the Weather Radar Laboratory. The new Radar, or NEXRAD for Next Generation Radar (officially WSR-88D), provides forecasters with a detailed look at storms through reflectivity and velocity displays. Reflectivity indicates rainfall or precipitation intensity and velocity displays the speed and direction of the winds within the storm.

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Tornadoes have enormous power and destructive ability. Injuries, property damage of risk of death remains high. Technological advances will facilitate earlier warning than previously available. This combined with public education and improved construction techniques, provides the opportunity for reductions in the number of injuries, reduction in property damage and loss of life. Based on past history, the likely adverse impact of future

FIGURE 3-22 WIND ZONES

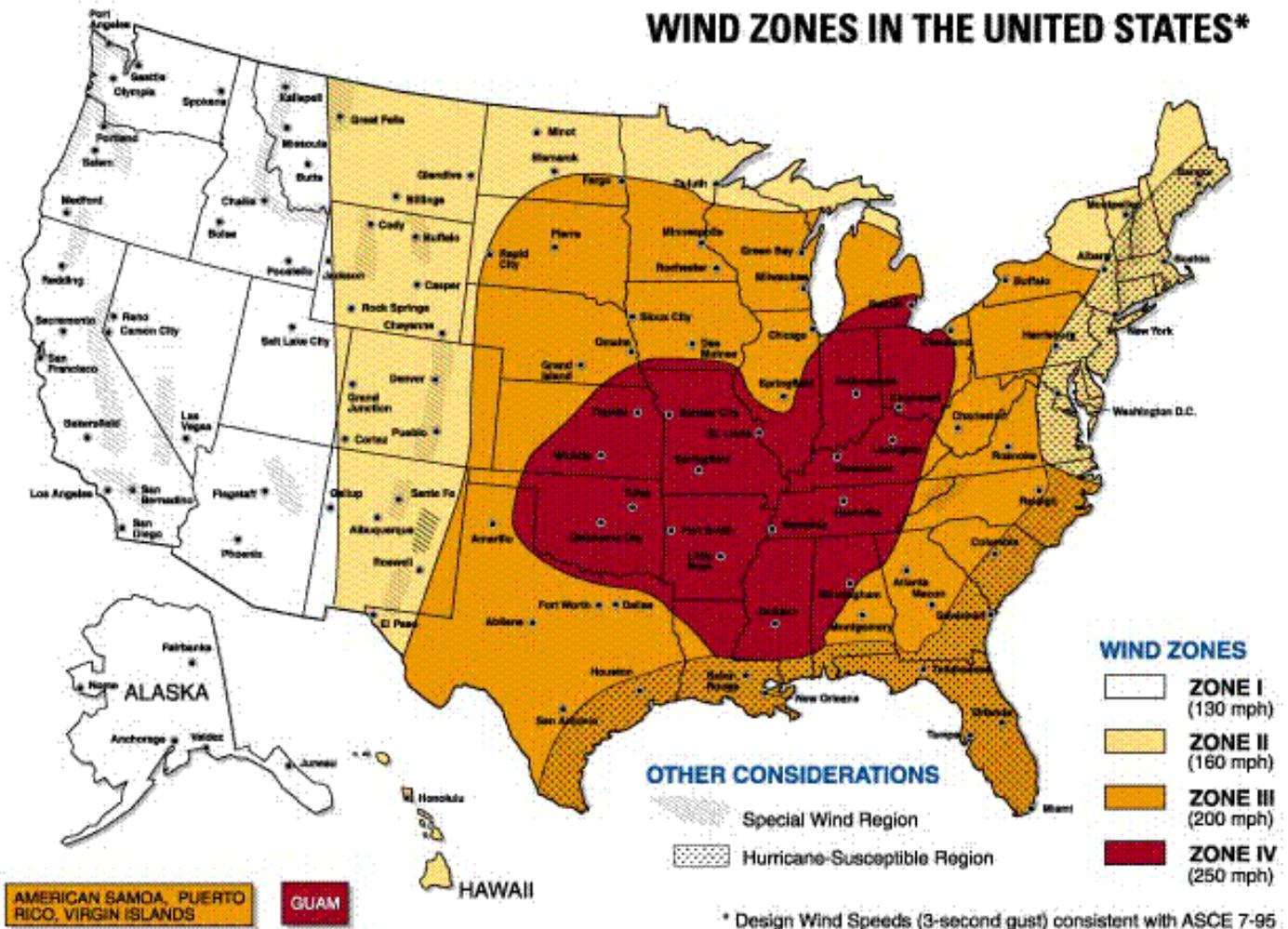


Figure I.2 Wind zones in the United States

Source: FEMA

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tornado and thunderstorm events is shown below. The next tornado or severe windstorm will most likely have a detrimental impact on the community in terms of injuries, property damage (up to millions dollars in damages from property damage) and death, based upon the past historic storm events.

The National Weather Service has assembled information on estimating wind speed from observed damage to trees and structures. Trees are assumed to have leaves. See Table 3-46.

Table 3-46 Estimating Straight Line Wind Speed from Damage

Wind Speed	Observations
30-44 mph (26-38 knots)	Trees in motion. Light-weight loose objects (e.g., lawn furniture) tossed or toppled.
45-57 mph (39-49 knots)	Large trees bend; twigs, small limbs break and a few larger dead or weak branches may break. Old/weak structures (e.g., sheds, barns) may sustain minor damage (roof, doors). Building partially under construction may be damaged. A few loose shingles removed from houses. Carports may be uplifted; minor cosmetic damage to mobile homes or pool lanai cages.
58-74 mph (50-64 knots)	Large limbs break; shallow rooted trees pushed over. Semi-trucks overturned. More significant damage to old/weak structures. Shingles, awnings removed from houses; damage to chimneys and antennas; mobile homes, carports incur minor structural damage; large billboard signs may be toppled.
75-89 mph (65-77 knots)	Widespread damage to trees with trees broken/uprooted. Mobile homes may incur more significant structural damage; be pushed off foundations or overturned. Roof may be partially peeled off industrial/commercial/warehouse buildings. Some minor roof damage to roof homes. Weak structures (e.g., farm buildings, airplane hangars) may be severely damaged.
90+ mph (78+ knots)	Many large trees broken and uprooted. Mobile homes severely damaged; moderate roof damage to homes. Roofs partially peeled off homes and buildings. Moving automobiles pushed off dry roads. Barns, sheds demolished.

Source - National Weather Service

Thunderstorms typically do not hit the five county area without warning. The National Oceanic and Atmospheric Administration Weather Radio, commercial radio and television announce the latest thunderstorm watches and warnings. Watches and warnings are listed below.

Severe Thunderstorm Watch – Watch is issued by the Storm Prediction Center in Norman, OK, National Weather Service, when the conditions are favorable for the development of severe thunderstorms in and close to the watch area. A severe thunderstorm is considered

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to be a thunderstorm which produces one inch hail or larger in diameter and/or winds equal to or exceed 58 miles per hours. They are normally issued well in advance of the actual occurrence of severe weather.

Severe Thunderstorm Warning – Warning is issued when either a severe thunderstorm is indicated by radar or a spotter reports a thunderstorm producing hail one inch in diameter or larger and/or winds equal to or exceed 58 miles per hours. People in the affected area should seek safe shelter immediately. The warning is issued by the local National Weather Service Forecast Office. A warning will have information about where the storm is located, what towns will be affected and the primary threat associated with the warning.

### **Vulnerability**

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to severe thunderstorms (wind/lightning/hail). For the thunderstorm losses there is no distinct pattern other than higher losses in those areas with greater exposure (population, population density, structures) which shows the randomness of severe thunderstorms. In this plan statistical analysis of data was used to determine vulnerability. Data sources included the National Climatic Data Center storm events data (1993 – July 2009), 2004-2008 crop insurance claims data from the U.S. Department of Agriculture, 2000 Census information, 2007 Census of Agriculture and the calculated Social Vulnerability Index for Missouri Counties from the Hazards and Vulnerability Research Institute at the University of South Carolina.

According to the 2010 State Plan, the Social Vulnerability Index (SVI) measures the social vulnerability of U.S. counties to environmental hazards for the purpose of examining the differences in social vulnerability among counties. Based on national data, primarily the 2000 Census, it synthesizes 42 socio-economic and built environment variables that research literature suggests contribute to reduction in a community's capacity to prepare for, respond to and recover from environmental hazards (i.e., social vulnerability). Eleven composite factors were identified that differentiate counties according to their relative level of social vulnerability: personal wealth; age; density of the built environment; single sector economic dependence; housing stock and tenancy; race (African American and Asian); ethnicity (Hispanic and Native American); occupation; and infrastructure dependence.

The SVI can be used to help determine where social vulnerability and exposure to (natural) disasters overlaps and how and where mitigation resources might best be used. The SVI was calculated for the counties in Missouri. Each county was assigned to one of five SVI categories: high (5) counties in the top 20 percent; medium-high (4) counties; medium (3) counties; medium-low (2) counties; and low (1) counties, lowest 20 percent.

The common data elements for analysis of wind, hail and lightning are housing density, building exposure, crop exposure and social vulnerability data. Lightning analysis did not consider crop exposure as crop losses are an unlikely result of lightning. To complete the statistical analysis performed for the 2010 Plan, additional data was collected.

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Table 3-47 Housing Density, Building Exposure and Crop Exposure Data by County from July 2010 Missouri State Hazard Mitigation Plan

County	Housing Units per Square Mile	Total Building Exposure (\$)	Crop Exposure (\$) (2007 Census of Agriculture)	Social Vulnerability Index (1-5)
Franklin	41.5	6,572,848,000	24,032,000	2
Jefferson	115.1	12,461,247,000	5,554,000	2
St. Charles	188.3	21,256,403,000	40,965,000	3
St. Louis	834.5	87,725,058,000	23,414,000	5
City of St. Louis	2,847.9	30,968,356,000	0	4

Source - July 2010 Missouri State Hazard Mitigation Plan

Table 3-48 Additional Statistical Data Compiled for Severe Thunderstorm Vulnerability Analysis for July 2010 Missouri State Hazard Mitigation Plan

County	Hail Incidents 1993 – July 2009	Total Hail Property Loss (\$)	Total Crop Insurance Paid for Hail Damage (\$)	Wind Incidents 1993 – July 2009	Total Wind Property Loss (\$)	Total Crop Insurance Paid for Wind Damage (\$)	Lightning Incidents 1993 – July 2009	Total Lightning Property Loss (\$)
Franklin	125	550,000	1,131	24	100,000	8,098	2	0
Jefferson	143	537,000	0	15	105,000	0	7	52,000
St. Charles	124	200,055,000	60,050	26	2,200,000	2,882	3	5,000
St. Louis	275	857,311,111	0	63	125,000	463	11	270,000
City of St. Louis	30	750,000	0	9	259,000	0	1	5,000

Source - July 2010 Missouri State Hazard Mitigation Plan

According to the 2010 Plan, the factors to consider in delineating overall vulnerability to lightning include housing density, likelihood of occurrence, building exposures, the average annual property loss ratio and social vulnerability. Crop exposure and average annual crop insurance claims were also considered in estimating vulnerability for hail and wind damage. A rating value of 1 (low) to 5 (high) was assigned to the data obtained for each of these factors. Table 3-49 presents the rating values for each of the factors considered to estimate vulnerability.

Table 3-49 Ranges for Severe Thunderstorm Vulnerability Factor Ratings

Factors Considered	Low (1)	Medium-low	Medium	Medium-high	High (5)
<b>Common Factors</b>					
Housing Density (# per square mile)	<50	50 to 99	100 to 299	300 to 499	>500
Building Exposure (\$)	<\$0.5B	\$0.5B to \$0.9B	\$1B to \$1.9B	\$2B to \$5.9B	>\$6B

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Factors Considered	Low (1)	Medium-low	Medium	Medium-high	High (5)
Crop Exposure (\$ in millions) (hail and wind only)	<\$10,000	\$10,000 to \$24,999	\$25,000 to \$49,999	\$50,000 to \$99,999	>\$100,000
Social Vulnerability	1	2	3	4	5
<b>Wind</b>					
Likelihood of Occurrence (# of events/ years of data)	.12 to .987	.988 to 1.855	1.856 to 2.723	2.7424-3.591	3.592 to 4.46
Average Annual Property Loss Ratio (annual property loss/exposure)	0 to 0.186	.0190-.0380	.0381 to .0570	.0571 to .0760	.0761-.226
Wind Crop Loss Ratio (annual crop claims/exposure)	0 to .0099	.010 to .019	.020 -.029	.030 to .040	.041-.1300
<b>Hail</b>					
Likelihood of Occurrence (# of events/ years of data)	1.15 to 4.273	4.274 to 7.397	7.298 to 10.521	10.522 to 13.645	13.646 to 16.77
Average Annual Property Loss Ratio (annual property loss/exposure)	0 to .015	0.16 to.031	.032 to .047	.048 to .063	.063 to .080
Hail Crop Loss Ratio (annual crop claims/	0 to .053	.054 to .10	.11 to .15	.16 to .21	.22 to .27
<b>Lightning</b>					
Likelihood of Occurrence (# of events/ years of data)	0 to .14	.15 to .30	.31 to .45	.46 to .61	.62 to .78
Average Annual Property Loss Ratio	0 to .000427	0.000428 to .000855	.000856 to .00128	.00128 to .00170	.00171 to .00572

Source -July 2010 Missouri State Hazard Mitigation Plan

Table 3-50 Likelihood of Occurrence of High Wind, Hail and Lightning Events based on 1993 – July 2009 Events Data (16.5 Years)

County	High Wind Average # Per Year	Hail Average # Per Year	Lightning Average # Per Year
Franklin	1.45	7.54	0.12
Jefferson	0.90	8.62	0.42
St. Charles	1.57	7.48	0.18
St. Louis	3.80	16.59	0.66
City of St. Louis	0.54	1.81	0.06

Source - July 2010 Missouri State Hazard Mitigation Plan

The vulnerability factor ratings were applied to all the factors considered for wind, hail and lightning, weighted equally and factored together to determine an overall vulnerability rating. From this a combined vulnerability rating was prepared. Hail and wind events were factored in with a multiplier of 2 since these types of events generally cause more damages. The table below presents the ranges for the severe thunderstorm combine

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vulnerability rating prepared for the 2010 Plan. The next table contains the calculated vulnerability ratings for wind, hail and lightning and the combined vulnerability rating for the severe thunderstorm hazard.

Table 3-51 Ranges for Severe Thunderstorm Combined Vulnerability Rating

	Low (1)	Medium-low (2)	Medium (3)	Medium-high (4)	High (5)
Severe Thunderstorm Combined Vulnerability	1.15 to 1.66	1.67 to 2.18	2.19 to 2.70	2.71 to 3.22	3.23 to 3.75

Source - July 2010 Missouri State Hazard Mitigation Plan

Table 3-52 Severe Thunderstorm Combined Vulnerability Rating

County	Overall Hail Vulnerability Rating	Overall Lightning Vulnerability Rating	Overall Wind Vulnerability Rating	Severe Thunderstorm Combined Rating	Combined Vulnerability
Franklin	2.14	2.00	2.00	2.06	Medium-low
Jefferson	2.29	2.80	2.00	2.27	Medium
St. Charles	3.14	2.80	2.57	2.85	Medium-high
St. Louis	3.86	4.20	3.43	3.75	High
City of St. Louis	2.57	3.20	2.57	2.70	Medium

Source - July 2010 Missouri State Hazard Mitigation Plan

For the 2010 Plan, the available historical loss data from the National Climatic Data Center and paid crop insurance claims from 1998 to 2008 was annualized and potential financial loss estimates to severe thunderstorms was calculated.

Table 3-53 Annualized Severe Thunderstorm Damages in Missouri

County	Wind – Annualized Property Loss and Crop Claims (\$)	Hail – Annualized Property Loss and Crop Claims (\$)	Lightning – Annualized Property Loss (\$)	Combined Annualized Losses (\$)
Franklin	6,768	33,275	0	40,043
Jefferson	6,333	32,388	3,136	41,858
St. Charles	132,952	12,071,503	302	12,204,756
St. Louis	7,581	51,707,546	16,285	51,731,412
City of St. Louis	15,621	45,235	302	61,158

Source - July 2010 Missouri State Hazard Mitigation Plan

There are no distinct patterns of loss, except that there are higher losses in areas with greater exposure (more structures, more population). This analysis demonstrated the random distribution of this hazard and its impact in the five county area.

**Problem Statement**

Because Tornados and Thunderstorms can strike quickly and unexpectedly, communities must be prepared in advance with emergency shelter both to provide protection to school

populations and other groups that might be at greater risk in a tornado event and also to provide shelter immediately following a severe event, where people may have lost their homes or where homes have been made unsafe. Communication is also important to help citizens to know when to take shelter and how to shelter.

## **5. Severe Winter Weather Hazard (Snow, Ice and Extreme Cold) Profile**

### **Background**

Winter weather is different than other hazards such as dam failure or tornadoes in that the hazard tends to occur over a much larger area, often times affecting from several counties to multiple states. Winter weather includes heavy snow, ice, freezing rain/sleet and seasonably low temperatures on widespread or localized basis.

Snow can range from snow flurries to white-out blizzard conditions. Ice conditions include sleet and freezing rain which can cause roadways being covered in sheets of ice and ice jams resulting in flooding. Freezing rain is 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 glaze of ice. Even small accumulations of ice can cause a significant hazard to motorists, pedestrians and home owners. The combination of seasonably cold temperatures and low wind chill values (15°F below normal) can impact human health and economic activity.

### **Location**

The risk of severe winter weather is planning area wide.

Winter weather in the five county area moves in an northwest to southeast direction. Late winter storms that have a tendency to be intense tend to generate in the southwest portion of the United States and move northeast, dependent upon the meteorology and the storm track. Winter weather is different than other hazards such as tornadoes in that the hazard tends to occur over a much larger area, often times affecting several counties to multiple states. See figure in the Appendix – Map Sets – County Natural Hazards which depicts those areas that are most susceptible for severe winter storms in the region.

### **Hazard Event History**

Information on winter weather events prior to 2010 can be found in the 2009 Plan Update. The following table contains information on winter weather events (cold/wind chill, winter storm, winter weather or heavy snow) which has occurred from 2005 to October 2014. NOAA does not track winter weather to the same degree as severe Midwest spring storms. This is mainly due to the fact that winter weather and winter

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storms are more "subjective" and this kind of information has not been summarized (graphically or otherwise). The National Weather Service reported that on February 2, 1906, St. Louis received 12.8 inches of snow and 12.4 inches on March 24, 2013. Starting on January 31, 1982, the area surrounding St. Louis received 25 inches of snow and left approximately 4000 motorists stranded for two days. During the 2010-2011 winter, 29.1 inches of snow fell. The five county area received a total of 15.8 inches during January 2014. Information on historical winter events can be found in the 2009 Plan Update and Appendix G.

Being in the northern hemisphere, Missouri’s geographic location has the potential to experience severe winter weather during the months of December through February. Extreme winter weather has, also, occurred in mid-November and into March. Winter storms in the five county area, as compared to winter storms to the north and west, are relatively mild. Table 3-54 contains information on winter weather events from 2005 to 2014.

Table 3-54 2005 – October 31, 2014 - Winter Weather Events

Location	Event Type	Deaths	Injuries	Property Damage (\$)
<b>December 8, 2005</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Winter Storm	2	0	0
<b>November 30 – December 1, 2006</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Winter Storm	0	67	115.2 M
<b>December 8 – 12, 2007</b>				
Franklin, Jefferson, St. Louis, City of St. Louis	Winter Weather	0	0	0
<b>December 15, 2007</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Heavy Snow	0	0	0
<b>January 31 – February 1, 2008</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Heavy Snow	0	0	0
<b>February 11, 2008</b>				
Franklin,	Winter Weather	0	0	0

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<b>Location</b>	<b>Event Type</b>	<b>Deaths</b>	<b>Injuries</b>	<b>Property Damage (\$)</b>
Jefferson, St. Louis, City of St. Louis				
<b>February 23 – 24, 2008</b>				
Franklin, Jefferson,	Winter Weather	0	0	0
<b>March 3 – 4, 2008</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Winter Storm	0	0	0
<b>January 26, 2009</b>				
Franklin, Jefferson, St. Louis, City of St. Louis	Winter Storm	0	0	0
<b>January 1 -12, 2010</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Cold/Wind Chill	0	0	0
<b>January 6 – 7, 2010</b>				
St. Charles, St. Louis, City of St. Louis	Winter Weather	0	0	0
<b>January 19 – 20, 2011</b>				
Franklin, St. Charles, St. Louis, City of St. Louis	Heavy Snow	0	0	0
<b>January 31 – February 2, 2011</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Winter Storm	0	0	0
<b>February 21, 2013</b>				
Franklin, Jefferson	Winter Storm	0	0	0
<b>March 24, 2013</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Heavy Snow	0	0	0
<b>December 12 – 13, 2013</b>				
St. Charles	Winter Storm	0	0	0
<b>January 5, 2014</b>				
Franklin,	Winter Storm	0	0	0

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Location	Event Type	Deaths	Injuries	Property Damage (\$)
Jefferson, St. Louis, City of St. Louis				
<b>January 6 – 7, 2014</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Cold/Wind Chill	0	0	0
<b>March 1 – 2, 2014</b>				
Franklin, Jefferson, St. Charles, St. Louis, City of St. Louis	Winter Storm	0	0	0

Source - Storm Events Database, National Climatic Data Center, National Oceanic and Atmospheric Administration

**Probability of Occurrence - High**

To calculate the probability of severe winter weather 2005-2014 NCEP event data was assembled. In nine out of ten years some form of severe winter weather was reported, there is a 90 percent chance of severe winter weather in any given year.

NOAA weather data shows that winter weather most commonly occurs in January (44 percent of storms occurred in this month), followed by December (22 percent). Records show that temperatures drop to zero or below an average of 2 or 3 days per year, and temperatures as cold as 32° F or lower occur less than 25 days in most years. Snowfall has averaged a little over 19.1 inches per winter season, and snowfall of an inch or less is received on 5 to 10 days in most years. The 2009 Plan Update and Appendix G contain historical information on winter storm events in the five county area.

Since records were maintained from 1885 through 2013, 53 years have experienced total annual snowfall over the average of 19.1 inches per year. Of these years, only six years experienced annual snowfall of over 40 inches.

Based in information from the National Oceanic and Atmospheric Administration and FEMA, severe winter weather occurs between 2-3 times per year in the five county area. NOAA data indicates that during the winter months the probability of measurable snowfall ranges between 91 and 100 percent depending on the reporting weather station. Records show that temperatures drop to zero or below an average of 2 or 3 days per year, and temperatures as cold as 32 degrees or lower occur less than 25 days in most years. The coldest day reported in the region from 1874 to 2013 was – 22° F on January 5, 1884. Snowfall has averaged a little over 19.1 inches per winter season

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### **Severity – High**

Percentage of Land Area Affected by Hazard – More than 50 percent

Sometimes winter storms are accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, severe drifting, and dangerous wind chill. Strong winds with these intense storms and cold fronts can knock down trees, utility poles and electrical and telephone or cable lines. Extreme cold often accompanies a winter storm or is left in its wake. Prolonged freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat. Long cold spells can cause rivers to freeze, disrupting shipping. Ice jams may form and lead to flooding. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage.

Types of damage that could occur in the five county area creates both property damage and personal injury vehicle accidents, residential fires due to dangerous use of heaters and other winter weather fatalities (heart attacks from shoveling snow) may result from severe winter weather conditions. Extreme cold temperatures are ranked based upon a wind chill chart that figures the temperature on how the wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at a faster rate, driving down the body temperature. Prolonged exposure to the cold can cause frostbite, hypothermia and become life threatening. Infants and the elderly are most susceptible. Seventy percent of snow injuries result from vehicle accidents, 25 percent occur in people getting caught in the weather. It is possible that people can become trapped in their home without utilities or their car without assistance.

Based on the 2005-2014 winter storm queries for Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis submitted to the National Climatic Database, there were two deaths and 67 injuries. Winter storms are considered deceptive killers because most deaths are indirectly related to the storm. People die in traffic accidents on icy roads and of hypothermia from prolonged exposure to cold. Everyone is potentially at risk during winter storms.

Other winter damage can include rooftop collapse as a result of the inability of the roofs to withstand the weight of a heavy snowfall event, automobile accidents, and downed power lines/power outages from ice storms. Heavy snow can strand commuters, closing airports, stop the flow of supplies and disrupt emergency and medical services. Livestock may be lost on farms.

There are a variety of transportation impacts due to cold weather. Diesel engines are stressed and, often diesel fuel gels in extreme cold weather impacting trucking and rail traffic. Rivers and lakes freeze, stopping barge and ship traffic. Subsequent ice jams threaten bridges and can close major highways. Cold temperatures take their toll on vehicle batteries. Also, extreme cold temperatures stress metal bridge structures. Transportation losses for the winter of 1976 -77 came to \$6.5 billion (in 1980 dollars) (NOAA, 1982).

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Cold temperature impacts on agriculture are frequently discussed in terms of frost and freeze impacts early or late in growing seasons. . Prolonged cold snaps can impact livestock not protected from the frigid temperatures. In the winter of 1983-84, a single cold snap around Christmas destroyed over \$1 billion of the citrus crops in Florida.

Energy consumption rises significantly during extreme cold weather. In the winter of 1976-77 additional energy consumption cost \$3.8 billion (1980 dollars) which includes increase costs of electricity, fuel oil, and coal.

Extreme cold temperatures can cause significant ground freezing problems, especially if there is little snow cover. Buried water pipes can burst causing massive ice problems and loss of water pressure in metropolitan areas. This poses a variety of public health and public safety problems.

Winter weather typically does not hit the region without warning. The NOAA Weather Radio, commercial radio, and television track and announce the latest winter storm watches, warnings, and advisories. Winter weather warnings are set up in stages of severity by the National Weather Service. These warnings are found below.

### WIND CHILL ADVISORY:

Notice that wind chill conditions will be present and to dress appropriately

### WINTER STORM WATCH:

Severe winter conditions, such as heavy snow and/or ice, are possible within the next day or two. Prepare.

### WINTER STORM WARNING:

Severe winter conditions have begun or are about to begin in your area. Stay indoors!

### WINTER WEATHER ADVISORY:

Winter weather conditions are expected to cause significant inconveniences and may be hazardous. If caution is exercised, these situations should not become life-threatening. The greatest hazard is often to motorists. BLIZZARD WARNING:

Snow and strong winds will combine to produce a blinding snow (near zero visibility), deep drifts, and life-threatening wind chill. Seek refuge immediately

### FROST/FREEZE WARNING:

Below freezing temperatures are expected and may cause significant damage to plants, crops, or fruit trees. In areas unaccustomed to freezing temperatures, people who have homes without heat need to take added precautions.

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**Vulnerability**

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to severe winter weather based on 1993-2009 data. This county-level severe winter weather vulnerability analysis based on: housing density; likelihood of occurrence; building exposure; crop exposure; average annual property loss ratio; average annual crop insurance claims; and social vulnerability. For a description of social vulnerability see page 3A-74. The individual factors were rated as: 1 (low); 2 (medium-low); 3 (medium); 4 (medium-high); and 5 (high). The sum of these scores were averaged to identify would help to identify the vulnerability by county for severe winter weather.

Table 3-55 Vulnerability Analysis for Severe Winter Weather Hazard by County

County	Housing Density Rating	Likelihood Rating	Exposure Rating	Property Loss Ratio Rating	Crop Exposure Rating	Crop Loss Ratio Rating	Social Vulnerability Index	Vulnerability Rating
Franklin	1	3	5	1	2	1	1	Medium-low
Jefferson	3	2	5	1	1	0	3	Medium
St. Charles	3	3	5	1	3	1	1	Medium
St. Louis	5	3	5	1	2	1	3	Medium-high
City of St. Louis	5	2	5	1	1		5	Medium-high

Source - Missouri State Hazard Mitigation Plan, July 2010

**Problem Statement**

Mitigation activities for the five county area should include the education of its workers and residents about prevention of injuries and deaths from severe winter weather. Although heat and cold present different kinds of problems, these extreme weather events tend to hit low income communities and the elderly harder than the general population. These weather events also tend to be region-wide, and therefore broad-based planning is more effective in addressing these challenges. When power is disrupted through storms, extreme cold weather can rapidly put very large numbers of citizens at risk. Developing a response plan in advance is therefore paramount to effective management of that risk.

## **6. Drought Hazard Profile**

### **Background**

Drought is defined as the deficiency of precipitation over an extended period of time, usually a season or more. This deficiency results in a water shortage for some activity, group, or environmental sector. Drought should be considered relative to some long-term average condition of balance between precipitation and evapotranspiration (i.e., evaporation plus transpiration) in a particular area, a condition often perceived as “normal”. It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rain events. Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with drought which can significantly aggravate its severity.

Drought should not be viewed as merely a physical phenomenon or natural event. Its impacts on society result from the interplay between a natural event (less precipitation than expected resulting from natural climatic variability) and the demand people place on water supply. Human beings often exacerbate the impact of drought. Recent droughts in both developing and developed countries and the resulting economic and environmental impacts and personal hardships have underscored the vulnerability of all societies to this hazard.

There are two main kinds of drought definitions: conceptual and operational. Conceptual definitions, formulated in general terms, help people understand the concept of drought and may help to establish drought policy. Drought is a protracted period of deficient precipitation resulting in extensive damage to crops, resulting in loss of yield. . Operational definitions help define the onset, severity, and end of droughts. No single operational definition of drought works in all circumstances, and this is a big part of why policy makers, resource planners, and others have more trouble recognizing and planning for drought than they do for other disasters. In fact, most drought planners now rely on mathematic indices to decide when to start implementing water conservation or drought response measures.

Research by Donald A. Wilhite, director of the National Drought Mitigation Center, and Michael H. Glantz, of the National Center for Atmospheric Research, in the early 1980s categorized the definitions in terms of four basic approaches to measuring drought: meteorological, hydrological, agricultural, and socioeconomic. The first three approaches deal with ways to measure drought as a physical phenomenon. The last approach to measuring drought deals with drought in terms of supply and demand, tracking the effects of water shortfall as it affects socioeconomic systems.

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*Meteorological drought* is usually an expression of precipitation's departure from normal over some period of time. This definition is usually region-specific. Meteorological measurements are the first indicators of drought.

*Agricultural drought* is defined by soil moisture deficiencies. Agricultural drought happens after meteorological drought but before hydrological drought. Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and soil characteristics. Deficient topsoil moisture at planting may hinder germination, leading to low plant populations per hectare and a reduction of final yield.

*Hydrological drought* refers to declining in surface and subsurface water supplies. It is measured as streamflow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and less water in streams, rivers, lakes, and reservoirs, so hydrological measurements are lagging indicators of drought. When precipitation is reduced or deficient over an extended period of time, this shortage will be reflected in declining surface and subsurface water levels. The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. 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. For example, a precipitation deficiency may result in a rapid depletion of soil moisture that is almost immediately discernible to agriculturalists, but the impact of this deficiency on reservoir levels may not affect hydroelectric power production or recreational uses for many months. Also, water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems escalates during drought events.

*Hydrological Drought and Land Use*-Although climate is a primary contributor to hydrological drought, other factors such as changes in land use (e.g., deforestation), land degradation, and the construction of dams all affect the hydrological characteristics of the basin. Because regions are interconnected by hydrologic systems, the impact of meteorological drought may extend well beyond the borders of the precipitation-deficient area. Changes in land use upstream may alter hydrologic characteristics such as infiltration and runoff rates, resulting in more variable streamflow and a higher incidence of hydrologic drought downstream. Land use change is one of the ways human actions alter the frequency of water shortage even when no change in the frequency of meteorological drought has been observed.

*Socioeconomic drought* is considered to occur when physical water shortage starts to affect people, individually and collectively and impacts supply and demand of some economic commodity.

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The most commonly used drought severity indicator is the Palmer Drought Severity Index (PDSI) developed by NOAA. The PDSI provides a standardized means of depicting drought severity throughout the U.S. It measures the difference between departure of water supply (in terms of precipitation and stored soil moisture) from demand (the amount of water required to recharge soil and keep rivers, lakes and reservoirs at normal levels). By relating these figures to the previous regional index a continuous flow of data is created reflecting long-term wet or dry tendencies.

4.0 or more	Extremely Moist Spell
3.0 to 3.99	Very Moist Spell
2.0 to 2.99	Unusual Moist Spell
1.0 to 1.99	Moist Spell
0.5 to 0.99	Incipient Moist Spell
0.49 to -0.49	Near Normal Spell
-0.5 to -0.99	Incipient Drought
-1.9 to -1.99	Mild Drought
-2.0 to -2.99	Moderate Drought
-3.0 to -3.99	Severe Drought
-4.0 or less	Extreme Drought

### Location

In the 2002 Missouri State Drought Plan, the state was divided into six regions which display similar climatic characteristics. The City of St. Louis and St. Louis, St. Charles and Franklin Counties are found in the southeastern section of Missouri Drought Region 2 (northeast) and display similar climatic characteristics. Jefferson County is in the northeast corner of Missouri Drought Region 5. Refer to Figure 3-23 below. Based on the National Drought Mitigation Center (NDMC) historic drought mapping of regions 2 and 5, the most common area for drought conditions to occur is within Missouri Drought Region 2 (including City of St. Louis, St. Louis, St. Charles, and Franklin Counties).

### Hazard Event History

Some of the worst droughts on record to affect Missouri Drought Region 2 occurred in 1901-02, 1913-14, 1930-31, 1934, 1936, 1940-41, 1953-56, 1963-64, 1980-81, 1988-89, 1999-2000, 2005-2007 and 2012. The 1953-56 drought is considered to be the worst on record for region 2.

Droughts on record to affect Missouri Drought Region 5 occurred in 1900-09, 1940-49, 1950-59, 1964-66, 1980, 2005-2007 and 2012. It appears that the drought from 1954-56 was the worst on record for region 5.

The months of May and June 2012 were very dry, one of the driest two month periods in Missouri history. By the end of July, all of the five county area was classified as having

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extreme drought conditions. In July 2012 the Secretary of the Department of Agriculture declared all of Missouri as a disaster area as a result of this drought. In early September rains from the remnants of Hurricane Isaac caused the drought status to be re-classified as severe.

An overall excellent drought resource on the Internet is the NDMC. The NDMC provides historical drought information for the U.S. from 1895 through current. Linking to the following address will supply you with volumes of drought information: <http://www.drought.unl.edu/whatis/what.htm>. For historical maps identifying severe and extreme drought periods, scroll down to the section labeled "Historical Maps of the Palmer Drought Index." The maps display all the climate divisions in the U.S. and the percentage of

FIGURE 3-23 MISSOURI DROUGHT REGIONS



Source: Missouri Department of Natural Resources

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time each district was experiencing a severe to extreme drought condition according to the Palmer Index. Refer to Table 3-57 below.

<b>Month</b>	<b>Division 2</b>	<b>Division 5</b>
January	-0.06	-0.04
February	-0.42	-0.94
March	-0.66	-1.16
April	-0.99	-1.70
May	-1.23	-1.62
June	-1.17	0.57
July	1.24	1.64
August	1.68	1.65
September	1.48	-0.40
October	0.65	-0.93
November	0.81	0.30
December	2.37	1.79

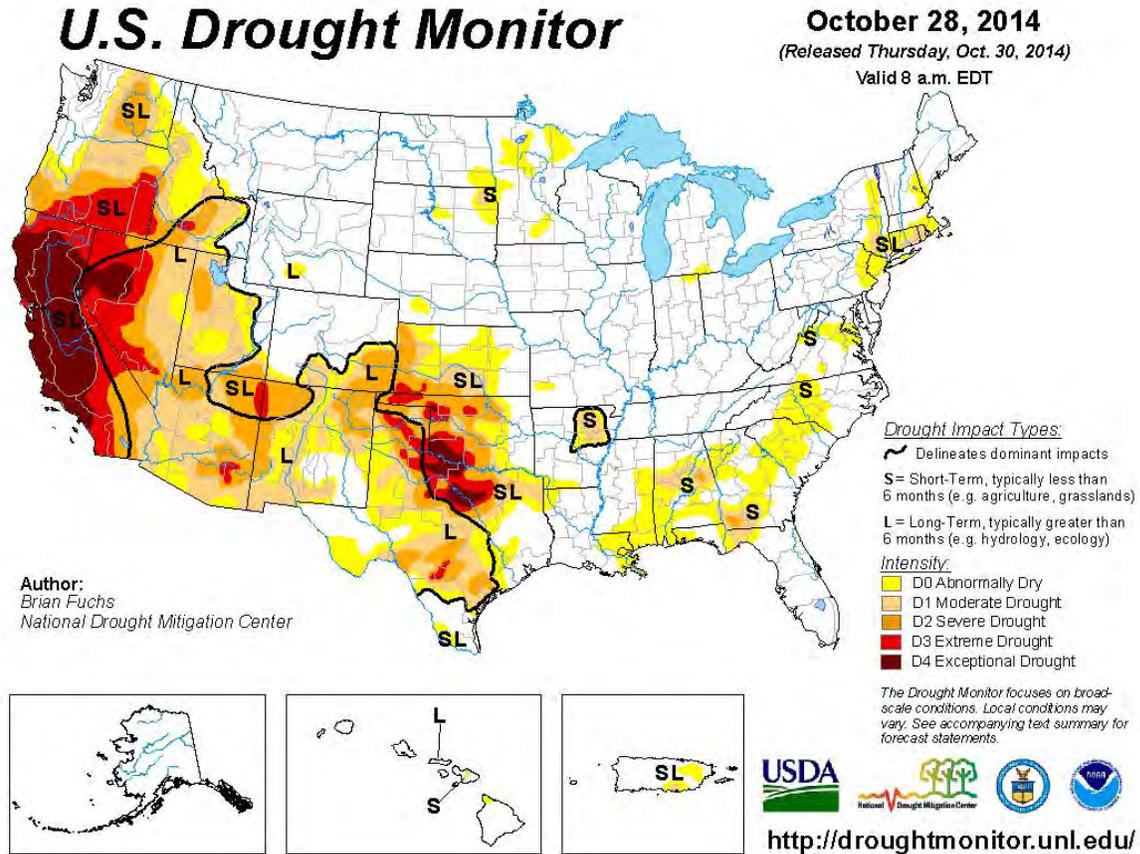
Within the past few years, the National Drought Mitigation Center has created a U.S. drought map that utilizes numerous indicators to determine the severity of a drought. These indicators include the Palmer Index, Crop Moisture Index, Standardized Precipitation Index, Percent of Normal Rainfall, Daily Streamflow, Snowpack, Soil Moisture, Vegetative Index, and Fire Danger Classifications. Figure 3-23 presents the drought conditions in the U.S. as of October 2014. The five county area was not experiencing any drought at this time.

**Probability of Occurrence - High**

The probable risk or likelihood of future occurrences of drought will most likely be similar to the climatologic past. However, the past number and severity of events is not necessarily a predictor of future occurrences. Based on information from the National Oceanic and Atmospheric Administration and FEMA droughts occur approximately every 10 years in the EWG planning region.

Between 1900 and 2014 (114 Years), 25 years (26) included drought for a 22 percent (23) chance of drought in any given year for those counties located in Missouri Drought region 2. Between 1900 and 2014 (114 Years), 38 years included drought for a 33 percent chance of drought in any given year for those counties located in Missouri Drought region 2. In the five county area from 2005 to 2014 there were three years with drought events, for a 30 percent chance of drought in any given year.

Figure 3-24 October 2014 Drought Map



Source – The National Drought Mitigation Center

**Severity - Low**

Percentage of Land Area Affected by Hazard – More than 50 percent

It is difficult to determine the direct and indirect costs associated with drought. Drought can have a broad impact and it is hard to specifically determine when a drought begins or ends.

The most commonly used drought severity indicators is the Palmer Drought Severity Index (PDSI) developed by NOAA. The PDSI provides a standardized means of depicting drought severity throughout the U.S. It measures the difference between departure of water supply (in terms of precipitation and stored soil moisture) from demand (the amount of water required to recharge soil and keep rivers, lakes and reservoirs at normal levels). By relating these figures to the previous regional index a continuous flow of data is created reflecting long-term wet or dry tendencies.

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The Drought Plan complements and supports the State Consolidated Plan and the State Emergency Operations Plan. Actions within the drought plan are triggered when the Palmer Drought Index reaches certain levels. The Drought Assessment Committee (DAC), chaired by the Director of the Department of Natural Resources, is activated in the Drought Alert Stage. The DAC then activates the Impact Task Forces, which cover the following topics: agriculture, natural resources and environmental recreation, water supplies, wastewater, health, social, economic and post drought evaluation.

The State of Missouri has a 2002 State Drought Plan in place. In it, the state has been divided into six regions that display similar climatic characteristics. For each region, drought severity can be determined according to the following schedule in Table 3-58:

4.0 or more	Extremely Moist Spell
3.0 to 3.99	Very Moist Spell
2.0 to 2.99	Unusal Moist Spellt
1.0 to 1.99	Moist Spell
0.5 to 0.99	Incipient Moist Spell
0.49 to -0.49	Near Normal Spell
-0.5 to -0.99	Incipient Droughtl
-1.9 to -1.99	Mild Drought
-2.0 to -2.99	Moderate Drought
-3.0 to -3.99	Severe Drought
-4.0 or less	Extreme Drought

In addition, Missouri's plan divides the state into three regions according to their susceptibility to drought. Susceptibility to drought depends on the characteristics of surface and ground water supplies. Regions were judged to have slight, moderate or high susceptibility to drought. Poor groundwater resources, surface water supplies that become inadequate during extended drought and inadequate irrigation water supplies characterize areas within Region C. This area is considered to have severe drought vulnerability. This region includes most of St. Louis County and the City of St. Louis. Areas in this region are designated as "Priority Drought Management Areas". Western St. Charles County, southern Franklin County and most of central/western Jefferson County are included in Region B: Moderate Susceptibility to drought. Areas along the Mississippi and Missouri River valley floodplain areas in Franklin, St. Charles and St. Louis Counties in this study are within Region A: Slight Susceptibility. These areas are underlain by alluvial sands and gravels and have a low susceptibility to drought.

The Drought Plan complements and supports the State Consolidated Plan and the State Emergency Operations Plan. Actions within the drought plan are triggered when the Palmer Drought Index reaches certain levels. The Drought Assessment Committee (DAC), chaired by the Director of the Department of Natural Resources, is activated in the Drought Alert Stage. The DAC then activates the Impact Task Forces, which cover the following topics: agriculture, natural resources and environmental recreation, water supplies, wastewater, health, social, economic and post drought evaluation.

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Drought characteristics include economic, social and environmental factors. The 1930s drought's direct effect is most often remembered as agricultural. Many crops were damaged by deficient rainfall, high temperatures, and high winds, as well as insect infestations and dust storms that accompanied these conditions. Although records focus on other problems, the lack of precipitation would also have affected wildlife and plant life, and would have created water shortages for domestic needs. The severity and aerial coverage of the event played a part in making the 1930s drought the widely accepted drought of record for the United States. For rural counties such as Franklin, that have crops and livestock, the immediate impact from drought may be more devastating than for more urban areas. Crops and livestock would be subject to lack of water and could result in livestock death and withered crop fields. In urban, developed areas, lack of rain can lead to water use restrictions.

Given the extent to which the U.S. relies on acceptable water supply for health and well-being, the need for advanced drought planning is obvious. In Missouri, it can be a problem of water supply. Types of damage can include the increasing incidence of fires (grass, brush, wooded areas), causing injuries and devastation to properties, depletion of groundwater supplies (residents being requested to cut water usage), poor crop growth, decrease in hay production for cattle, economic challenges for agricultural-related efforts, reduced revenues from recreational areas, environmental damages and contaminant levels in surface and groundwater due to decrease in volume of stream flow.

The drought of 1988-89 cost the U.S. an estimated \$39 billion dollars. To provide perspective, estimated damages of the record flood of 1993 were in the range of \$12-\$16 billion. The social and economic costs of drought are substantial. Given the extent to which the US relies on acceptable water supply for health and well-being, the need for advanced drought planning is obvious.

Although the 1988–1989 drought was the most economically devastating disaster in the history of the United States (Riebsame et al., 1991), a close second is undoubtedly the series of droughts that affected large portions of the United States in the 1930's. Determining the direct and indirect costs associated with this period of droughts is a difficult task because of the broad impacts of drought, the event's close association with the Great Depression, the fast revival of the economy with the start of World War II, and the lack of adequate economic models for evaluating losses at that time. However, broad calculations and estimates can provide valuable generalizations of the economic impact of the 1930s drought. In 1937, the Works Progress Administration (WPA) reported that drought was the principal reason for economic relief assistance in the Great Plains region during the 1930s (Link et al., 1937). Federal aid to the drought-affected states was first given in 1932, but the first funds marked specifically for drought relief were not released until the fall of 1933. In all, assistance may have reached \$1 billion (in 1930s dollars) by the end of the drought (Warrick et al., 1980).

By nature, drought occurs very slowly. Existing warning systems have been developed by Missouri Department of Natural Resources (Missouri Drought Response Plan). . The

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function of the plan is to assist in the response, monitoring and prediction, communication, planning in the event of a drought. The plan provides for operations and administrative procedures that activate the Drought Assessment Committee, Impact Task Forces, Governor's Drought Executive Committee, and the State Emergency Operations Center. The Governor's declaration empowers State agencies to implement water shortage emergency actions. The statute or authority that regulates this activity is the State Water Resources Plan (Revised statutes of Missouri Chapters 640.415). The primary agencies involved in drought activities include: MDNR (primary), Missouri Dept. of Agriculture, Missouri Dept. of Public Safety, MDC, Missouri Dept. of Social Services, University of Missouri-Columbia, USDA, U.S. Army, DOI, EPA, and FEMA. The drought plan serves the following groups: Water supply systems of individual ranchers and farmers, local governments, federal agencies, domestic water users, health care facilities, public uses such as electric power generation, firefighting, key military facilities, communications, and wastewater systems.

As a part of the Plan, monthly drought monitoring (consisting of water monitoring data and weather data) is provided to the State Emergency Management Agency by the Department of Natural Resources and the National Weather Service. MDNR utilized the Palmer Drought Index as a trigger to determine drought phases and actions to be taken.

Palmer greater than or equal to -1.0: Phase 1 (Advisory Phase)

Palmer -1.0 to -2.0: Phase 2 (Drought Alert)

Palmer -2.0 to -4.0: Phase 3 (Conservation Phase)

Palmer less than or equal to -4.0: Phase 4 (Possible Local Rationing Phase)

Once the data demonstrates that there is a Phase 2 drought condition, the Water Resources Program Director will request that the Governor declare drought alert for any region of the State and the Director of the Department of Natural Resources may activate and chair the Drought Assessment Committee (DAC). The DAC then activates the Impact Task Forces that includes a number of state departments, federal agencies, regional planning commissions, local organizations and the University of Missouri-Columbia.

### **Vulnerability**

The Missouri Drought Plan divides the state into three regions according to drought susceptibility (slight, moderate or severe). Region A has very little drought susceptibility. It is a region underlain by alluvial deposits and can be found in southeast Missouri and along the Missouri River and Mississippi River floodplains. Parts of Franklin, Jefferson, St. Charles and St. Louis Counties and the City of St. Louis are in Region A. Surface and groundwater resources are generally adequate for all needs. The counties in Region B have moderate drought susceptibility. Groundwater resources are adequate for domestic and municipal water needs but not for agriculture irrigation purposes. The majority of Franklin, Jefferson and St. Charles Counties are in Region B. The counties in Region C have severe drought vulnerability. Surface water sources usually become inadequate during extended drought. In the five county area, St. Louis County and the City of St. Louis are in Region C. The

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groundwater resources are normally poor, and typically supply enough water only for domestic needs. Irrigation is generally not feasible.

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to drought. U.S. Department of Agriculture (USDA) 1998 – 2008 statistical data on crop insurance paid and 2007 USDA Census of Agriculture crop exposure information was used to estimate vulnerability of Missouri counties to drought. Historical statistics were used to develop seven factor values for each county. Each factor was divided into five ranges with five being the highest and 1 being the lowest. Table 3-59 presents the ranges applied to the annualized crop insurance claims paid and the crop loss ratio rating factors.

Table 3-59 Vulnerability of Missouri Counties to Drought

County	Total Crop Insurance Paid for Drought Damage 1998-2008 (\$)	Crop Claims Ratio Rating	Annualized Crop Insurance Claims/ Drought Damage (\$)	Crop Exposure (\$)	Annual Crop Claims Ratio (%)	Crop Loss Ratio Rating
Franklin	627,701	1	57,064	24,032,000	0.237	1
Jefferson	46,178	1	4,198	5,554,000	0.076	1
St. Charles	1,198,945	1	108,995	40,965,000	0.266	1
St. Louis	322,059	1	29,278	23,414,000	0.125	1
City of St. Louis	0	1	0	0	0.000	1

Source - Missouri State Hazard Mitigation Plan, July 2010

Table 3-60 Ranges for Drought Vulnerability Factor Ratings

Factors Considered	Low (1)	Medium-low (2)	Medium (3)	Medium-high (4)	High (5)
Crop Loss Ratio Rating (%)	0 – 0.628	1.256 - 0.629	1.884 - 1.257	2.512 - 1.885	3.141 - 2.513
Annualized Claims Paid (\$)	< 340K	670K - 669K	670K - 999K	1M – 1.29M	> 1.3M

Source - Missouri State Hazard Mitigation Plan, July 2010

According to this analysis, all of the five county area has a low vulnerability to crop loss as a result of drought.

### Problem Statement

Drought is a disaster that creeps in slowly. While the region generally enjoys abundant water supply, long term drought can provide risk for agriculture, forestry, as well as the general public. Education of residents on watering restrictions of lawns is a basic strategy to address in drought and near drought conditions. More long term, the region can address ways to capture and slow down rainfall runoff, so that it percolates into the ground instead of being directly to flow rapidly off the land and into creates and streams.

## **7. Heat Wave Hazard Profile**

### **Background**

A heat wave is a prolonged period of excessive heat and humidity lasting more than two days. High humidity can make the effects of heat more harmful. The National Weather Service steps up its procedures to alert the public during these periods of excessive heat and humidity. Based on a NCDC 1980 report, heat and drought events result in the highest amount of damage (in the range of 120 billion dollars from 1980 to 1999 based on 46 weather related events) when compared to other natural weather hazards.

The mortality from heat wave events in the U. S. from 1979 to 1998 is greater than the number of lives claimed by lightning, hurricanes, tornadoes, floods, or earthquakes combined (National Center for Environmental Health). From 2004 -2013 the National Weather Service calculated that there is an average of 123 heat-related fatalities in the U.S. In 2013 92 people died as a result of extreme heat, down from 155 deaths in 2012. Even during a normal year without a catastrophic heat wave, the National Weather Service claims that an average of about 175 people succumb to summer heat. . Despite the presence of improving technology (e.g., air conditioning, architectural design, and improved accuracy in weather forecasting), heat waves continue to take many lives. From the early 20th century to the present time, Americans have experienced a significant rise in the cost of property damage from severe weather events, at the same time the number of lives lost has decreased.

It is often the case that many fatalities during even the most severe heat waves occur after the first day of extreme heat. This means that there is time to help people who do not have, or cannot afford, air conditioning. People 65 years or older are especially vulnerable to extreme heat. Heat waves of the past have often been more intense in urban areas. More people would be at risk when a heat wave occurs in the five county area, power companies would be heavily stressed trying to keep more people cool, and "urban heat islands" (urban areas where heat is retained by a high density of man-made structures) would be created, or enhanced if they already existed in the region. Finally, there are a few other societal impacts to be considered such as: water usage (heat waves often occur during droughts), urban pollution building up during heat waves, and the economic impact (the cost to keep millions of people cool).

Heat waves do pose a definite health hazard, however, and socio-economic conditions are major factors. Some people may not have air conditioning, while people living in high crime areas may not want to open their windows or go to cooling centers. Also, there may be problems with getting information out to the public in the languages of all residents.. Some people living in inner city apartments do have air conditioners, but will not turn them on because they do not want additional utility costs.

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However, additional solutions may come from community organizations working to reduce heat wave impacts. For example, if people are afraid to leave their homes to go to cooling centers, members of a community organization who are less at risk from heat could watch their homes while they are gone. It would also be easier for community-based organizations to conduct the door-to-door checks on people. In the case of heat waves, the city government or mayor's office could still facilitate the voluntary registering of people for well-being checks, but then distribute the lists of people to be checked to the community organizations.

### **Location**

Heat waves are area-wide. No specific portion of the five county planning area is any more likely to experience a heat wave than any other.

Heat wave weather in the five county area slowly comes into the area. Heat wave weather is different from other hazards such as tornadoes in that the hazard tends to occur over a much larger area, often times affecting from several counties to multiple states and evidence of impact may be delayed as much as two days.

### **Hazard Event History**

The St. Louis metropolitan area experienced a heat wave in July 1980. It was the first real prolonged period of extreme heat for the metropolitan area since 1966 when 246 heat deaths were reported. The heat began around the 4th of July. By the 12th, it was apparent that there was a very real crisis in the City of St. Louis. Emergency Medical Services (EMS) crews were finding dead or very ill persons in many areas of the City. City officials recommended to the Mayor that a heat emergency be declared. The Governor mobilized the National Guard and sent it to St. Louis to search door-to-door for victims. The American Red Cross opened emergency shelters.

In 1981, the St. Louis City Department of Health and Hospitals put together a heat illness prevention plan, titled "The Lion in Summer" that included a slide/sound show and speakers (health educators and EMS personnel) that was marketed to community and senior citizens' groups throughout the summer of 1981 and again in 1982. By then, health officials in the City of St. Louis and St. Louis County had developed a joint plan to monitor summer temperatures that would quickly warn citizens of anticipated periods of excessive heat.

Operation Weather Survival (OWS) began as a formal contract in 1982 between the City and several social service agencies to provide necessary assistance during periods of extreme heat or cold. It eventually became a broad group of public health, government, human service, utilities, and for-profit companies and agencies that worked together to prevent illness or death from either extreme heat or cold. In 1996, a more formal structure was initiated to assure the continuation of the organization. OWS is staffed by the United Way and now includes all the major counties in Missouri and Illinois that are considered part of the Metropolitan St. Louis area.

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St. Louis experienced additional heat waves in 1993, 1988, 1995 and 2012 without again experiencing death rates close to the total of 113 in 1980.

Table 3-61 Top Ten Consecutive Periods with Temperatures 90° or Higher in the St. Louis Metropolitan Area

Total of Days	Ending Date
28	July 29, 1936
23	July 19, 2012
23	August 11, 1941
21	July 7, 1954
21	August 28, 1936
21	July 31, 1916
20	August 19, 2007
20	July 21, 1921
20	August 3, 1901
19	August 20, 1937

Source -National Weather Service

The following tables show the impact of excessive heat and heat events in the five county area from 2005 onward.

Table 3-62 2005 – July 31, 2014 - Excessive Heat Events

Dates	County	Deaths	Injuries	Property Damage	Crop Damage
<b>2007</b>					
August 4 - 16	St. Charles, St. Louis, City of St. Louis	8	941	0	0
August 5 - 16	Franklin, Jefferson	0	5	0	0
<b>2008</b>					
July 20 - 21	St. Charles, St. Louis, City of St. Louis	0	68	0	0
<b>2009</b>					
June 17 - 27	St. Charles, St. Louis, City of St. Louis	2	123	0	0
June 21 - 27	Franklin, Jefferson	0	0	0	0
<b>2010</b>					
June 18 - 23	All	0	74	0	0
June 26 - 27	Jefferson St. Charles St. Louis City of St. Louis	0		0	0
July 14	All	0	34	0	0
July 17	All	0	13	0	0
July 22 – 24	All	0	23	0	0
July 28	St. Charles	0	3	0	0

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Dates	County	Deaths	Injuries	Property Damage	Crop Damage
	St. Louis City of St. Louis				
August 2 – 4	All	1	13	0	0
August 8 - 14	All	2	85	0	0
<b>2011</b>					
June 4 - 11	St. Charles St. Louis City of St. Louis	1	59	0	0
<b>2012</b>					
June 27 – July 8	All	19	258	0	0
July 16 - 19	All	2	53	0	0
July 22 - 27	All	0	75	0	0
July 31 – August 1	All	0	0	0	0
<b>2014</b>					
June 30	St. Charles, St. Louis, City of St. Louis	0	3	0	0
July 26	All	0	5	0	0
August 20 – 27	All	0	0	0	0
September 4	All	0	2	0	0
<b>Total</b>		35	1,847	0	0

Source - National Climatic Data Center, Storms Event Database

Table 3-63 2005 – July 31, 2014 - Heat Events

Dates	County	Deaths	Injuries	Property Damage	Crop Damage
<b>2005</b>					
June 6	City of St. Louis	1	0	0	0
June 23	Jefferson, St. Charles, St. Louis, City of St. Louis	0	0	0	0
June 23 - 30	Franklin	0	0	0	0
July 20 - 26	All	3	65	0	0
<b>2006</b>					
July 13 - 21	City of St. Louis	4	437	0	0
July 14 - 21	Franklin, Jefferson, St. Charles, St. Louis	3	306	0	0
July 29 – August 2	All	1	94	0	0
August 7	City of St. Louis	1	0	0	0
<b>2007</b>					
May 12	City of St. Louis	0	2	0	0
May 13	City of St. Louis	0	0	0	0

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Dates	County	Deaths	Injuries	Property Damage	Crop Damage
<b>2009</b>					
August 8 - 9	St. Louis, City of St. Louis		7	0	0
<b>2011</b>					
July 1 – 3	All	0	22	0	0
July 7 – 12	All	1	60	0	0
July 17 – August 3	All	8	412	0	0
August 6 -7	All	0	10	0	0
August 24	All	0	4	0	0
August 31 – September 3	All	1	17	0	0
<b>2012</b>					
June 24	St. Louis	1	0	0	0
July 10	St. Louis	1	0	0	0
<b>2013</b>					
August 27 – September 1	St. Charles St. Louis City of St. Louis	1	25	0	0
August 31 – September 1	Franklin Jefferson	0	0	0	0
Total		26	1,451	0	0

Source - National Climatic Data Center, Storms Event Database

**Probability of Occurrence - High**

Heat waves are sporadic phenomena that occur throughout the United States. Frequency, intensity, and duration of heat waves, however, vary drastically from year to year. From 1874-2013 there have been 75 periods of high temperatures ranging from ten days in length to 28 days.

Over 139 years there have been 75 heatwaves. There is a 54 percent probability of a heat wave occurring in any given year.

**Severity – High**

Percentage of Land Area Affected by Hazard – More than 50 percent

Heat wave weather slowly comes into the five county area. It moves over an area as a large, deep air mass with descending air, retarding the development of any significant precipitation that would provide relief to the ground surface's rising temperatures. As this air mass moves slowly or just sits over one area for days or even weeks, its rising surface temperatures begin to take their toll on the people who are trapped in this high pressure weather zone. Heat wave weather is different than other hazards such as tornadoes in that the hazard tends to occur over a much larger area, often times affecting from several counties to multiple states.

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North American summers are hot; most summers see heat waves in one section or another of the United States. East of the Rockies, and especially in the five county area, they tend to combine both high temperature and high humidity. Heat waves typically occur during the summer months of June, July and August and early September. The stagnant atmospheric conditions of the heat wave trap pollutants in urban areas and add the stresses of air pollution to the already dangerous effects of hot weather.

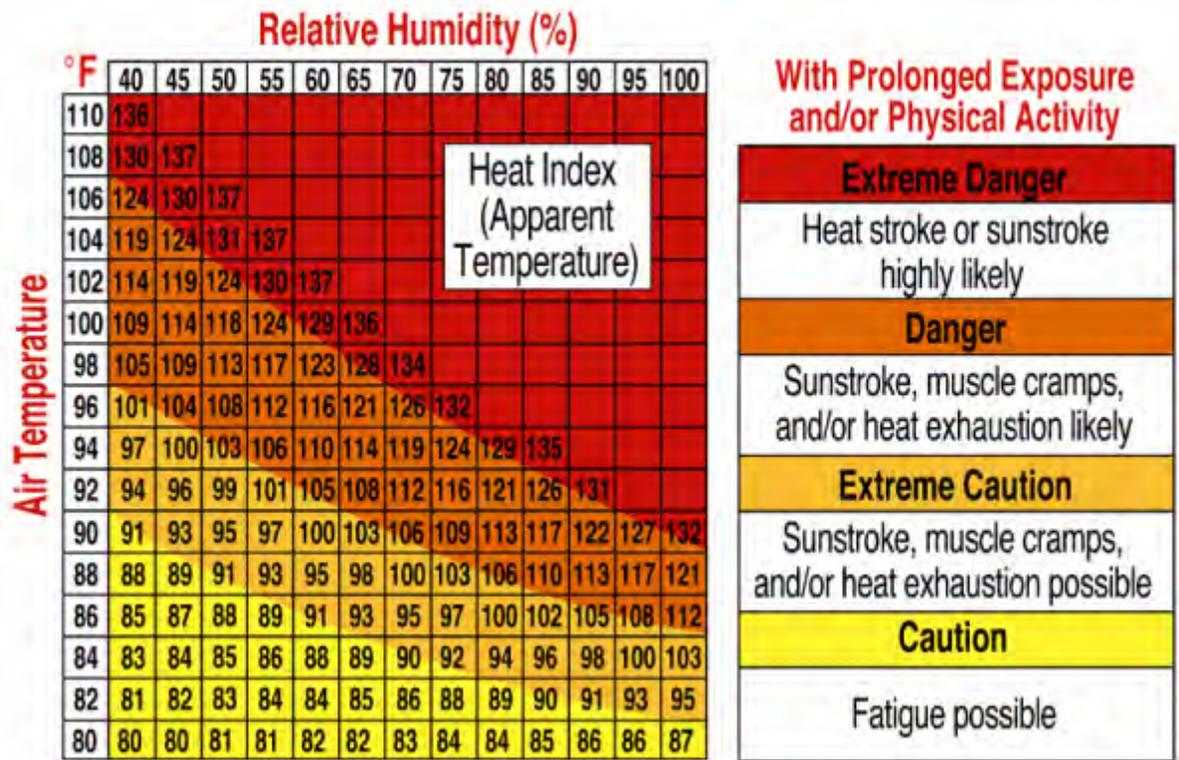
Since the 1980 record heat wave, the National Weather Service (NWS) has stepped up its efforts to alert more effectively the general public and appropriate authorities to the hazards of heat waves--those prolonged excessive heat/humidity episodes. Based on the latest research findings, the NWS has devised the "Heat Index"(HI), (or the "apparent temperature"). The HI, given in degrees F, is an accurate measure of how hot it really feels when the relative humidity (RH) is added to the actual air temperature. To find the HI, look at the Heat Index Chart. As an example, if the air temperature is 95° F (found on the left side of the table) and the RH is 55 percent (found at the top of the table), the HI is 110° F. This is at the intersection of the 95-degree row and the 55 percent column. Refer to Figure 3-25 for the Heat Index Chart with descriptions of the associated health impacts

The NWS will initiate alert procedures when the Heat Index (HI) is expected to exceed 105 degrees F to 110 degrees F (depending on the local climate) for at least two consecutive days. The expected severity of the heat determines whether advisories or warnings are issued. A common guideline for the issuance of excessive heat alerts is when the maximum daytime HI is expected to equal or exceed 105°F and a nighttime minimum HI of 80°F or above for two or more consecutive days. Some regions and municipalities are more sensitive to excessive heat than others. As a result, alert thresholds may vary substantially from these guidelines. Excessive heat alerts thresholds are being tailored at major metropolitan centers based on research results that link unusual amounts of heat-related deaths to city-specific meteorological conditions.

The alert procedures are:

- Include HI values in zone and city forecasts.
- Issue Special Weather Statements and/or Public Information Statements presenting a detailed discussion of (1) the extent of the hazard including HI values, (2) those individuals most at risk, (3) safety rules for reducing the risk.
- Assist state and local health officials in preparing Civil Emergency Messages in severe heat waves. Meteorological information from Special Weather Statements will be included as well as more detailed medical information, advice, and names and telephone numbers of health officials.
- Release to the media and over Nona's own Weather Radio all of the above information.

FIGURE 3-25 HEAT INDEX CHART



Source - National Weather Service

Operation Weather Survival was created in 1981 to address the needs of the community during extreme weather conditions. It is comprised of public and private organizations working together to prevent illness or death from extreme hot and cold weather.

Heat kills by taxing the human body beyond its abilities. Normally, the body has ways of keeping itself cool, by letting heat escape through the skin, and by evaporating sweat (perspiration). If the body does not cool properly or does not cool enough, the victim may suffer a heat-related illness. Anyone can be susceptible although the very young and very old are at greater risk. Heat-related illnesses can become serious or even deadly if unattended. The elderly and the chronically ill are more vulnerable to the effects of high temperatures and may be using medications which can have an impact on the body's response to heat. Among the natural hazards, only the cold of winter--not lightning, hurricanes, tornadoes, floods, or earthquakes-- takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the disastrous heat wave of 1980, more than 1,250 people died. Damage to the body ranges from heat cramps to death.

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- **Heat Cramps:** Heat cramps are muscular pains and spasms due to heavy exertion. They are often the first signal that the body is having trouble with the heat..
- **Heat Exhaustion:** Heat exhaustion is less dangerous than heat stroke. It typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases causing blood flow to decrease to the vital organs, resulting in a form of mild shock. If not treated, the condition of the victim will worsen. Body temperature may rise and victim may suffer heat stroke.
- **Heat Stroke:** Also known as sunstroke, heat stroke is life-threatening. The victim's temperature control system, which produces sweating to cool the body, stops working. The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly.

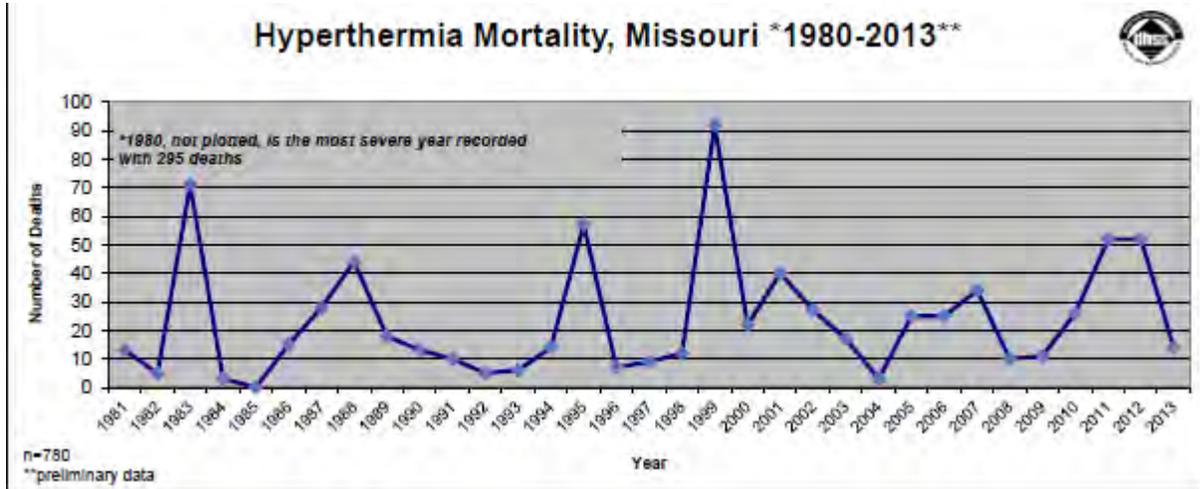
The highest temperature documented during the 1936 heat wave of 28 days was 108° F. The highest temperature on record was 115° F on July 14, 1954.

Compared to other meteorological hazards that pose threats to property and human health (e.g., floods, hurricanes, and tornadoes), heat waves rank first as the cause of human mortality. Extremes of heat have a broad and far-reaching set of impacts on the nation. These include significant loss of life and illness, economic costs in transportation, agriculture, production, energy and infrastructure. In June to September 1980 the nation saw a devastating heat wave and drought that claimed at least 1,700 lives and had estimated economic costs \$20 billion in 1980 dollars. For information on damages and mortality figures for period prior to 2010 please refer to the 2009 Plan Update. Figure 3-26 presents information from 1980 to 2013 on statewide heat mortality. Since 1980, there have been 780 deaths in Missouri attributed to heat. From 2000 to 2013, there have been 127 heat-related deaths in St. Louis County and the City of St. Louis.

Case studies have documented several impacts on transportation. Aircraft lose lift at high temperatures. The Phoenix airport has been closed due to periods of extreme heat that made aircraft operations unsafe. Highways, roads and train rails are damaged by excessive heat. Asphalt roads soften and concrete roads have been known to buckle. Stress is placed on the cooling systems of automobiles, diesel trucks and railroad locomotives.

Various sectors of the agriculture community are affected by extreme heat. Livestock, such as rabbits, pigs and poultry, are severely impacted by heat waves. . Milk production and cattle reproduction also decreases during heat waves. High temperatures at the wrong time can inhibit crop yields. Extreme high temperatures can significantly reduce all wheat, rice, maize, potato, and soybean crop yields at key development stages.

Figure 3-26 Hyperthermia Mortality in Missouri



Source - Missouri Department of Health and Senior Services

The combination of extreme heat and the added demand for electricity to run air conditioning causes transmission line temperatures to rise and fail during heat waves.

The demand for electric power during heat waves is well documented. In 1980, consumers paid \$1.3 billion more for electric power during the summer than the previous year. The demand for electricity, 5.5 percent above normal, outstripped the supply, causing electric companies to have rolling black outs.

The demand for water increases during periods of hot weather. In extreme heat waves, water can be used to cool bridges and other metal structures susceptible to heat failure. This water usage may cause a reduced water supply and pressure. This can significantly contribute to fire suppression problems for both urban and rural fire departments.

The rise in water temperature during heat waves contributes to the degradation of water quality and negatively impacts fish populations. It can also lead to the death of many other organisms in the water ecosystem. High temperatures are also linked to rampant algae growth, causing fish kills in rivers and lakes.

Heat waves are sporadic phenomena that occur throughout the United States. Frequency, intensity, and duration of heat waves, however, vary drastically from year to year. The levels of severity, by Heat Index apparent temperature are found below.

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- Extreme Danger (heat stroke or sunstroke highly likely at 130° F or higher).
- Danger (sunstroke, muscle cramps, and/or heat exhaustion likely at 105 ° F to 129° F).
- Extreme Caution (sunstroke, muscle cramps, and/or heat exhaustion possible at 90° F to 104° F)
- Caution (fatigue possible at less than 90° F).

### **Vulnerability**

All areas (incorporated and unincorporated) are vulnerable to the impacts of heat wave. Places with a higher percentage of elderly may be more at risk due to the increased vulnerability of this group. Approximately 13 percent of the population in the five county area is age 65 or older. Figure 2-7 in Chapter 2 shows the distribution of population age 65 and over in the five county area.

Heat waves typically occur during the summer months of June, July and August and early September. The majority of heat-related deaths occur in these months.

Health care providers in Missouri are required to report cases of hyperthermia (illnesses and deaths) to the Department of Health and Senior Services. Figure 3-27 presents information from 1980 to 2013 on statewide heat mortality. Since 1980, there have been 780 deaths in Missouri attributed to heat. From 2000 to 2013, there have been 127 heat-related deaths in St. Louis County and the City of St. Louis.

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to heat wave. In the period 2000 – 2008, there were a total of 203 heat-related deaths statewide. Most of these deaths occurred during July and August and were primarily recorded in the metropolitan areas of Jackson County (Kansas City) and St. Louis County and the City of St. Louis. Approximately 54 percent of these deaths (109) were in the 65 years and older group. Heat-related illnesses can become serious or even deadly if unattended. The elderly and the chronically ill are more vulnerable to the effects of high temperatures and may be using medications which can have an impact on the body's response to heat. Contributing causes for deaths to people in the five through 64 years included outdoor physical activity (work or sports), medical conditions or substance abuse. During this period, statewide there were 10 deaths of children less than five years old. As the portion of the population aged 65 years and older increases, counties will experience greater hyperthermia deaths when heat waves occur.

### **Problem Statement**

Heat waves hit the elderly and the low income communities hardest, largely because they may not have the resources to protect themselves. Local government watch programs to check on those in greatest danger from extended heat waves will work also for other severe

weather conditions. Extreme heat is particularly a problem for all residents when power fails, and people who have air conditioning find they are without it. There is also need to educate those people who work outdoors of the dangers of extended exposure to a combination of high temperatures and high humidity.

## **8. Dam Failure Hazard Profile**

### **Background**

The purpose of a dam is to impound (store) water, wastewater or liquid borne materials for any of several reasons, e.g. flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, and recreation or pollution control. Many dams fulfill a combination of the above functions.

Manmade dams may be classified according to the type of construction material used, the methods used in construction, the slope or cross-section of the dam, the way the dam resists the forces of the water pressure behind it, the means used for controlling seepage and, occasionally, according to the purpose of the dam.

The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (such as plastic or rubber) and any combination of these materials. Dams are owned and operated by individuals, private and public organizations and the government. Associated works include spillways, water supply facilities, and lake drain structures. Most dams have an earth embankment and one or two spillways.

Embankment dams are the most common type of dam in use today in Missouri (99 percent of all dams in Missouri are made of earthen materials and one percent are constructed of concrete). Materials used for embankment dams include natural soil or rock, or waste materials obtained from mining or milling operations. An embankment dam is termed an "earthfill" or "rockfill" dam depending on whether it is comprised of compacted earth or mostly compacted or dumped rock. The ability of an embankment dam to resist the reservoir water pressure is primarily a result of the mass weight, type and strength of the materials from which the dam is made.

Concrete dams may be categorized into gravity and arch dams according to the designs used to resist the stress due to reservoir water pressure. Gravity dams are the most common form of concrete dam. Because the purpose of a dam is to retain water effectively and safely, the water retention ability of a dam is of prime importance. Water may pass from the reservoir to the downstream side of a dam by:

- Passing through the main spillway or outlet works
- Passing over an auxiliary spillway
- Overtopping the dam

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- Seepage through the abutments
- Seepage under the dam

Overtopping of an embankment dam is very undesirable because the embankment materials may be eroded away. Additionally, only a small number of concrete dams have been designed to be overtopped. Water normally passes through the main spillway or outlet works; it should pass over an auxiliary spillway only during periods of high reservoir levels and high water inflow. All embankment and most concrete dams have some seepage. However, it is important to control the seepage to prevent internal erosion and instability. Proper dam construction, and maintenance and monitoring of seepage provide this control.

Thousands of people have been injured, many killed and billions of dollars of property damaged by dam failures in the United States including the catastrophic dam failure upstream from Johnstown, Pennsylvania that killed 2,209 people in May 31, 1889 as a result of a poor and inappropriate maintenance of a poorly constructed dam. The problem of unsafe dams in Missouri was underscored by dam failures at Lawrenceton in 1968 (just south of Jefferson County), Washington County in 1975 and a near failure in Franklin County in 1978.

Safety is of paramount importance to the effectiveness of a dam. Dam failures can be devastating for the dam owners, to the dam's intended purpose and, especially, for downstream populations and property. Property damage can range in the thousands to billions of dollars.

Although the majority of dams in the U.S. have responsible owners and are properly maintained, still many dams fail every year. In the past several years, there have been hundreds of documented failures across the nation (this includes 250 after the Georgia Flood of 1994). A life was recently lost in New Hampshire as a result of a dam failure. Dam and downstream repair costs resulting from failures in 23 states reporting in one recent year totaled \$54.3 million.

In Missouri, the first state legislation aimed at regulating dams was passed in 1889 and was called the Dam Mills and Electric Power Law. The law was concerned only with damaged caused by construction and lake formation. It did not address the engineering aspects of design or downstream safety of dams.

In 1972, Congress passed the National Dam Safety Act (P.L. 92-367) that called for an inventory of dams in the U.S. and one time inspection of dams that would result in loss of life from a failure. In 1986, Congress enacted the Water Resources Development Act (P.L. 99-662). Title XII-Dam Safety authorized the U.S. Army Corps of Engineers (USACE) to maintain and periodically update the inventory of dams. In 1988 funds were appropriated for this effort. FEMA and USACE developed a Memorandum of Agreement where FEMA assumed responsibility for maintaining and updating the inventory using the funds authorized. The Water Resources Development Act of 1996 (P.L. 104-303) Section 215 re-

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authorized periodic update of the National Inventory of Dams (NID) by USACE and continued a funding mechanism.

### **Location**

Locations affected by dam failure will be low-lying areas that are below dams, near a creek, stream or river valley. Residents, structures, farm animals, businesses and roads and infrastructure in the path of the on-rushing dam waters can become quickly inundated and destroyed.

In 1972, Congress passed the National Dam Safety Act (P.L. 92-367) that called for an inventory of dams in the U.S. and one time inspection of dams that would result in loss of life from a failure. The National Inventory of Dams (NID) was first published in 1975. In 1986, Congress enacted the Water Resources Development Act (P.L. 99-662) in which one section the U.S. Army Corps of Engineers (USACE) to maintain and periodically update the NID. The Water Resources Development Act of 1996 (P.L. 104-303) Section 215 re-authorized periodic update of the National Inventory of Dams (NID) by USACE and continued a funding mechanism.

The NID has definitions for downstream hazard potential to the downstream area. These definitions were published by the Federal Emergency Management Agency in the 2004 Federal Guidelines for Dam Safety. The NID definitions are as follows:

1. Low Hazard Potential - Dams assigned to the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
2. Significant Hazard Potential - Dams assigned to the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental change, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
3. High Hazard Potential - Dams assigned to the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

The dam classifications developed by the Missouri Department of Natural Resources, Dam and Reservoir Safety Program are different from the NID definitions. State regulated dams are assigned to one of three classes which reflect the potential to do downstream damage should a failure occur.

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Missouri Class 1 – The area downstream from the dam that would be affected by inundation contains ten (10) or more permanent dwellings or any public building. Inspection of these dams must occur every two years.

Missouri Class 2 – The area downstream from the dam that would be affected by inundation contains one (1) to nine (9) permanent dwelling, or one (1) or more campgrounds, with permanent water, sewer and electrical services or one (1) or more industrial buildings. Inspection of these dams must occur once every three years.

Missouri Class 3 – The area downstream from the dam that would be affected by inundation does not contain any of the structures identified for Class 1 or Class 2 dams. Inspection of these dams must occur once every five years.

The following tables list High Hazard Potential dams by county according to the State of Missouri. NID and the State of Missouri have summarized the status of dams in the five county area based on their specific hazard classifications. Map of dams found in the five county area can be found in the Appendix – Map Sets – Dam Classification. The NID list of dams and their classification can also be found in Appendix I.

Table 3-64 Summary of Dams in Five County Area by Hazard Classification

NATIONAL INVENTORY (NID)				STATE REGULATED			
Hazard Classification				Hazard Classification			
Total	High	Significant	Low	Total	High	Significant	Low
449	247	19	183	99	48	41	10

Source: Missouri Department of Natural Resources

Table 3-65 Dams in Five County Area

County	Total	State-Regulated
Franklin	144	23
Jefferson	150	36
St. Charles	119	27
St. Louis	45	13
City of St. Louis	0	0
<b>Total</b>	<b>458</b>	<b>99</b>

Source - Missouri Dam Report by County March 9, 2007, Missouri Department of Natural Resources

Table 3-66 NID Hazard Potential Classifications by County

County	High Hazard	Low Hazard	Significant Hazard
Franklin	55	89	2
Jefferson	101	27	9
St. Charles	52	61	6
St. Louis	39	6	2
City of St. Louis	0	0	0
<b>Total</b>	<b>247</b>	<b>183</b>	<b>19</b>

Source - National Inventory of Dams July 1, 2014, U.S. Army Corps of Engineers

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Table 3-67 Franklin County State-Regulated High Hazard Dams

Dam Name	Stream	Built	Length (feet)	Dam Height (feet)	NEW Nearest Community (miles)*	Emergency Action Plan Completed
Las Brisas Dam	Trib Of Little Fox Creek	1970	470	46	Eureka	Yes
Long View Lake Dam	Trib Brush Creek	1957	730	36	Labadie	Yes
Baudendistel Dam	Trib To Mo	2000		48	New Haven	Yes
Whispering Valley Lake #2 Dam	Trib Bouef Creek	1970	538	38	Rural	Yes
Anich Dam	Trib Fiddle Creek	2003	500	38	Rural	Yes
Lake Torino Dam	Tr Little Calvey Creek	1969	570	38	Rural	Yes
Boston Lakewood Park Dam	Trib Bourbeuse River	1970	1080	41	Robertsville	Yes
Lake Serene Dam	Tributary Of Calvey Creek	1957	1175	42	Rural	Yes
Lake St. Clair Dam	Tr To Meramec River	1970	1000	49	Piney Park 3	Yes
Abell Lake Dam	Little Meramec River	1965	630	36	Lonedell 4	Yes
Winter Lake Dam	Trib Bourbeuse River	1969	520	40	Rural	Yes
Port Hudson Lake Dam	Cedar Fork	1992	1080	48	Rural	Yes
Whispering Valley Lake #1 Dam	Trib Bouef Creek	1969	640	41	Rural	Yes
Lonedell Lake Dam	Tr To Tyrey Creek	1972	796	56	Richwoods 3	No
Lake Thunderbird Dam	Trib Meramec River	1972	700	45	Rural	No
Melody Lake Dam	Tr-Bourbeuse River	1964	1070	53	Rural	No

Source -Missouri Department of Natural Resources, Water Resources Center, Dam and Reservoir Safety Program, November 2014

\*National Inventory of Dams, FEMA and USACE - source of information for Nearest Community (incorporated, unincorporated, rural), if no miles given, assume within community.

Table 3-68 Jefferson County State-Regulated High Hazard Dams

Dam Name	Stream	Built	Length (feet)	Dam Height (feet)	NEW Nearest Community (miles)*	Emergency Action Plan Completed
Morse Mill Lake Dam	Trib Belew Creek	2006	650	52	Morse Mill 1	Yes
Vatterott Dam	Trib Sandy Creek	1962	685	40	Rural	Yes
Lake Tishomingo Dam	Trib Belew Creek	1950	870	68	Cedar Hill 4	Yes
Lake Briarwood Dam	Ball Branch	1970	1400	57	DeSoto 1.5	Yes
Glenwilfern Lake Dam	Trib to LaBarque Creek	1953	540	38	Rural	Yes
Lake Montowese Dam	Trib Big River	1942	1000	54	Rural	Yes
Lake Wauwanoka Dam	Dry Creek	1942	1045	50	Rural	Yes
Summer Set Dam	Trib Joachim Creek	1974	1200	59	DeSoto 2	Yes
Lake Lorraine Dam	Trib Sandy Creek	1957	1100	46	Goldman 1	Yes
Coles Dam	Trib Big River	1948	1370	37	Rural	Yes
Sunrise Big Lake Dam	Trib to Joachim Creek	1961	480	38	Rural	Yes
Winter Haven Lake Dam	Falling Rock Branch	1978	730	49	DeSoto 2	Yes

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Dam Name	Stream	Built	Length (feet)	Dam Height (feet)	NEW Nearest Community (miles)*	Emergency Action Plan Completed
Silver Lake Dam	Ditch Creek	1981	1600	80	Rural	Yes
Marshall Lake Dam	Trib Big River	1989	700	49	Rural	Yes
Raintree Plantation Dam	Belew Creek Tributary	1981	1350	71	Rural	Yes
Raintree Dam #2	Belew Creek Tributary	1989	1000	55	Rural	Yes
Lake Forest Estates Dam	Trib Glaize Creek	1979	470	38	Rural	Yes
Spring Lake Dam	Trib Ball Branch	1970	0	20	Victoria 4	Yes
Spring Lake Dam	Trib Falling Rock Branch	1976	600	42	DeSoto 2	Yes
Sunrise Lake Upper Dam	Trib to Joachim Creek	1961	360	37	DeSoto 6	Yes
Lake Trails	Trib Joachim Creek	1967	550	46	Festus 2.1	No
Hidden Valley Lake Dam	Trib Big River	1971	330	36	Rural	No
Rustic Hills Lake Dam	Trib LaBarque Creek	1968	500	37	Rural	No
Crystal Lake Dam	Trib LaBarque Creek	1965	600	45	Rural	No
Weber Hill Terrace Lake Dam	Trib Bear Creek	1957	519	36	Weber Hill 1	No
Kostyshock Lake Dam	Trib Joachim Creek	1948	625	38	DeSoto 3.5	No
Cedar Hill #1 Dam	Trib Big River	1949	600	35	Cedar Hill 1.5	No
Valle Lake Dam	Trib Joachim Creek	1955	820	39	DeSoto 6	No
Cedar Hill #2 Dam	Trib Big River	1949	460	39	Cedar Hill 1.5	No
River Cement Company Dam	Trib Mississippi River	1965	605	57	Crystal City 4	No
Wildwood Lake Dam	Trib Plattin Creek	1972	700	44	Olympian Village 1	No
Stonehenge #1 Dam	Trib to Sugar Creek	1990	360	41	Rural	No
Dresser No. 11	Trib to Big River	1975	500	90	Rural	No
Lost Trails Estate Dam	Trib Rock Creek	1978	420	38	High Ridge 5	No
Dresser No. 10 Dam	Trib Big River	1974	765	100	Rural	No
Valley View Lake Dam	NA	NA	NA	NA	Rural	No

Source - Missouri Department of Natural Resources, Water Resources Center, Dam and Reservoir Safety Program, November 2014

\*National Inventory of Dams, FEMA and USACE - source of information for Nearest Community (incorporated, unincorporated, rural), if no miles given, assume within community.

Table 3-69 St. Charles County State-Regulated High Hazard Dams

Dam Name	Stream	Built	Width (feet)	Length (feet)	NEW Nearest Community (miles)*	Emergency Action Plan Completed
Weber Dam	Trib Femme Osage Creek	2002	710	72	New Melle 1.8	Yes
Warvid Lake Dam	Trib Femme Osage	1989	660	69	Defiance	Yes
Sycamore Valley Lake	NA	NA	NA	NA	Defiance 2.2	Yes

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Dam Name	Stream	Built	Width (feet)	Length (feet)	NEW Nearest Community (miles)*	Emergency Action Plan Completed
<b>Dam</b>						
Callaway Forks Dam	Trib Femme Osage	1981	600	80	New Melle	Yes
Beaver Lake Dam	Trib to Missouri River				Rural	Yes
Lake St. Louis Dam	Peruque Creek	1973	900	47	Lake St. Louis	Yes
Key Harbor Estate Dam #1	Peruque Creek	1992	350	44	Wentzville	Yes
Key Harbor Estate Dam #2	Peruque Creek	1992	350	41	Wentzville	Yes
Busch Wildlife #35	Schote Creek	1963	930	37	Rural	Yes
Howell Dam	Trib Femme Osage Creek	1978	500	40	Not Available	Yes
Khani Dam	Trib Peruque Creek	2001	980	57	Not Available	Yes
Warwick Downs Dam	Trib Dardenne Creek	1969	300	42	Kampville 4	Yes
Park Charles South Dam	Trib-Dardenne Creek	1965	800	39	St. Peters 3	Yes
Incline Village Lake Dam	Indian Camp Creek	1978	950	41	Old Monroe	Yes
Greengate Farms Dam	Femme Osage Creek	1994	2475	46	Not Available	Yes
De Villa Trails Lake Dam	Trib to Missouri River	1995	230	61	St. Charles	Yes
New Melle Quarry Dam	Trib Femme Osage Creek	1999	1230	90	New Melle	Yes
Stergen Lake Dam	Trib Femme Osage Creek	1970	600	46	Femme Osage 1	Yes
True Femme Osage Dam	Trib Femme Osage Creek	2000	1200	73	New Melle	Yes
Lake Sainte Louise Dam	Branch Peruque Creek	1967	790	52	Lake St. Louis	Yes
Essen Lake Dam	Trib Femme Osage Creek	1980	560	50	Weldon Spring	Yes
Busch Wildlife #37 Dam	Trib Dardenne Creek	1970	1200	36	Rural	Yes
Struckhoffs Lake Dam	Trib to Missouri River	1972	410	37	Augusta 2	Yes
Ameren Sioux Power Plant Dam	NA	NA	NA	NA	Portage des Sioux 3	No

Source - Missouri Department of Natural Resources, Water Resources Center, Dam and Reservoir Safety Program, November 2014

\*National Inventory of Dams, FEMA and USACE - source of information for Nearest Community (incorporated, unincorporated, rural), if no miles given, assume within community.

Table 3-70 St. Louis County State-Regulated High Hazard Dams

Dam Name	Stream	Built	Width (feet)	Length (feet)	NEW Nearest Community (miles)	Emergency Action Plan Completed
Chesterfield Village #2 Dam	Bonhomme Creek	NA	400	44	Chesterfield	Yes
Wildhorse Creek Parkway Dam	Tr Bonhomme Creek	1989	300	41	Chesterfield 5	Yes
Joe Machs Lake Dam	Trib Fox Creek	1996	460	56	Not Available	Yes

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Dam Name	Stream	Built	Width (feet)	Length (feet)	NEW Nearest Community (miles)	Emergency Action Plan Completed
Lasiandra Lake Dam	Trib Bonhomme Creek	1994	525	42	Chesterfield	Yes
Fountain Lake Dam	NA	NA	NA	NA	Sunset Hills 0.5	Yes
Lake Post Commons Dam	Trib Bonhomme Creek	1976	320	44	Chesterfield	Yes
Chesterfield Village #3 Dam	Bonhomme Creek	NA	425	51	Chesterfield 1	Yes
Dierberg Lake Dam	Tr Caulks Creek	1982	370	68	Chesterfield 3	Yes
Cherry Hill Dam	Tr Hamilton Creek	1988	225	68	Chesterfield 2	Yes
Friendship Village Dam					Bellefontaine Neighbors 0.5	Yes
City Place Dam	Tr Creve Coeur Creek	1988	560	51	Creve Coeur	Yes
Woods Mill Cove Dam	Trib Of Creve Coeur Creek	1988	210	42	Rural	Yes
Fienup Lake Dam	Tr-Bonhomme Creek	1970	380	62	Chesterfield	Yes

Source - Missouri Department of Natural Resources, Water Resources Center, Dam and Reservoir Safety Program, November 2014

\*National Inventory of Dams, FEMA and USACE - source of information for Nearest Community (incorporated, unincorporated, rural), if no miles given, assume within community.

There are no dams located within the City of St. Louis. On the Mississippi River at the northeast limit of the City there is a non-moveable, natural rock, low water dam referred to as Lock and Dam #27. Lock and Dam #27 is maintained and operated by the USACE. This dam is considered to be a nonmoveable (natural rock) low water dam. It is 2,500 feet across with a pool size of 13,000 acres. The lock is at a separate location on the manmade Chain of Rocks canal.

The Missouri Department of Natural Resources (MDNR), Dam and Reservoir Safety Program, has begun working with dam owners and emergency management personnel to develop Emergency Action Plans (EAPs) for the state-regulated High Hazard Potential Dams in Missouri. The State regulated (over 35 foot) high hazard (federal definition) dams are also the same as class 1 and 2 (State hazard designation) dams. The State does not have regulatory authority to require owners of dams less than 35 feet high to prepare an EAP or to meet any standards. Part of the EAP effort is mapping and analyzing potential inundation areas for all state-regulated dams in Missouri. An inundation map is to be part of the Emergency Action Plan prepared by all dam owners. As of 2013, 370 inundation maps have been provided to dam owner and 180 EAPs have been prepared by dam owners. When an EAP is completed, the dam owner is to provide a copy to MDNR and their respective county Emergency Management agency. In the five county area, 68 EAPs

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have been completed and work is continuing on the remaining 19. MDNR staff is currently working with the owners of regulated dams which do not have EAPs and anticipate 100 percent completion by the end of 2015. Tables 3-64 to 3-67 contain information of the EAPs by county. Source is Missouri Department of Natural Resources, Water Resources Center, Dam and Reservoir Safety Program (<http://dnr.mo.gov/env/wrc/dam-safety/index.html> ).

### **Hazard Event History**

Thousands of people have been injured, many killed, and billions of dollars of property damaged by dam failures in the United States. Dam failures at Lawrenceton in 1968, Washington County in 1975, Fredericktown in 1977, a near failure in Franklin County in 1978 and the 2005 Taum Sauk failure underscored the problem of unsafe dams in Missouri

Listed below is a summary of the frequency of dam failures in Missouri. Four dams failed in ten years.

Lawrenceton.....	1968
Washington County.....	1975
Frederickton.....	1977
Franklin County (near failure) .....	1978
Taum Sauk.....	2005

### **Probability of Occurrence - Low**

According to the discussion on the Dam Failure Hazard from the Missouri State Hazard Mitigation Plan, Final 2013, there were 17 dam failures recorded in Missouri for the 26-year period for which dam failure statistics are available. The comprehensive dam data collected by Stanford University was not updated past 2001. The Taum Sauk failure in 2005 is not included. Using this data, there is an annual probability of 65 percent in any given year for at least one dam failure event in the state. However, with 5,420 dams in Missouri, this translates to an overall low probability per dam structure.

### **Severity – Medium**

Percentage of Land Affected by Hazard – 10 to 25 percent Franklin, Jefferson, St. Charles and St. Louis Counties and less than 10 percent for the City of St. Louis

Federal law and the Association of Dam Safety Officials (ASDSO) Model State Dam Safety program define a dam as “any artificial barrier, including appurtenant works, which impounds or diverts water and which is 25 feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier, or from the lowest elevation of the outside limit of the barrier, if it is not across a stream channel or watercourse to the maximum water storage elevation; or has an impounding capacity at the maximum water storage elevation of fifty acre-feet or more.

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This Act does not apply to any such barrier which is not in excess of six feet in height, regardless of storage capacity, or which has a storage capacity at a maximum water storage elevation not in excess of fifteen acre-feet, regardless of height (P.L. 92-367; Dam Safety Act of 1972) unless such barrier, due to its location or other physical characteristic, is likely to pose a significant threat to human life or property in the event of its failure.” (P.L. 99-662, Water Resources Development Act of 1986).

In 1972, Congress passed the National Dam Safety Act (P.L. 92-367) that called for an inventory of dams in the U.S. and one time inspection of dams that would result in loss of life from a failure. In 1986, Congress enacted the Water Resources Development Act (P.L. 99-662). Title XII-Dam Safety authorized the U.S. Army Corps of Engineers (USACE) to maintain and periodically update the inventory of dams. In 1988 funds were appropriated for this effort. FEMA and USACE developed a Memorandum of Agreement where FEMA assumed responsibility for maintaining and updating the inventory using the funds authorized. The Water Resources Development Act of 1996 (P.L. 104-303) Section 215 re-authorized periodic update of the National Inventory of Dams (NID) by USACE and continued a funding mechanism.

Criteria for dams in the NID are as follows: all high hazard potential classification dams; all significant hazard potential classification dams; and low hazard or undetermined potential classification dams. Low hazard potential dams include those which equal or exceed 25 feet in height and which exceed 15 acre-feet in storage and those which equal or exceed 50 acre-feet storage and exceed 6 feet in height. The NID has definitions for downstream hazard potential to the downstream area. These definitions were published by the Federal Emergency Management Agency in the 2004 Federal Guidelines for Dam Safety. The NID definitions are as follows:

1. Low Hazard Potential - Dams assigned to the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner’s property.
2. Significant Hazard Potential - Dams assigned to the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental change, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
3. High Hazard Potential - Dams assigned to the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Missouri House Bill 603 (called the Dam Safety Law) was passed by the Missouri Legislature and became effective in September 1979. This law excluded certain dams from regulation, those less than 35 feet high, and allowed exemptions for others used for agricultural

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purposes and those regulated by other state or federal agencies. The law requires that a construction permit application be made to construct new dams or modify, remove or alter existing dams. Owners of existing dams 35 feet or more in height must obtain a registration permit and owners of new dams 35 feet or more in height must obtain a safety permit after construction to operate the structures. All regulated dams must be inspected periodically to assure that their continued operation does not constitute a hazard to public safety, life and property. The construction of dams in Missouri has always been an important part of the state’s economy primarily from the standpoint of the recreational areas they create.

The Missouri Dam and Reservoir Safety Program is responsible for ensuring that all new and existing non-agricultural, non-federal dams 35 feet or more in height meet minimum safety standards. The program reviews engineering plans and specifications; issues permits, conducts hydrologic, hydraulic and structural analysis of dams; monitors construction of new dams and modification of existing dams; data management; performs safety inspections of existing dams; inundation mapping for high hazard potential dams; and responds to dam safety emergencies.

The dam classifications developed by the Missouri Department of Natural Resources, Dam and Reservoir Safety Program are different from the NID definitions. State regulated dams are assigned to one of three classes which reflect the potential to do downstream damage should a failure occur.

Missouri Class 1 – The area downstream from the dam that would be affected by inundation contains ten (10) or more permanent dwellings or any public building. Inspection of these dams must occur every two years.

Missouri Class 2 – The area downstream from the dam that would be affected by inundation contains one (1) to nine (9) permanent dwelling, or one (1) or more campgrounds, with permanent water, sewer and electrical services or one (1) or more industrial buildings. Inspection of these dams must occur once every three years.

Missouri Class 3 – The area downstream from the dam that would be affected by inundation does not contain any of the structures identified for Class 1 or Class 2 dams. Inspection of these dams must occur once every five years.

Table 3-71 compares the NID and the State hazard potential definitions.

Table 3-71 Hazard Potential Definitions

Federal/NID	State
High Hazard Potential dams If the dam were to fail, lives would be lost and extensive property damage could result.	Class 1 and Class 2 dams Address loss of live only and not property damage.
Significant Hazard Potential dams Failure would not result in the loss of life but there could be extensive property damage.	Class 3 dams No expected loss of life, but expected property damage.

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Federal/NID	State
Low Hazard Potential dams Failure results in only minimal property damage.	Class 3 dams No expected loss of life, but expect property damage.

Dam owners are solely responsible for the safety and the liability of the dam and for financing its upkeep, upgrade and repair. While most infrastructure facilities (roads, bridges, sewer systems, etc.) are owned by public entities, the majority of dams in the United States are privately owned. Many different types of people and entities own and operate dams. About 58 percent are privately owned. Local governments own and operate about 16 percent of all dams. State ownership is next with about four percent. And the federal government, public utilities and undetermined interests each own smaller numbers of dams (5 percent). Tables 3-61 – 3-67 contain information on dams in the five county area and Appendix I has information on the dams contained in the NID.

Dams are innately hazardous structures. Failure or mis-operation can result in the release of the reservoir contents--this includes water, mine wastes or agricultural refuse--causing negative impacts upstream or downstream or at locations remote from the dam. Negative impacts of primary concern are loss of human life, economic loss including property damage, lifeline disruption and environmental damage. The term High Hazard Potential just reflects the potential of the dam for doing damage downstream should it fail.

High Hazard dams are not being built, however more downstream development is occurring. Dam and reservoir safety regulators generally have no control over local zoning issues or developers' property rights. So this issue continues to worry regulators as the trend persists.

Some dams are considered to have a greater hazard potential than others. There are approximately 10,000 state-regulated "high-hazard" potential dams in the U.S. "High-Hazard" is a term used by a majority of state dam safety programs and federal agencies as part of a three-pronged classification system used to determine how hazardous a dam's failure might be to the downstream area. Historically, dams that failed had some deficiency, as characterized above, which caused the failure. These dams are typically termed "unsafe." Currently, there are about 2,000 "unsafe" dams in the U.S. There are unsafe dams in almost every state. (A majority of states and federal agencies define an "unsafe" dam as one that has been found to have deficiencies that leave it more susceptible to failure.)

The characteristics of a dam failure, based on the International Commission of Large Dams (ICOLD) include following the three major categories of dam failure: (1) overtopping by flood; (2) foundation defects; and (3) piping. For earthen dams, the major reason for failure is piping or seepage. For concrete dams, the major reasons for failure are associated with foundations. Overtopping has been a significant cause of dam failure primarily in cases where there was an inadequate spillway.

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Dam failures are most likely to happen for one of five reasons:

- Overtopping caused by water spilling over the top of a dam
- Structural failure of materials used in dam construction
- Cracking caused by movements like the natural settling of a dam
- Inadequate maintenance and upkeep
- Piping—when seepage through a dam is not properly filtered and soil particles continue to progress and form sink holes in the dam

Various climatic conditions and other situations may result in dam failure including such elements of risk as natural phenomena such as floods and landslides during wet weather seasons. These hazards threaten dam structures and their surroundings. Floods that exceed the capacity of a dam's spillway and then erode the dam or abutments are particularly hazardous, as is seismic activity that may cause cracking or seepage. Similarly, debris from landslides may block a dam's spillway and cause an overflow wave that erodes the abutments and ultimately weakens the structure. Dam failures are generally isolated incidents.

The Missouri Department of Natural Resources (MDNR), Dam and Reservoir Safety Program, has begun working with dam owners and emergency management personnel to develop Emergency Action Plans (EAPs) for the state-regulated High Hazard Potential Dams in Missouri. The State regulated (over 35 foot) high hazard (federal definition) dams are also the same as class 1 and 2 (State hazard designation) dams. The State does not have regulatory authority to require owners of dams less than 35 feet high to prepare an EAP or to meet any standards. Part of the EAP effort is mapping and analyzing potential inundation areas for all state-regulated dams in Missouri. An inundation map is to be part of the Emergency Action Plan prepared by all dam owners. As of 2013, 370 inundation maps have been provided to dam owner and 180 EAPs have been prepared by dam owners. When an EAP is completed, the dam owner is to provide a copy to MDNR and their county Emergency Management agency. In the five county area, 68 EAPs have been completed and work is continuing on the remaining 19. MDNR staff is currently working with the owners of regulated dams which do not have EAPs and anticipate 100 percent completion by the end of 2015. Tables 3-64 – 3-67 contains information of the EAPs by county. Source is Missouri Department of Natural Resources, Water Resources Center, Dam and Reservoir Safety Program. For more information about EAPs and associated inundation maps in Franklin, Jefferson, St. Charles and St. Louis Counties use the following links:

Franklin County – [www.fcema@franklinmo.net](mailto:www.fcema@franklinmo.net)

Jefferson County - [www.jeffcomo.org/EmergencyManagement](http://www.jeffcomo.org/EmergencyManagement)

St. Charles County – [www.sccmo.org/680/Emergency-Management](http://www.sccmo.org/680/Emergency-Management)

St. Louis County – [www.stlouisco.com/LawandPublicSafety/EmergencyManagement](http://www.stlouisco.com/LawandPublicSafety/EmergencyManagement)

Missouri Department of Natural Resources – [www.dnr.mo.gov/env/wrc/dam-safety](http://www.dnr.mo.gov/env/wrc/dam-safety)

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The intensity or strength of resultant damages from dam failures is dependent upon the amount of water stored behind the dam as well as the weather. A large rain event can exacerbate an already critical emergency situation.

The cost of a dam failure is difficult to assess because flooding can affect large areas. Local communities may be directly impacted due to building damage, injuries fatalities, lost water supply, damaged transportation and infrastructure and lost recreational assets. The extent of an owner's liability will vary from state to state depending on the statutes and case law precedents. The concept of strict liability imposes liability on a dam owner for damages that occur regardless of the cause of failure. The alternative theory of negligence considers the degree of care employed by the owner in constructing, operating and maintaining a dam. Historically, courts have sought to compensate those injured by a dam failure. When assessing liability, the standard of care exercised by an owner will be closely examined and should be in proportion to the downstream hazards involved. Where the risk is great, owners must be cautious. In many cases, dams regulated by the federal government or a state dam safety program must be designed to withstand an unprecedented flood or earthquake.

- 1972-Buffalo Creek Dam, West Virginia-125 dead, \$400 million in damages.
- 1976-Teton Dam, Idaho-14 dead, over \$1 billion in damages
- 1977-Laurel Run Dam, Pennsylvania-40 dead, \$5.3 million in damages
- 1977-Kelly Barnes Dam, Georgia-39 dead, \$30 million in damages
- 1982-Lawn Lake Dam, Colorado-3 dead, \$25 million in damages
- 1988-Quail Creek Dam, Utah-\$12 million in damages

The failures of Teton Dam and the Kelly Barnes Dam focused national attention to the problem of unsafe dams. Dam failures, however, continue to occur with destructive and sometimes fatal results.

Missouri dam failures at Lawrenceton in 1968, Washington County in 1975, Fredericktown in 1977, and a near failure in Franklin County in 1978 underscored the problem of unsafe dams in the state.

FIGURE 3-27 DAM FAILURE: TAUM SAUK



Taum Sauk Failure: December 2005  
Source: MDNR

Intersecting almost all the issues above is the issue of public education about dams. The ordinary citizen is unaware that the lakes they use for recreation or fishing are only there because of manmade dams. Development may occur in dam-break flood inundation areas. Some developers and local officials may be completely unaware of dams within their community. Even if citizens understand and are aware of dams, they still can be overly confident in the infallibility of these manmade structures. Living in dam-break flood-prone areas is a risk since any dam owners do not realize their responsibility and liability toward the downstream public and environment.

### **Vulnerability**

According to the Missouri State Hazard Mitigation Plan – Final December 2013 there are 683 state-regulated dams. The National Inventory of Dams lists 5,420 dams in the state. There are 99 state-regulated dams in the five county area and approximately 350 unregulated dams. It is difficult to analyze vulnerability for them due to data limitations.

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to dam failure in terms of population and property damages. Out of the 458 dams in the five county area, only the 99 state-regulated dams were part of this analysis. For this analysis it was assumed that residential structures were the most prevalent structure downstream of dams. The average value for

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residential structures was obtained from HAZUS-MHMR4. The estimated structure loss was estimated to be 50 percent of the value of the structure. Census information on household size was used to estimate the population at risk to failure of state-regulated dams. Analysis indicated that there is a concentration of vulnerability to dam failure in central eastern Missouri, including Franklin, Jefferson, St. Charles and St. Louis Counties, based on building loss and population exposure (See Table 3-72).

Table 3-72 County-by-County Vulnerability Analysis for Failure of State-Regulated Dams – 2010

County	# of Dams	Estimated # of Buildings Vulnerable	Average Exposure Value per Structure (\$)	Estimated Total Potential Building Exposure (\$)	Average Residential Occupancy	Estimated Total Population Exposure	Estimated Building Losses (\$)
Franklin	24	145	120,628	17,491,104	2.66	385.7	8,745,552
Jefferson	37	285	130,491	37,190,035	2.74	780.9	18,595,017
St. Charles	30	185	166,592	30,819,574	2.76	510.6	15,409,787
St. Louis	15	110	179,585	19,754,351	2.47	271.7	9,877,175
City of St. Louis	0	0	178,477	0	2.29	0	0

Source - Missouri State Hazard Mitigation Plan, July 2010

According to the Dam and Reservoir Safety Program within MDNR, the future occurrence of dam failure is very likely, due to the age of dams in Missouri. While the definition varies from place to place, it generally means if failure of a high-hazard dam occurs, there probably will be loss of life. It must be emphasized that this determination does not mean that these dams are in need of repair--these dams could be in excellent condition or they could be in poor condition. "High hazard" just reflects the dam's potential for doing damage downstream should it fail.

### **Problem Statement and Recommendation**

Like any structure, a dam must be maintained to reduce risk of failure. Failure can be catastrophic, since those downstream, or protected, may be suddenly inundated. Regular inspections of dams can go a long way to identify shortcomings and deficiencies so that they can be addressed in a timely manner. In addition, many dam owners are unaware of the need to maintain a dam and their liabilities and responsibilities. Owners of dams may be unaware of the risks, liability and repair needs. Local governments can play an important role in requiring inspection of dams, and in educating dam owners about their responsibilities. Finally, communities can develop plans to address properties that would be at risk from a dam failure and to educate those who live and work in risk areas about the potential hazard and evacuation strategies.

## 9. Wild Fires Hazard Profile

### Description

The term wildfire is defined as “a highly destructive, uncontrollable fire.” Typical sites for wild fires include open vegetated areas, brush and wooded areas. Fires that burn forest plants can be classified in three ways: ground fires, surface fires, and crown fires. Ground fires burn the humus layer of the forest floor, surface fires burn forest undergrowth and surface litter, and crown fires advance through the tops of trees. Atmospheric factors such as temperature, humidity, and rainfall are important factors in determining the combustibility of a given forest.

Humans, either through negligence, accident, or intentional arson, have caused approximately 90 percent of all wildfires in the last decade in the U.S. Accidental and negligent acts include unattended campfires, sparks, burning debris, and irresponsibly discarded cigarettes. The remaining 10 percent of fires are mostly caused by lightning, but may also be caused by other acts-of-nature such as volcanic eruptions or earthquakes. Refer to Table 3-73 below.

During March and April 2000, Missouri sustained devastating fire damage to thousands of acres resulting from wildland fires. Warm temperatures and low humidity increased the occurrence and fueled the flames scorching many areas of the state. In an attempt to raise the public’s awareness of the hazardous situations, the Governor and the State Fire Marshal issued a statewide voluntary burn ban, urging citizens to refrain from conducting any open burning. In addition, the Missouri Department of Conservation (MDC) and U.S. Forestry Service issued burn bans throughout state and federally owned land.

TABLE 3-73 REASONS FOR FIRES IN MISSOURI	
Lightning	> 1%
Camping	1%
Smoking	4%
Debris Burning	58%
Arson	20%
Equipment Use	3%
Railroads	1%
Children	1%
Miscellaneous Causes	12%

Source: MDC

The Missouri Division of Fire Safety is urging fire service agencies and local governments to begin planning for this situation by adopting a local ordinance to prohibit open burning

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during a high fire hazard time period. Missouri statutes do not allow the state to issue a MANDATORY burn ban at the state level.

One responsibility of the Forestry Division within MDC is protecting state and privately-owned land from the destructive effects of wildfires. The Forestry Division works closely with rural fire departments to assist with fire suppression activities. Nearly 900 rural fire departments have mutual aid agreements with the division. Forestry personnel provide training, equipment and grants to rural fire departments to help them become a more effective fire-fighting team.

Statutory authority is given to fire protection districts via RSMo 321.220 (12) to "adopt and amend bylaws, fire protection and fire prevention ordinances..." However, coordination with the county prosecuting attorney's office is strongly recommended before implementing such an ordinance to ensure enforcement ability. Voluntary fire service associations should also coordinate similar efforts at the local level.

Not only is the land affected, but also personnel throughout many fire service agencies are pushed to their limit battling these types of fires. These situations place Missouri citizens and responding fire fighters at risk.

Fire danger is based upon the burning index (BI). The burning index takes into account the fuel moisture, relative humidity, wind speed, temperature and recent precipitation. The BI is the basis for fire suppression crew staffing levels.

The vegetative types and fuel types are different in Missouri than in the western states; as a result, the wildfires in Missouri are rare and are nearly not as severe. In addition, with the humid climate, fuel decomposes much faster as compared to the West. As a result, the wildfires in Missouri are rare and are nearly not as severe in nature..

### **Location**

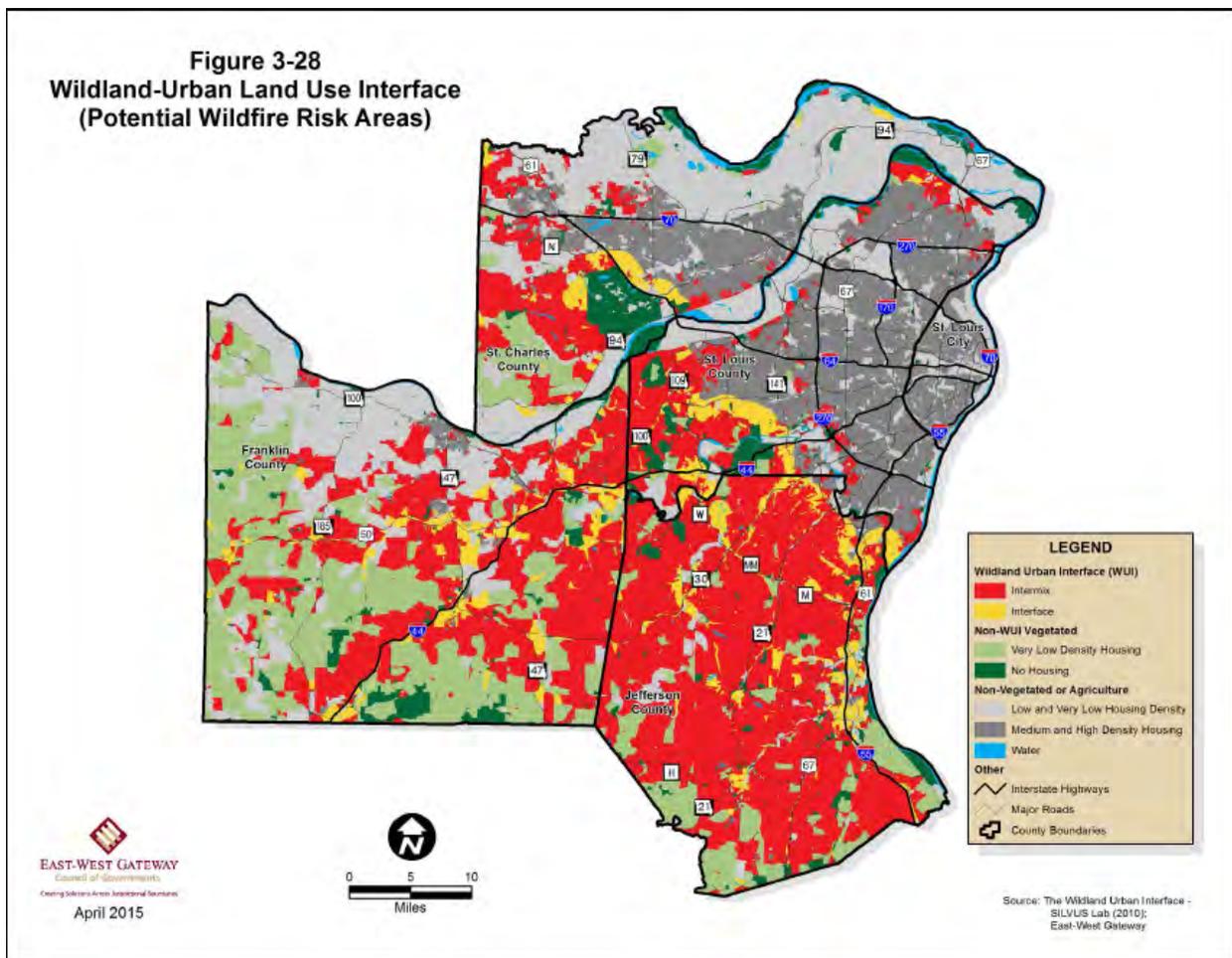
Fires typically occur in highway medians and shoulders, near residential structures and outbuildings. People who live near the edge of woods and vegetative debris are at a higher risk of having a fire affect their homes and property.

The SILVIS Lab at the University of Wisconsin has assembled housing and land cover data to assess and map the Wildland-Urban Interface (WUI) at the national and state level for 1990, 2000 and 2010. The WUI is the area where human development meets or intermingles with natural areas. Wildlands are considered to be forests, native grasslands, shrubs, wetlands and transitional lands (clear cut areas). Row crops, pastures and orchards are not considered wildland. Housing in WUI interface and WUI intermix areas must meet or exceed a minimum housing density of one structure per 40 acres. Intermix areas are places where residential structures (more than one house per 40 acres) are interspersed (intermingle) with continuous wildland vegetation. WUI interface areas are where

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residential structures are adjacent (within 1.5 miles) to areas with contiguous vegetation. Both intermix and interface areas may be at risk of wildfires. However, the wildfire risk for the five county area is extremely low. There have been no reported large scale wildfires within the study area for the past fifty years. Figure 3-28 presents the 2010 WUI for the five county area.

According to the MDC Forester, Missouri should be identified as a wild fire prone state, but urban and suburban areas which lack large densely forested areas are less at risk. There is some possibility of future occurrences in Franklin and Jefferson Counties as a result of the influx of greater numbers of residents moving into rural areas, where the homes are close to woods and vegetative debris. But for the region as a whole, the risk of wildfire is relatively low.



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### Hazard Event History

In accordance with Missouri Statute 254.230 and 321.220(12), the state is currently setting up a central fire reporting system. In the past, it was the responsibility of volunteer, local and district fire departments to report wild fires to the state. However, this is rarely been done. MDC is preparing an online central reporting system that will keep track of fires. Due to current lack of reporting, a historical summary of fires was not available.

No Missouri fires are listed by the U.S. Department of Agriculture as among the significant wildfires in the U.S. since 1825. Fires covering more than 300 acres are considered large in Missouri. The St. Louis metropolitan area has not experienced a significant wildfire in the past century. Forest Park located in the City of St. Louis, is the largest urban park in the U.S., with over 1,200 acres of trees and grassy areas. As such it is considered a slight to moderate risk of wild fire.

According to the State Hazard Mitigation Plan – Final 2014, SEMA, there were 5,306 wildfires in Missouri in 2012. Approximately 89,150 acres were burned. Table 3-74 lists the causes of the forest and grass fires in 2012 in Missouri. Each year, about 3,700 wildfires burn more than 55,000 acres of forest and grassland. Missouri's wildfire season is in the spring and fall, unlike the Western states that have a summer fire season. Dead vegetation, combined with the low humidity and high winds typical of these seasons, makes wildfire risk greater at these times.

Table 3-74 2012 Statewide Forest and Grassland fires by Cause

Cause	Number	Acres Consumed
Lightning	37	247
Campfire	73	438
Smoking	90	548
Debris	1,754	22,649
Arson	250	12,992
Equipment	421	5,057
Railroad	14	20
Children	37	109
Miscellaneous	678	9,933
Unknown	1,832	33,745
Not reported	120	3,412
<b>Total</b>	<b>5,306</b>	<b>89,150</b>

Source – Missouri Department of Conservation

According to the MDC Forestry Office, in the past twenty years, there have been only about five fires in the St. Louis Metropolitan area. For the most part the rural fire departments fight their own fires. Some areas of land are not covered even by volunteer fire departments. In this event, the MDC will cover fires in these areas. Missouri has very few fires that occur as a result of lightning. Most fires result from arson, campers and from residents that burn trash.

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### **Probability of Occurrence - Low**

Due to the initial stage of the MDC database development, probability of occurrence was not obtained. Generally, occurrences of fires are based on the weather, humidity and available fuel.

Based upon the history of the lack of wildfires in St. Charles and St. Louis Counties and the City of St. Louis, a conflagration is unlikely, especially in light of the fact that these areas are considered developed. Forest Park in the City of St. Louis has hundreds of trees; however, there is little understory vegetation and leaf litter. Heavily forested areas in Franklin, Jefferson and St. Charles Counties are vulnerable to fires as are the forested areas in western St. Louis County near Wildwood and Eureka. A number of residents are moving into rural areas where homes are close to forested areas and vegetative debris. Dry weather and available fuel make fire a random occurrence. Frequency, intensity and duration of these conditions vary drastically from year to year. Fires will possibly take place and will generally consist of grass fires along the side of roads and railroad tracks and fires near residential structures in rural areas.

### **Severity – Low**

Percentage of Land Affected by Hazard – Less than 10 percent

The season for wildfires in Missouri is between the end of February and the end of April, or whenever the environment is dry from lack of rain. Due to the lack of moisture throughout many areas Missouri, from late winter (February) through spring (May) the conditions are often favorable for the high risk of wildland fires.

Missouri, including the five county area, does not have large conflagrations and crown fires like in the West, where embers from the fire are thrown a long way resulting in the ignition of other dry areas. Fires that do occur are neither intense nor strong as a result of the weather and fuel conditions, as compared to the fires in the West. Damage may result in the burning of outbuildings, possibly a home and nearby grassy areas. Missouri fires consist mainly of grassy areas, leaves, ground letter, plants, shrubs, and trees.

As new housing developments in forested rural areas, the risk of fires will increase, especially in Franklin and Jefferson Counties and western St. Louis County. The MDC and Department of Public Safety recommend that homes in likely locations should not be built with cedar shake shingles. Typically homes catch on fire when dry brush, bushes trees are very close to the house.

The Fire Departments and Districts in the five county area and Missouri Department of Conservation rely upon the news media to help warn citizens of high fire danger. A set of standardized fire danger adjectives has been developed for fire warnings. These adjectives include a brief description of burning conditions, open burning suggestions for homeowners and fire crew staffing levels. Residents should always check with their specific fire department/district or District Forester for local fire conditions.

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Due to the initial stage of the MDC database development, specific information on lives lost, injuries, property damage and economic losses was not available.

**Vulnerability**

The July 2010 Missouri State Hazard Mitigation Plan contains the best data available for estimating the vulnerability of the five county area to wild fire. To develop overall vulnerability, 2004-2008 wildfire data from the MDC was reviewed. For each county factor values were prepared for the likelihood of wildfire and annualized acres burned. Each factor was divided into five ranges with five being the highest and one the lowest. Table 3-75 presents the ranges applied to these factors. This data did not provide an estimated dollar value of damages.

Table 3-75 Ranges for Wildfire Vulnerability Factor Ratings

Factors Considered	Low (1)	Medium-low (2)	Medium (3)	Medium-high (4)	High (4)
	Level 1 Range	Level 2 Range	Level 3 Range	Level 4 Range	Level 5 Range
Likelihood Rating	<29.56	29.56 to 59.11	59.12 to 88.67	88.68 to 118.23	>118.23
Annualized Annual Burned Rating	<100	100 to 199	200 to 499	500 to 999	>999

Source - Missouri State Hazard Mitigation Plan, July 2010

Table 3-76 contains the statistical data used in the 2010 State Plan analysis and the factor ratings. To determine overall vulnerability, the two factor ratings were summed and the average calculated (Table 3-77). All fractions were rounded up to the next whole number.

The amount of acreage burned is the primary damage result from wildland fire. Structures in the Wildland Urban Interface (WUI) are also at risk. The WUI is that area where structures and other forms of development meet or intermingle with undeveloped land. According to the Missouri State Hazard Mitigation Plan, July 2010, the 2004-2008 wildfire data from the MDC showed that 655 buildings statewide were damaged by wildfires or an annualized 131 buildings damaged in this five year period.

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Table 3-76 Statistical Data and Factor Ratings for Wildlife Vulnerability

County	Wildfires 2004-2008	Average Annual # of Wildfires	Likelihood Rating	Acres Burned	Average Annual Acres Burned	Average Annual Acres Burned Rating	Total Buildings Damaged
Franklin	334	66.8	3	914.74	183	2	7
Jefferson	291	58.2	2	790.233	158	2	2
St. Charles	64	12.8	1	276.486	55	1	1
St. Louis	34	6.8	1	76.661	15	1	0
City of St. Louis	9	1.8	1	1.95	0	1	2

Source - Missouri State Hazard Mitigation Plan, July 2010

Table 3-77 Wildfire Vulnerability

County	Vulnerability
Franklin	Medium
Jefferson	Medium-low
St. Charles	Low
St. Louis	Low
City of St. Louis	Low

Source - Missouri State Hazard Mitigation Plan, July 2010

**Problem Statement**

Although fire can be a serious threat, the region does not typically experience wildfires that affect significant acreage or large numbers of people. In order to maintain a low risk of wild fire, a coordinated effort to respond to any fire is more important than special planning for the very unusual event. With improve communications, and with equipment that can be shared easily among jurisdiction, emergency service, police and fire districts are better able to coordinate rapid response.

Missouri Department of Conservation and Fire Departments/Districts can develop an education outreach program for communities that have a greater chance of future fires. MDC has an ongoing educational effort in certain at risk areas. This effort includes visiting schools, local fairs and other events to educate and pass out fire prevention pamphlets in terms of seasonal or broad fire prevention approach. Establishing local ordinances to prohibit open burning during hazardous conditions is a proactive approach and will help reduce the number of wild fires in the future.

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**St. Louis Regional Hazard Mitigation Plan  
Update for 2015-20**

**Prepared for Franklin, Jefferson, St. Charles, St. Louis Counties  
and the City of St. Louis**

**Prepared By**

**East-West Gateway Council of Governments**

**Chapter 3, part B, of 4 chapters**

**HAZARDS AND RISK ASSESSMENT**

**Approved July 13, 2015**

**314-421-4220  
One S. Memorial Drive, Suite 1600  
St. Louis, MO 63102**

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**B. RISK ASSESSMENT AND VULNERABILITY ANALYSIS**

Risk Assessment Terminology

Community Assets – the people, structures, facilities and systems that have value to the community
Vulnerability – characteristics of community assets that make them susceptible to damage from a given hazard
Impact – the consequences or effects of a hazard on the community and its assets

FEMA, Local Mitigation Plan Review Guide, October 2011

Vulnerability Assessment

This Hazard Mitigation Plan has identified the key hazards that are likely to affect the five Missouri Counties in the St. Louis region.

The following tables show the overall vulnerability assessments for the five county area and the incorporated units and school districts within them for the hazards discussed in this plan. Vulnerability is based on exposure to hazards, socio-economic information, location of community or school district, repetitive loss claims and hazard event history. Vulnerability was rated as low, medium or high. Detailed analyses are presented in the following sections.

Table 3-62 Vulnerability Assessment by Jurisdiction and Hazard

Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Franklin	L	M	H	H	H	H	L	M
Jefferson	L	M	H	H	H	H	L	M
St. Charles	L	M	H	H	H	H	L	H
St. Louis	L	M	H	H	H	H	L	H
City of St. Louis	L	M	H	H	H	H	L	H

L – Low M – Medium H - High

Table 3-63 Incorporated Units Franklin County Vulnerability Assessment

Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Berger	L	M	H	H	M	H	L	M
Charmwood	L	M	H	L	M	H	L	M
Gerald	L	M	H	L	M	H	M	M
Leslie	L	M	H	L	M	H	M	M
Miramiguoa Park	L	M	H	M	M	H	L	M
New Haven	M	M	L	M	M	H	L	M

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Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Oak Grove Village	L	M	L	L	M	H	L	M
Pacific	L	M	L	H	M	H	L	M
Parkway	M	L	L	L	M	H	L	M
St. Clair	M	M	L	H	M	H	L	M
Sullivan	L	M	L	L	M	H	M	M
Union	L	M	L	M	M	H	L	M
Washington	L	M	L	M	H	H	L	H

L – Low M – Medium H - High

Table 3-64 Incorporated Units Jefferson County Vulnerability Assessment

Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Arnold	L	M	H	H	M	M	L	H
Byrnes Mill	M	M	H	M	M	M	L	M
Cedar Hill Lakes	M	M	H	M	M	M	L	M
Crystal City	L	M	H	H	H	M	L	H
DeSoto	M	M	H	H	H	H		H
Festus	L	M	H	H	M	M	L	M
Herculaneum	L	M	H	M	M	M	L	M
Hillsboro	L	M	H	L	H	M	L	H
Kimmswick	L	M	H	H	M	M	L	M
Lake Tekakwitha	M	M	H	M	M	M	L	M
Olympian Village	M	M	H	L	M	M	L	M
Parkdale	L	M	H	L	M	M	L	M
Peaceful Village	L	M	H	L	M	M	L	M
Pevely	L	M	H	L	M	M	L	M
Scottsdale	L	M	H	L	M	M	L	M

L – Low M – Medium H - High

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Table 3-65 Incorporated St. Charles County Vulnerability Assessment

Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Augusta	L	L	H	L	M	H	L	M
Cottleville	M	L	H	M	M	H	L	M
Dardenne Prairie	L	L	H	M	M	H	L	M
Flint Hill	L	L	H	L	M	H	L	M
Foristell	L	L	H	L	M	H	L	M
Josephville	L	L	H	L	M	H	L	M
Lake Saint Louis	M	L	H	L	M	H	L	M
New Melle	L	L	H	L	M	H	L	M
O'Fallon	M	L	H	M	H	H	L	H
Portage des Sioux	L	L	H	H	M	H	L	M
St. Charles	M	L	H	H	H	H	L	H
St. Paul	M	L	H	M	M	H	L	M
St. Peters	L	L	H	H	M	H	L	H
Weldon Spring	M	L	H	L	M	H	L	M
Weldon Spring Heights	L	L	H	L	M	H	L	M
Wentzville	M	L	H	L	M	H	L	M
West Alton	L	L	L	H	M	H	L	M

L – Low M – Medium H – High

Table 3-66 Incorporated St. Louis County Vulnerability Assessment

Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wild-land Fire	Severe Winter Weather
Ballwin	L	L	H	M	M	M	L	M
Bel-Nor	L	L	H	L	H	M	L	H
Bel-Ridge	L	L	H	L	H	M	L	H
Bella Villa	L	L	H	L	M	M	L	M
Bellefontaine Neighbors	L	L	H	M	M	H	L	M
Bellerive Acres	L	L	H	L	M	M	L	M
Berkeley	L	L	H	L	M	H	L	M
Beverly Hills	L	L	H	L	M	M	L	M
Black Jack	L	L	H	L	M	M	L	M

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Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wild-land Fire	Severe Winter Weather
Breckenridge Hills	L	L	H	H	M	H	L	M
Brentwood	L	L	H	H	H	H	L	H
Bridgeton	L	L	H	H	M	H	L	M
Calverton Park	L	L	H	L	H	H	L	H
Champ	L	L	H	L	M	H	L	M
Charlack	L	L	H	L	M	H	L	M
Chesterfield	M	L	H	H	M	H	L	M
Clarkson Valley	M	L	H	L	M	H	L	M
Clayton	L	L	H	L	M	H	L	M
Cool Valley	L	L	H	M	M	H	L	M
Country Club Hills	L	L	H	L	M	H	L	M
Country Life Acres	L	L	H	L	M	H	L	M
Crestwood	L	L	H	H	M	H	L	M
Creve Coeur	M	L	H	M	M	H	L	M
Crystal Lake Park	L	L	H	L	M	H	L	M
Dellwood	L	L	H	L	M	H	L	M
Des Peres	L	L	H	M	M	H	L	M
Edmundson	L	L	H	L	M	H	L	M
Ellisville	L	L	H	M	M	H	L	M
Eureka	L	L	H	M	M	H	L	M
Fenton	M	M	H	H	H	H	L	H
Ferguson	L	L	H	H	H	H	L	H
Flordell Hills	L	L	H	L	M	H	L	M
Florissant	L	L	H	L	H	H	L	H
Frontenac	L	L	H	H	M	H	L	M
Glen Echo Park	L	L	H	L	M	H	L	M
Glendale	L	L	H	L	M	H	L	M
Grantwood Village	L	L	H	L	M	H	L	M
Green Park	L	L	H	L	M	H	L	M
Greendale	L	L	H	L	M	H	L	M
Hanley Hills	L	L	H	L	H	H	L	H
Hazelwood	L	L	H	H	M	H	L	M

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Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wild-land Fire	Severe Winter Weather
Hillsdale	L	L	H	L	M	H	L	M
Huntleigh	L	L	H	M	M	H	L	M
Jennings	L	L	H	M	H	H	L	H
Kinloch	L	L	H	L	H	H	L	H
Kirkwood	L	L	H	M	M	H	L	M
Ladue	M	L	H	H	M	H	L	M
Lakeshire	L	L	H	L	M	H	L	M
Mackenzie	L	L	H	L	M	H	L	M
Manchester	L	L	H	H	M	H	L	M
Maplewood	L	L	H	L	M	H	L	M
Marlborough	L	L	H	L	M	H	L	M
Maryland Heights	M	L	H	H	M	H	L	M
Moline Acres	L	L	H	L	H	H	L	H
Normandy	L	L	H	L	H	H	L	H
Northwoods	L	L	H	H	H	H	L	H
Norwood Court	L	L	H	L	M	H	L	M
Oakland	L	L	H	L	M	H	L	M
Olivette	M	L	H	M	M	H	L	M
Overland	M	L	H	L	M	H	L	M
Pagedale	L	L	H	M	H	H	L	H
Pasadena Hills	L	L	H	L	H	H	L	H
Pasadena Park	L	L	H	L	H	H	L	H
Pine Lawn	L	L	H	L	M	H	L	M
Richmond Heights	L	L	H	M	M	H	L	M
Riverview	L	L	H	M	M	H	L	M
Rock Hill	L	L	H	H	M	H	L	H
St. Ann	L	L	H	H	M	H	L	M
St. John	L	L	H	L	M	H	L	M
Shrewsbury	L	L	H	M	M	H	L	M
Sunset Hills	M	L	H	M	M	H	L	M
Sycamore Hills	L	L	H	L	M	H	L	M
Town and Country	M	L	H	M	M	H	L	M
Twin Oaks	L	L	H	L	M	H	L	M

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Community	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wild-land Fire	Severe Winter Weather
University City	L	L	H	H	H	H	L	H
Uplands Park	L	L	H	L	M	H	L	M
Valley Park	L	L	H	H	M	H	L	M
Velda City	L	L	H	L	H	H	L	H
Velda Village Hills	L	L	H	L	H	H	L	H
Vinita Park	L	L	H	L	H	H	L	H
Vinita Terrace	L	L	H	L	H	H	L	H
Warson Woods	L	L	H	L	M	H	L	M
Webster Groves	L	M	H	M	M	H	L	M
Wellston	L	L	H	L	H	H	L	H
Westwood	L	L	H	L	M	H	L	M
Wilbur Park	L	L	H	L	M	H	L	M
Wildwood	M	L	H	M	M	H	L	M
Winchester	L	L	H	L	M	H	L	M
Woodson Terrace	L	L	H	L	M	H	L	M

L – Low M – Medium H – High

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Table 3-67 School Districts Vulnerability Assessment

District	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Affton 101	L	L	H	L	M	M	L	M
Bayless	L	L	H	L	M	M	L	M
Brentwood	L	L	H	H	M	M	L	M
Clayton	L	L	H	L	M	M	L	M
Crystal City 47	L	L	H	H	H	M	L	H
DeSoto 73	M	L	H	H	H	M	L	H
Dunklin R-V	L	L	H	M	M	M	L	M
Ferguson-Florissant	L	L	H	M	H	H	L	H
Festus R-VI	L	L	H	M	M	M	L	M
Fort Zumwalt R-II	M	L	H	M	H	H	L	H
Fox C-6	L	L	H	H	M	M	L	M
Francis Howell R-III	M	L	H	M	M	M	L	M
Franklin County R-II	L	M	H	M	M	M	L	M
Grandview R-II	L	L	H	L	H	M	L	H
Hancock Place	L	L	H	M	H	H	L	H
Hazelwood	L	L	H	H	M	H	L	M
Hillsboro R-III	L	L	H	L	H	M	L	H
Jefferson County R-VII	L	L	H	H	M	M	L	M
Jennings	L	L	H	M	H	M	L	H
Kirkwood	L	L	H	M	M	H	L	M
Ladue	L	L	H	H	M	M	L	M
Lindbergh R-VIII	L	L	H	M	M	M	L	M
Lonedell R-XIV	L	M	H	L	M	H	M	M
Maplewood Richmond Heights (MRH)	L	L	H	M	M	M	L	M
Mehlville R-IX	L	L	H	L	M	M	L	M

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District	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Meramec Valley R-III	L	M	H	H	M	M	L	M
New Haven	L	M	H	M	M	M	L	M
Normandy Schools	L	L	H	L	H	M	L	H
Northwest R-I	M	L	H	M	M	H	L	M
Orchard Farm R-V	L	L	H	M	M	H	L	M
Parkway	L	L	H	H	M	M	L	M
Pattonville R-III	M	L	H	H	M	H	L	M
Ritenour	L	L	H	L	M	H	L	M
Riverview Gardens	L	L	H	M	M	M	L	M
Rockwood R-VI	M	L	H	M	M	M	L	M
Special School District	L	L	H	M	M	M	L	M
St. Charles R-VI	M	L	H	H	H	H	L	H
St. Clair R-XIII	M	M	H	H	M	M	L	M
St. Louis City Public	L	L	H	L	H	H	L	H
Spring Bluff R-XV	L	M	H	L	M	M	M	M
Strain-Japan R-XVI	L	M	H	L	M	M	M	M
Sullivan	L	M	H	L	M	M	M	M
Sunrise R-IX	L	L	H	H	H	M	L	H
Union R-XI	L	M	H	M	M	M	L	M
University City	L	L	H	M	H	H	L	H
Valley Park	L	L	H	H	M	M	L	M
Washington	L	M	H	M	H	M	L	H
Webster Groves	L	L	H	M	M	M	L	M
Wentzville R-IV	M	L	H	L	M	M	L	M

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District	Dam	Drought	Earthquake	Flood	Heat Wave	Tornado	Wildland Fire	Severe Winter Weather
Windsor C-I	L	L	H	H	M	M	L	M

L – Low M – Medium H – High

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Table 3-68 Building Inventory Count by Land Use Category

County	Population	Land Use							Total
		Resid	Comm	Ind	Agric	Religion	Govt	Educ	
Franklin	101,492	43,141	1,927	779	271	204	89	59	46,470
Jefferson	218,733	86,630	2,821	1,054	254	250	112	79	91,200
St. Charles	360,485	137,583	4,788	1,501	388	347	142	116	144,865
St. Louis	998,954	176,673	7,714	1,891	143	901	223	180	187,725
City of St. Louis	319,294	437,964	17,201	4,821	844	1,478	556	453	463,317

State Emergency Management Agency, Missouri State Hazard Mitigation Plan – Final 2013

Table 3-69 Estimated Values for Key Occupancies (Uses) for Missouri in \$1,000

County	Land Use							Total
	Resid	Comm	Ind	Agric	Religion	Govt	Education	
Franklin	7,946,690	987,762	614,408	40,044	139,423	66,481	481,339	10,276,147
Jefferson	17,223,681	1,408,309	542,560	36,749	220,711	101,839	995,509	20,529,358
St. Charles	32,280,959	3,315,000	808,965	62,566	324,991	135,724	2,228,945	39,157,150
St. Louis	27,757,391	8,246,761	2,364,136	21,631	877,625	228,654	1,918,059	41,414,257
City of St. Louis	97,273,559	16,787,295	4,844,894	208,337	1,398,844	553,031	6,431,778	127,497,738

State Emergency Management Agency, Missouri State Hazard Mitigation Plan – Final 2013

## **Development Trends**

Regionally, over the next thirty years, population growth is anticipated to be the strongest in St. Charles and Jefferson Counties. In St. Charles, most of the growth is predicted along the I-70 and I-64 freeways. Though some growth will probably still occur in the eastern sections of this area, it is more likely that most will occur in the areas west of Highway K in O'Fallon. Additional growth is predicted in northeast Jefferson County near I-55.

Employment growth is predicted to occur along major roadway corridors. Similar to population growth, it is anticipated that St. Charles County will receive a majority of employment growth along the I-70 and I-64 freeways. It is also anticipated that St. Louis County will see some growth sprinkled along major corridors, especially west of I-270 as well as north of I-70. Additional employment growth is likely to spread into Jefferson County along I-55.

At present, Franklin County is principally agricultural in nature, especially in the western portion of the county. About 80 percent of the county is classified as agricultural. Historically, the county has had a consistently upward growth pattern. However, there is expectation of continued out migration from the St. Louis metropolitan core. Of the county population of 101,492 in the year 2010, 48 percent lived outside incorporated areas. Franklin County has a current master plan, zoning, subdivision regulations, stormwater regulations, and a building code. Of the municipalities in the county, four answered in 2004 that they have master plans, four do not, and two did not answer. Eight have zoning, subdivision, and building codes, two do not, and one did not answer. Six have stormwater regulations, four do not, and one did not answer.

At present, Jefferson County is more densely developed in the northern third of the county; along Interstate 55, located along its eastern boundary; and the State Highway 21 and State Highway 30 corridors. Jefferson County's population was 218,733 in 2010. Approximately 60 percent of the residents live outside incorporated areas. Jefferson County has a current master plan, zoning, subdivision regulations, and a building code. Of the municipalities in the county, seven answered in 2004 that they have master plans and six did not answer. Seven have zoning, subdivision, stormwater, and building codes; six did not answer.

St. Charles County has been one of the fastest growing counties in the St. Louis metropolitan area. Projections are for this several decade long trend to continue. The county has grown in population from 52,970 in 1960 to 360,485 in 2010, an increase of over 580 percent. Of the 2010 population, 26 percent do not reside in an incorporated area. St. Charles County has a current master plan, zoning, subdivision regulations, stormwater regulations, and a building code. Of the municipalities in the county, four answered in 2004 that they have master plans, four do not, and two did not answer.

## *St. Louis Regional Hazard Mitigation Plan*

Eight have zoning, subdivision, and building codes, two do not, and one did not answer. Six have stormwater regulations, four do not, and one did not answer

St. Louis County's population as of the 2010 census was 998,954. Most of the County has been urbanized. Approximately 85 percent of the population are residents of incorporated municipalities. St. Louis County has a current master plan, zoning, subdivision regulations, stormwater regulations, and a building code. Of the municipalities in the county responding to the survey, 48 answered that they have master plans, 11 do not; 58 have zoning, 2 do not; 43 have subdivision regulations, 15 do not; all have stormwater regulations as enacted through MSD and through additional regulations in some municipalities; all respondents have building codes.

The legal boundaries of the City of St. Louis were set in 1876. It cannot annex and is considered to be built out. There are areas of redevelopment in the City. Vacant and abandoned properties are present in various parts of the City. So far, there has been a major initiative to revitalize downtown St Louis drawing the support of government, business and civic leaders. St. Louis is already a regional center for activity in the areas of plant and life sciences, information technology, and advanced manufacturing.

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Risk Assessment Worksheet

FLOOD RISK ASSESSMENT WORKSHEET		
<b>Sector</b>	<b>Essential Facilities at Risk</b>	
	Those facilities in low lying areas within 100 or 500 year floodplains not constructed to building code.	
	<b>Population at Risk</b>	
	Those living and working in low lying areas within 100 or 500-year floodplains in buildings not constructed to building code.	
	<b>Infrastructure at Risk</b>	
	Infrastructure in poor condition or located in low-lying areas within 100 or 500-year floodplains in facilities not constructed to building code.	
<b>Franklin</b>	<b>Property at Risk</b>	
	<b>Expected Extent of Damage</b>	<b>Percent of Sector Property</b>
	Catastrophic	
	Critical	
	Limited-14%	14% area of county subject to flooding risk to 100-year event
	Negligible	86%
<b>Jefferson</b>	<b>Property at Risk</b>	
	<b>Expected Extent of Damage</b>	<b>Percent of Sector Property</b>
	Catastrophic	
	Critical	
	Limited-11%	11% area of county subject to flooding risk to 100-year event
	Negligible	89%
<b>St. Charles</b>	<b>Property at Risk</b>	
	<b>Expected Extent of Damage</b>	<b>Percent of Sector Property</b>
	Catastrophic	
	Critical	
	Limited-44%	41% area of county subject to flooding risk to 100-year event 3% subject to flooding risk 500-year event
	Negligible	56%
<b>St. Louis</b>	<b>Property at Risk</b>	
	<b>Expected Extent of Damage</b>	<b>Percent of Sector Property</b>
	Catastrophic	
	Critical	
	Limited-23%	19% area of county subject to flooding risk to 100-year

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FLOOD RISK ASSESSMENT WORKSHEET		
		event 4% subject to 500-year event
	Negligible	77%
City of St. Louis	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic	
	Critical	
	Limited-10%	10% area of county subject to flooding risk to 100-year event
	Negligible	90%

EARTHQUAKES RISK ASSESSMENT WORKSHEET		
<b>Sector</b>	<b>Essential Facilities at Risk</b>	
	Worst case scenario-older buildings or those not constructed to building code, near total devastation from New Madrid earthquake	
	<b>Population at Risk</b>	
	Entire population at risk in older buildings or those not constructed to building code	
	<b>Infrastructure at Risk</b>	
	Entire infrastructure at risk in older facilities or those not constructed to building code	
Franklin	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-near total devastation	35%
	Critical	55%
	Limited	5%
	Negligible	5%
Jefferson	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-near total devastation	45%
	Critical	45%
	Limited	5%
	Negligible	5%
St. Charles	Property at Risk	
	Expected Extent of	Percent of Sector Property

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EARTHQUAKES RISK ASSESSMENT WORKSHEET		
	<b>Damage</b>	
	Catastrophic-near total devastation	45%
	Critical	45%
	Limited	5%
	Negligible	5%
<b>St. Louis</b>	<b>Property at Risk</b>	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-near total devastation	40%
	Critical	40%
	Limited	10%
	Negligible	10%
<b>City of St. Louis</b>	<b>Property at Risk</b>	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-near total devastation	45%
	Critical	45%
	Limited	5%
	Negligible	5%

TORNADO RISK ASSESSMENT WORKSHEET		
<b>Sector</b>	<b>Essential Facilities at Risk</b>	
	Buildings in path of storm not constructed to building code.	
	<b>Population at Risk</b>	
	Populations that do not have safe rooms to seek refuge	
	<b>Infrastructure at Risk</b>	
	Infrastructure in path of storm	
<b>All Counties</b>	<b>Property at Risk</b>	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-in path of storm; dependent upon magnitude of storm, damage could be catastrophic	1%
	Critical-in path of storm; dependent upon magnitude of storm, damage could be critical	4%

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TORNADO RISK ASSESSMENT WORKSHEET		
	<b>Limited</b> -in path of storm; dependent upon magnitude of storm, damage could be limited	5%
	<b>Negligible</b> -in path of storm; dependent upon magnitude of storm, damage could be negligible	90%

WINTER WEATHER RISK ASSESSMENT WORKSHEET		
Sector	Essential Facilities at Risk	
	Some buildings in path of storm may experience power outages.	
	Population at Risk	
	Dependent upon where storm hits, entire population, especially those who work outdoors, drive for a living, homeless people.	
	Infrastructure at Risk	
	Utility poles downed by ice storms; roads, bridges impassible	
<b>All Counties</b>	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	<b>Catastrophic</b>	1%
	<b>Critical</b>	1%
	<b>Limited</b>	90%
	<b>Negligible</b>	8%

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DROUGHT RISK ASSESSMENT WORKSHEET		
Sector	Essential Facilities at Risk	
	All essential facilities that depend on water will be at risk.	
	Population at Risk	
	In severe drought, entire population living and working in five county area, the health and welfare of humans and animals is at risk.	
	Infrastructure at Risk	
	Entire infrastructure pertaining to water supply, water treatment, utility operations will be affected.	
All Counties	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-	45%
	Critical-Damage to essential facilities, population, infrastructure, agricultural industry will be critical to catastrophic	45%
	Limited	5%
	Negligible	5%

HEAT WAVE RISK ASSESSMENT WORKSHEET		
Sector	Essential Facilities at Risk	
	All facilities affected by heat (no air conditioning) are at risk	
	Population at Risk	
	Entire population at risk; elderly, young, ill, homeless people	
	Infrastructure at Risk	
	All infrastructure affected by heat (roads, bridges, rail lines) is at risk	
All Counties	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic-limited to elderly, ill population	Approximately 14%
	Critical	3%
	Limited	3%
	Negligible	80%

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DAM FAILURE RISK ASSESSMENT WORKSHEET		
Sector	Essential Facilities at Risk	
	Buildings downstream from failed dam	
	Population at Risk	
	Individuals living downstream from dams that are failing	
	Infrastructure at Risk	
	Roads, bridges, utilities	
All Counties	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic- in areas affected, damage could be catastrophic in path of released waters	5%
	Critical	5%
	Limited- topographically higher areas	10%
	Negligible	80%

WILDLAND FIRE RISK ASSESSMENT WORKSHEET		
Sector	Essential Facilities at Risk	
	Buildings in path of fire may be burned In St. Louis County these are at a minimum In City of St. Louis little to no residences located near forest areas	
	Population at Risk	
	Residents living and working near forested areas	
	Infrastructure at Risk	
	May burn utility lines	
Franklin	Property at Risk	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic	
	Critical	
	Limited	2%
	Negligible-wildfires possible, limited to negligible magnitude	99%
Jefferson	Property at Risk	
	Expected Extent of	Percent of Sector Property

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WILDLAND FIRE RISK ASSESSMENT WORKSHEET		
	Damage	
	Catastrophic	
	Critical	
	Limited	1%
	Negligible-wildfires possible, limited to negligible magnitude	99%
<b>St. Charles</b>	<b>Property at Risk</b>	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic	
	Critical	
	Limited	1%
	Negligible-wildfires possible, limited to negligible magnitude	99%
<b>St. Louis</b>	<b>Property at Risk</b>	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic	
	Critical	
	Limited	
	Negligible-wildfires possible, limited to negligible magnitude	100%
<b>City of St. Louis</b>	<b>Property at Risk</b>	
	Expected Extent of Damage	Percent of Sector Property
	Catastrophic	
	Critical	
	Limited	
	Negligible-wildfires possible, limited to negligible magnitude	100%

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**St. Louis Regional Hazard Mitigation Plan  
Update for 2015-20**

**Prepared for Franklin, Jefferson, St. Charles, St. Louis Counties and the City  
of St. Louis**

**Prepared By**

**East-West Gateway Council of Governments**

**Final Plan  
Chapter 4 of 4 chapters**

**Approved July 13, 2015**

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## Chapter 4 – The St. Louis Region’s Hazard Mitigation Strategy

### Preface

In consultation with the Plan Working Group, with county emergency managers, and with municipal and school district representatives who attended workshops, the action steps in this chapter were developed, revised, and prioritized. The chapter provides a list of proposed actions. The priorities by individual jurisdiction are found in the spreadsheet following chapter 4. These priorities are subject to change as disasters occur, as community leadership changes, and as actions are completed.

The chapter begins with a list of overall goals for the plan. The chapter then provides recommended actions to address the various problems identified in Chapter 3 of the plan. The Goals of this plan are the same as the Goals of the plan for 2010-2015; however, the Action Steps have been reorganized to enable a clear focus on actions which address many or all disasters and actions that are specific to specific disasters. The reorganization of the actions grew out of the problem statements in chapter 2.

### Hazard Mitigation Goals Requirement 44 CFR §201.6(c)(3)(i)

The regional goals for the Hazard Mitigation Plan are as follows:

1. Prepare communities in advance of a natural disaster to prevent loss of life, minimize injury and illness
2. Preserve and maintain property, including public and private infrastructure, businesses, and individual homes, and improve community vitality
3. Encourage regional, county and local planning and development that is consistent with the hazard mitigation plan and that reduces future risk from natural disaster.

Because there are many general actions that will support community preparation for all natural disasters, and there are also many specific related actions for specific hazards, the action steps first include actions that address multiple natural disasters and then actions the address specific natural disasters.

### Action Steps to address Natural Disaster Mitigation (Requirement 44 CFR §201.6(c)(3)(ii))

This plan addresses two related aspects of hazard mitigation, the actions that reduce the impact of the immediate disaster, and actions that can reduce the harmful after effects of a natural disaster. These actions were reviewed by the Working Group and formed the basis for the Hazard Mitigation Plan workshops held in seven locations in the region. Participating municipalities and school districts and their representatives have identified the priority level (high, medium or low) for each action, and have further described whether work on each action is on-going, complete or deferred (not yet begun). These priority rankings are in the spreadsheet at the end of this section.

The list of actions with description is below, followed by the spreadsheet which identifies the priorities for each of the responding communities. The communities prioritized the action steps or delegated their planning to their county emergency management agencies, which prioritized based on the needs of communities they represent throughout their county. The School Districts that did not attend the workshops delegated their planning to EducationPlus, the Cooperating School Districts, which prioritized actions based on the regional needs of the school districts.

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This list of numbered actions provides a framework for collaboration and planning that will continue through the five years of this plan update. Community leaders can also use the list to compare priorities with other communities in the region.

### **Public Information and Awareness for Mitigating Natural Disasters**

*Problem Statement: In planning to mitigate for any hazard, a common concern is that the public is poorly informed about how to respond to a serious disaster. Since the ability to respond quickly to a disaster can greatly reduce the risk to human life or human injury, the community needs a well-informed public and a plan for both individual response and responsibility and for coordinated agency response to disasters of any kind. The problem of building awareness is high when there have been no recent disasters, and the public and volunteer agencies can be complacent and unprepared when an event occurs. Engaging volunteers who can be prepared is an important step in addressing any or all of the potential hazards the region faces. Special populations have specific needs and challenges and agencies can work to help them be prepared. Likewise communities that train volunteers to respond to disasters can minimize the secondary impact of a disaster.*

1. **Public Awareness and Involvement: Using newsletters, websites and other means of communication, local government and school district can effectively educate and inform the public and encourage advance preparation to mitigate the impact of natural disasters.** Public awareness and preparation can be important to addressing both pre-disaster preparation and warning and post disaster impacts. It is in this general area that the St. Louis Metropolitan region has seen the most significant progress during the last five years. Organizations that have been involved in long term recovery planning and action have now come together in both a regional and local COAD (Community Organizations Active in Disasters) groups that are making great strides to inform the public of disasters and prepare for immediate response in order to reduce the immediate impact of any type of disaster. Municipal governments and school districts have a unique opportunity to link hazard mitigation efforts with the COADs to support overall disaster planning, prevention and response. (low cost based on current initiatives)
  - a. **Create and strengthen Community Organizations Active in Disasters (COAD):** COAD groups are identifying needs and responsible parties to address each type of need. Therefore, as an important action in this updated hazard mitigation plan, EWG has been informing municipalities and school districts of the importance of the COADs, how to become involved and bring active COADs into their communities, and how to promote involvement in the COADs of local social service organizations. (While some seed money for organizing work is definitely helpful, this activity relies primarily on voluntary organizations. Costs to municipalities are low because they can join initiatives already underway in each county.)
  - b. **Participate in All Ready Campaign:** In the last five years, the American Red Cross of Eastern Missouri, City of St. Louis Office on the Disabled, Paraquad, and LINC, in partnership with EWG St. Louis Area Regional Response System (STARRS), has begun promoting the All Ready Campaign which encourages those with functional and access needs to be prepared to address their own needs in the aftermath of a disaster. Advance preparation of this type can be a significant factor in reducing loss of life. In addition to supporting the functional and access needs population, municipalities can publicize advance preparation for all citizens. (The work of

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## St. Louis Regional Hazard Mitigation Plan

the All Ready Campaign has been developed, and promotional materials exist, so costs to advance the program are low.)

- c. **Participate and support emergency training for citizen volunteers:** St. Charles County has the most fully organized COAD as this plan is being written, and the regional steering committee for the COADs is using the St. Charles model to support expanded initiatives in the other counties in the region. The target goal for this five year plan is to have municipalities, school districts, police and fire departments fully informed and aligned with the regional and local COADs by 2020. Participation in and support for Citizen Emergency Response Training (CERT): Local governments have been involved in training volunteers to assist in natural disaster response for many years. New training initiatives under the CERT have strengthened the training initiatives and offer unique opportunities to inform citizens of hazard mitigation as well as hazard response actions. Trained volunteers who are aware of risks before natural disaster strikes and be valuable resources in advance preparation as well as valuable aids to reduce impact when a disaster hits by helping to identify the population impacted and in need of assistance. (Costs are low, and training volunteers can reduce costs to local government for staff in times of disaster.)
- d. **Educate the Public and local government staff and elected officials about relevant hazards:** With the support of STARRS, the emergency managers in each county and the non-profit organizations involved in the St. Louis Area Coalition of COADS (SLARCC), All Ready and other initiatives, local governments can expand training public awareness and preparation. As a part of the 2014 planning process, EWG has encouraged communities to put Hazard Mitigation Planning on the agenda of the elected boards and councils. (Costs can vary widely, but education and training is available for low cost,)
- e. **Promote awareness about the 211 Service:** the United Way has developed a rapid information sharing system through a 2-1-1 phone information line. In cooperation with the All Ready Campaign, the United Way is able to refer regional residents to agencies who can help them prepare for disasters. In addition, they can connect residents to agencies and resources to assist them after a disaster. Local governments can encourage use of this service by publicizing it in newsletters and on their websites. (The cost to promote this service is very low.)

### Creating Effective Response to Any Natural Disaster

*Problem Statement: Citizens expect immediate and effective response to any disaster, no matter how unexpected, or how severe. Local governments and school districts face a challenge to be prepared for any disaster, and to be able to respond effectively. Many response efforts must begin with good communication, especially to provide advance notice of a disaster whenever possible. In addition, public facilities are often the best locations to provide relief to people in need immediately following a disaster, so communities must be prepared to make cost-effective preparations in advance of a natural disaster. Communications among departments and between emergency management, police, fire, and health departments as well as communications among communities affected can be stressed during a disaster, especially if normal electric power sources are cut off. Therefore, planning for effective warning systems, and for effect communications immediately following a disaster is a high priority.*

2. **Public Actions to prepare for Natural Disasters: Local governments and school districts should take certain steps in advance of a variety of natural disasters.**
  - a. **Build safe rooms that can also serve as relief centers:** When local governments or school districts are building new buildings, this is a perfect time to design and build safe rooms that can withstand tornado or earthquake and also serve as a refuge for citizens who lose their homes or

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who lose power in a heat or cold weather event. (Cost to build safe rooms is very high; in many cases it is prohibitive. Cost to staff such facilities is also a concern of local governments and school districts.)

- b. **Create and improve early warning systems for all disasters, including sirens, and targeted response such as Reverse 9-1-1, Code Red, Nixle, etc.:** Over the past five years, a number of communities have adopted one or more of these systems to assist in communications. There are also apps that can now alert people of tornado watches and warnings including the American Red Cross's Tornado app (<http://www.redcross.org/mobile-apps/tornado-app>). (Because these initiatives are already being developed the additional costs for individual communities is low.)
- c. **Integrate communications systems to provide rapid communication and response:** This action item has been on-going since the first plan, and it is nearly complete in the St. Louis region through the work and leadership of the STARRS program. (The cost is high but the expense is being covered in large part by STARRS through U.S. Department of Homeland Security grant funding.)
- d. **Conduct assessment of risk for all natural disasters:** Local governments and school districts and other agency can focus on specific risk assessment and then update operation procedures to meet identified risks. Most local governments and school districts have assessments in place, and this plan serves as a reminder that such assessments need to be reviewed and updated, preferably on an annual basis. (Costs vary widely depending on need, whether an assessment has been done in the past, and whether a plan is already a part of the ongoing community activity, or whether it is something new for a community or school district.)
- e. **Review opportunities for joint purchases of supplies and equipment:** Local governments and school districts can implement joint purchase agreements where possible. A number of communities are purchasing road salt through a cooperative agreement that ensures supply and keeps cost low. Cooperative planning for auxiliary power may also have potential payback for communities. (There is an initial cost of time and effort to identify opportunities, but the long term impact will be a net gain by reducing costs of supplies.)

### Mitigation Needed to Prepare for Tornadoes

*Problem Statement: Because Tornadoes can strike quickly and unexpectedly, communities must be prepared in advance with emergency shelter both to provide protection to school populations and other groups that might be at greater risk in a tornado event and also to provide shelter immediately following a severe event, where people may have lost their homes or where homes have been made unsafe. Communication is also important to help citizens to know when to take shelter and how to shelter.*

3. **Prepare for Tornado: Local governments and school districts should cooperate to enhance community safety.** In addition to the above described actions, two specific steps are recommended for tornado mitigation.
  - a. **Build safe rooms for schools, community centers and for mobile home communities:** Local governments and school district can designate existing facilities that are already constructed or they can build new facilities and prepare advance plans for staffing of such facilities. Communities have indicated that a challenge is staffing facilities in a timely manner, and this is an area where regional cooperation during the next five year plan can solve this challenge. (This cost is high and often prohibitive for school districts or local governments.)
  - b. **Develop early warning systems to target specific, vulnerable communities:** For example, MoDOT has developed a connection with the National Weather Service and is exploring ways to

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use highway lighted traffic sign boards to convey information. Communities can also explore use of apps for cell phone users. STARRS continues to explore regional solutions to support these initiatives. (The regional solution holds the most promise for providing a lower cost option for local governments and school districts.)

### Mitigation Needed to Prepare for Floods

*Problem Statement: Because flood risk areas are identified, communities can move to reduce risk both for humans and property by effective advance planning. Of course in addition to mapping flood risk areas, educating citizens about the nature of the risk and the appropriate actions to reduce risk is a critical part of the plan. An area that is flood prone, but where a flood has not occurred in recent years can be especially high risk because property owners can become complacent and unprepared should a flood occur. Flash flooding on small streams is a serious risk, because there are many properties next to streams where development has already taken place and where flood waters are rarely seen. Another risk lies in areas protected by dams or levees, where the public assumes property is safe because it is protected by these structures. Failure of a dam or levee can create a very high hazard, due to the speed with which water can inundate a previously protected area.*

#### 4. Reduce risk of flood damage: Communities should take special action to reduce flood damage.

- a. **Protect stream buffers from development:** Most of the larger municipalities have already implemented stream buffer ordinances, or intend to do so, in part to meet NPDES Phase II standards. Other communities can implement stream development setbacks or buffer ordinances in order to reduce risk of flash flood damage to property, especially along smaller streams which tend to experience flash flooding. (The cost is low in most cases.)
- b. **Municipalities should use floodplain best management practices:** Specifically, municipalities can prohibit building permits for residences within floodplains. (Costs may vary widely, but communities with extensive flood plain areas will have greater costs; and communities with more legacy development in flood plains can expect greater cost to improve safety of properties.)
- c. **Join the FEMA Community Rating System (CRS):** Communities that want in enhance flood protection and already have developed property in flood plains can join the FEMA Community Rating System and work to implement best practices. [See section X for more detail on specific actions taken as part of Community Rating System and a list of communities that are part of the CRS.] (There is cost associated with staff to fill out the paper work and track aspects of the program, but many other costs are already part of doing businesses for local governments.)
- d. **Use Green Infrastructure to manage stormwater where it falls:** Municipalities and counties have control over land use decisions. The use of green infrastructure requirements in new and renewed construction permits can facilitate capture and temporary storage of rainwater where it falls and help to reduce flash flooding and erosion. (If added to development requirements this tool is low cost to municipal governments.)
- e. **Buy out frequently flooded properties:** The cost of insurance and claims is an on-going burden usually born by individual property owners and federal taxes, but the cost of serving homeowners during a flood is born by local governments. Reducing flood damage through buyouts may provide more resources for other needs at the local level. (High cost. Some communities may use flood buy-out funds from FEMA to purchase frequently flooded properties, but the matching cost requirement is still substantial and is often serious hurdle to overcome.)

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### Mitigation Needed to Prepare for Various Kinds of Extreme Weather

*Problem Statement: Although heat and cold present different kinds of problems, these extreme weather events tend to hit low income communities and the elderly harder than the general population. These weather events also tend to be region-wide, and therefore broad-based planning is more effective in addressing these challenges. When power is disrupted through storms (sometimes accompanied by high demand for electricity especially in heat waves), extreme hot or cold weather can rapidly put very large numbers of citizens at risk. Developing a response plan in advance is therefore paramount to effective management of that risk.*

5. **Prepare for Extreme Weather (heat and cold, thunderstorms or drought): The most serious problems arise when extreme weather is accompanied by power outages. Local government can provide both advance preparation and rapid response.**
  - a. **Create and support neighborhood initiatives:** Communities should prepare for and respond quickly to extreme weather. Local governments should encourage neighborhood watch programs to check in on the elderly or special needs populations; provide training and support for neighborhood organizations and promote neighborhood resiliency. Support organizations already exist in some counties and can be a catalyst for developing grassroots initiatives. (This is a low cost alternative for most local governments.)
  - b. **Establish relief centers and encourage the public to use the centers:** The key element identified by a number of municipalities is the need to have both the center and the operational plan for the center in place. Residents can call 2-1-1 to find the locations of heating/cooling centers in their area. (Staffing costs may be substantial and a barrier for some communities.)

### Mitigation Needed to Prepare for Wildfires

*Problem Statement: Although fire can be a serious threat, the region does not typically experience wildfires that affect significant acreage or large numbers of people. In order to maintain a low risk of wild fire, a coordinated effort to respond to any fire is more important than special planning for the very unusual event. With improve communications, and with equipment that can be shared easily among jurisdiction, emergency service, police and fire districts are better able to coordinate rapid response.*

6. **Prepare for and contain wildfires:**
  - a. **Continue coordinated response efforts among fire districts and fire departments to address any fire:** While not a major problem in most communities, the primary reason fire is not a problem is that fire districts already coordinate response efforts effectively to address any kind of fire. (Low additional cost , because this service is provided largely by existing fire district operations.)
  - b. **Restrict open burning:** Most municipalities and counties in the region restrict open burning and require permits for special circumstances. (Low cost to implement.)

### Mitigation Needed to Prepare for Earthquakes

*Problem Statement: Although there is a low probability in any given year, there is very high potential for severe, widespread damage from a large earthquake. Earthquake damage zones have been identified,*

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*but communities cannot truly protect themselves from an earthquake. What communities can do is to be prepared with effective communications systems in the event of widespread power outages, and with effective construction ordinances that require buildings to be constructed to withstand earthquakes. In addition, the public is generally unaware of the risk and what individuals can do to be prepared in advance as well as immediately after an earthquake.*

## **7. Prepare for Earthquakes:**

- a. **Improve Early Warning systems:** (Workshop attendees recommended removing this item, but since it was in the spreadsheet that community representatives used to document their priorities, we have left it in the list of actions in order to have a consistent numbering and lettering system.) (High cost, not currently feasible in a significant way.)
- b. **Review and Update Building Codes:** Regionally most municipalities and counties moved to the 2009 building code. Based on past experience, within the next five years most communities will move to the next standard. (Low cost; but this element requires regional cooperation to be successful as communities seek to have similar requirements for new construction.)
- c. **Integrate communications systems for Rapid response:** The regional microwave communications system should be complete by the end of 2014 with training and integration to continue through 2015. (High cost to begin with, this system will soon be in place and operate at low cost to communities.)
- d. **Promote individual and household preparation:** Communities should encourage owners of older homes to make structural improvements and encourage all residents to develop emergency kits. Encourage participation in the annual Great ShakeOut: (<http://www.shakeout.org/centralus/>). Costs for this action fall mainly on building owners and can vary widely. Cost to communities directly is low.)

## **Mitigation Needed to Address Risk of Failure in Dams and Levees**

*Problem Statement: Like any structure, a dam or levee must be maintained to reduce risk of failure. Failure can be catastrophic, since those downstream, or protected, may be suddenly inundated. Regular inspections of dams and levees can go a long way to identify shortcomings and deficiencies so that they can be addressed in a timely manner. In addition, many dam owners are unaware of the need to maintain a dam and their liabilities and responsibilities. Owners of dams may be unaware of the risks, liability and repair needs. Local governments can play an important role in requiring inspection of dams, and in educating dam owners about their responsibilities.*

## **8. Reduce risk of dam or levee failure**

- a. **Encourage annual inspection of dams** and levees that are not covered under the state permitting requirements. Local governments can identify key structures and contact owners to encourage external inspection, or implement their own inspection programs. (Most communities have few structures to inspect, so costs will be relatively low.)
- b. **Improve structural integrity of dams, using incentives where possible.** (Cost will be high to implement, especially if it includes incentives.)
- c. **Educate owners about responsibilities and liabilities:** Communities should provide dam owners with information about the need to maintain level of service of any dam. (Low cost to implement.)

## **Individual Community Action Strategies**

### **Requirement 44 CFR §201.6(c)(3)(iv)**

All community representatives that attended a workshop were invited to complete the priorities worksheet. In some communities, more than one representative completed the worksheet and identified priorities, based on the agency they work for within the community. In other cases, the community representatives filled out one priority form for the community. Where municipalities have authorized the county emergency management officials to be their representatives in the plan development, the county priorities also represent the municipal priorities. In St. Louis County a large percentage of municipalities have contracted with the county for planning and ordinance development, and in St. Charles County, most of the smaller communities contract for emergency management services through the county, therefore, county priorities effectively represent these municipalities. Communities with smaller staff capacity are generally supported by the county emergency management agencies, and this is an important factor in developing a regional hazard mitigation plan. In Franklin and Jefferson Counties, emergency managers already work closely with municipalities and collaborate on many strategies.

Likewise the school districts were represented in the planning by EducationPlus, the Cooperating School Districts office. A few filled out their own priorities, but most have gone with the regional priorities as identified by the Cooperating School Districts. This approach will enable to more focused approach from the regional level and serve to build awareness and steady progress.

The spreadsheet at the end of this chapter details the priorities and current state of action for participating municipalities and school districts. Those which do not appear individually are represented by the county plan priorities. By adopting the plan, municipalities and school districts

Note: The numbers and letters on the spreadsheet correspond with the numbers in the action plan. This spreadsheet includes the identifiable action items for specific jurisdictions

## **Incorporating Plans into other planning mechanisms over the next five year period. 44CFR §201.6(c)(4)(ii)**

Over the next five years, local communities working with the county emergency managers, the Community Organizations Active in Disasters (COADs), and STARRS will be able to address the specific actions and incorporate relevant actions into other local government activities. The specific actions and priorities identified are already included in the STARRS plans and in many of the county and municipal planning initiatives. The Hazard Mitigation Plan is also included in the regional OneSTL plan adopted by East-West Gateway's Board of Directors in December 2013. With an annual review and presentation at the STARRS meetings, and with an annual presentation at the SLARCC meetings this plan should advance more completely than in previous periods.

## **Evaluation and assessing changes in priorities**

### **44CFR §201.6(d)(3)**

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## *St. Louis Regional Hazard Mitigation Plan*

This new five year plan update is based on the changing conditions in the region. The advancement of STARRS and the regional security initiative to form COADs is the single most important advance in the last five years. This opportunity is now available to all municipalities and provides a means to address a wide range of issues in community preparedness and education at low cost to governments and school districts while at the same time building the capacity of non-profit and religious organizations to respond to natural disasters.

Built into this plan is an annual review of the plan at the regional level through STARRS and all emergency response agencies.

### **Community Action Strategies Spreadsheet**

See attached separate spreadsheet document – The column codes (1A, 2A, 2B, etc.) correspond to the numbers and letters of the action steps in this chapter.

The spreadsheet includes a list of priorities for municipalities and school districts in the region that chose to set their own priorities.

Other municipalities (not currently listed separately) have delegated their planning in this process to their specific county emergency management officials and are represented by the county priorities.

Other school districts have delegated their planning in this process to EducationPlus (the Cooperating School Districts office) and are represented by the priorities given by EducationPlus.

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## Hazard Mitigation Actions

The list of mitigation actions was prepared by staff, reviewed by the Working Group, and then presented at the Workshops. Representatives used the worksheet to set their community actions and priorities. Results of the ranking are in the spreadsheet following. On the left side are the jurisdictions. Across the top of the chart are the corresponding number and letter of the actions listed below. Unless listed separately, the jurisdictions are represented by the county emergency management priorities.

1. Public Awareness of all natural disasters
  - a. Create and strengthen COADs to prepare for rapid disaster response
  - b. Participate in All Ready Campaign
  - c. Participate and support CERT for citizen volunteers
  - d. Educate the public and local officials about relevant hazards
  - e. Promote public awareness about 211 Service
2. Public Actions to support all disasters
  - a. Build safe rooms that can also function as relief centers
  - b. Create and improve early warning systems for all disasters, including sirens and call systems e.g., “reverse 911” or “Code Red”
  - c. Integrate communications systems for rapid response
  - d. Conduct assessment of risk for all natural disasters
  - e. Joint purchasing of supplies (e.g. road salt)
3. Tornado:
  - a. Build safe rooms for schools, community centers and mobile home parks
  - b. Develop early warning systems for vulnerable communities
4. Floods
  - a. Protect stream buffers from development
  - b. Use floodplain best management practices
  - c. Join FEMA Community Rating System
  - d. Use Green Infrastructure to manage stormwater where it falls
  - e. Buy out frequently flood properties
5. Extreme Weather (heat and cold)
  - a. Create neighborhood support initiatives
  - b. Establish relief centers and encourage people to use the centers
6. Wildfire
  - a. Develop coordinated response systems among fire districts
  - b. Restrict open burning
7. Earthquake
  - a. Improve early warning systems
  - b. Review and update building codes
  - c. Integrate communications system for rapid response
  - d. Promote individual/household preparation (including strengthening structures)
8. Dam Failure
  - a. Encourage annual inspection of dams
  - b. Improve structural integrity of dams, using incentives where necessary
  - c. Educate dam owners on responsibilities and liabilities

Name	PRIORITY			ACTION		
Title	H - High			O - Ongoing		
Community	M - Medium			C - Complete		
Date	L - Low			D - Deferred		
ACTIONS				Circle One		
<b>1. Public Awareness for All Disasters</b>						
a. Create and strengthen COADs to prepare for disaster	H	M	L	O	C	D
b. Participate in All Ready Campaign	H	M	L	O	C	D
c. Participate and support CERT for citizen volunteers	H	M	L	O	C	D
d. Educate the public and local officials about relevant hazards	H	M	L	O	C	D
e. Promote public awareness about 211 Service	H	M	L	O	C	D
<b>2. Public Actions to Support All Disasters</b>						
a. Build safe rooms that can also function as relief centers	H	M	L	O	C	D
b. Create and improve early warning systems for all disasters, including sirens and call systems, e.g. "reverse 911" or "Code Red"	H	M	L	O	C	D
c. Integrate communications systems for rapid response	H	M	L	O	C	D
d. Conduct assessment of risk for all natural disasters	H	M	L	O	C	D
e. Joint purchases of supplies (e.g., rock salt)	H	M	L	O	C	D
<b>3. Tornado</b>						
a. Build safe rooms for schools, community centers and mobile home parks	H	M	L	O	C	D
b. Develop early warning systems for vulnerable communities	H	M	L	O	C	D
<b>4. Floods</b>						
a. Protect stream buffers from development	H	M	L	O	C	D
b. Use floodplain best management practices	H	M	L	O	C	D
c. Join FEMA Community Rating System	H	M	L	O	C	D
d. Use Green Infrastructure to manage stormwater where it falls	H	M	L	O	C	D
e. Buy out frequently flooded properties	H	M	L	O	C	D
<b>5. Extreme Weather (heat and cold)</b>						
a. Create neighborhood support initiatives	H	M	L	O	C	D
b. Establish relief centers and encourage people to use the centers	H	M	L	O	C	D
<b>6. Wildfire</b>						
a. Develop coordinated response systems among fire districts and departments	H	M	L	O	C	D
b. Restrict open burning	H	M	L	O	C	D

Page 2	Priority			Action		
ACTIONS				Circle One		
<b>7. Earthquake</b>						
a. Improve early warning systems	H	M	L	O	C	D
b. Review and update building codes	H	M	L	O	C	D
c. Integrate communications systems for rapid response	H	M	L	O	C	D
d. Promote individual/household preparation (including strengthening structures)	H	M	L	O	C	D
<b>8. Dam Failure</b>						
a. Encourage annual inspection of dams	H	M	L	O	C	D
b. Improve structural integrity of dams, using incentives where necessary	H	M	L	O	C	D
c. Educate dam owners on responsibilities and liabilities	H	M	L	O	C	D

St. Louis County Action Step Priorities and Status  
 (The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

LNAME	FNAME	TITLE	MUNICIPALITY	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	4A	4B	4C	4D	4E	5A																	
				P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P																
Adams	Brian	Emergency Mgmt Specialist, OEM	St. Louis County	M	O	M	O	L	D	H	O	L	D	L	D	H	O	H	C	H	O	M	C	H	O													
Wyse	Justin	Asst City Administrator/Dir Plng	City of Brentwood	L	D	M	D	M	O	M	O	L	D	L	D	H	C	H	C	H	O	H	C	H	O	L												
Geisel	Mike	Director, Public Services	City of Chesterfield	M	O	M	O	M	O	H	O	M	O	L	D	M	O	H	O	M	O	M	O	L	O	L	O	L										
Finkbiner	Nikki	Community Dev. Director	City of Fenton					H	D			H	D	H	C	M	D	M	D	H	C	H	C	H	D	H	O	H	C	M								
Barrett	Tim	City Engineer	City of Florissant	M	O	M	O	H	C	H	O	M	O	L	D	H	O	H	O	M	O	L	D	M	D	H	C	H	C	H	C	M	C	L	D	M		
Boslnert	Kevin	Sgt/EMD	City of Florissant	M	O	L	D	H	O	H	O	L	O	L	D	H	O	M	D	M	O	L	D	L	D	H	O					L	D	M				
Hunot	Bill	Alderman	City of Greendale	H	O	H	D	H	D	H	O	H	D	H	D	H	D			L	D	H	O	H	D	M	D	L		L		O	L	H				
Huddleston	Monica M.	Mayor	City of Greendale			H	O	M	D	H	C	H	O		H	D	H	D	H	O						H	O			H	O					H		
Lamitola	Anne	Public Works Director	City of Ladue	L	D	L	O	L	D	M	O	L	D	L	D	H	C	H	O	M	O	M	O	L	O	M	O	H	O	H	O	L	D	H	O	L	D	L
Wooldridge	Michael	Assistant to the Mayor/City Clerk	City of Ladue	L	D	L	O	L	D	M	O	L	D	L	D	H	C	H	O	M	O	M	O	L	O	M	O	H	O	H	O	L	D	H	O	L	D	L
Walsh	Tim	Emergency Management	City of Manchester	H	O	M	O	M	O	H	O	M	O	M	O	M	O	M	O	M	O	M	O	M	O	M	O	H	O	H	O	M	O	M	O	M	O	H
Ebert	David	Police Officer	City of Manchester	H	O	M	O	H	O	H	O	M	O	H	D	M	O	M	O	M	O	M	O	M	O	H	O	M	O	M	O	M	O	M	O	M	O	H
Davis	Tiffany	Assistant Director, Public Works	City of Maplewood	H	D	H	D	H	O	M	O	M	D	H	C	H	C	M	D	H	D	M	D			M	D	M	O	M	O	M		H	O	M		
Herr	Brian	Building Official/Fire Marshal	City of Maplewood	M	D	L	D	L	D	M	D	M	D	L	D	M	O	H	O	L	D	M	O	L	D	L	L	L	D	H	O	H	O	L	D	L	L	
Simpson	Kris	Assistant to the City Administrator	City of Maryland Heights	L	O	L	D	M	O	M	O	M	D		C	L	D	M	O	M	O	H	C	M	O	L	D	H	O	H	O		M	O	L	D	L	
Moore	Joseph E.	Deputy Building Commissioner	City of Maryland Heights	H	D	H	D	M	O	M	O	H	D	M	C	H	O	H	O	M	O	H	O	H	O		H	O	H	O	H	O	H	O	M	O	M	
Lovings	Craig	Director, Public Works	City of Pagedale	H		H		L		O		O	L		H		M				O	H		H		L		M		O	M		H		H			
Yackley	Jennifer	City Administrator	City of Rock Hill	L	D	M	D	M	C	L	O	M	D	L	D	M	O	M	O	L	D	L	C	L	D	M	O	H	C	H	C	L	D	M	O	L	D	
Greever	Jonathan	Director of Administration	City of Shrewsbury	M	O	H	D	H	C	H	O	H	O	M	D	M	O	H	C	L	D	M	C	M	D	H	D	H	O	M	O	M	D	L	D	L	D	H
Ratliff	Sharon	Assistant Village Clerk	Village of Twin Oaks	H	O	M	O	H	O	M	O	M	O	M	O	L	C	L	C	M	O	L	O	H	O	L	C	L	C	L	C	M	C	H	O	L	C	H
Schaub	Jeff	Building Commissioner	City of Valley Park	M	D	M	D	H	D	M	O	M	D	L	D	M	O	M	D	M	D	L	D	M	D	H	O	H	O	H	O	L	D	M	O	M	D	M
Cusack	David W.	Emergency Management Director	City of Valley Park	H	O	L	D	L	D	M	O	H	O	L	D	H	O	H	O	H	O	L	D	L	D	M	C	H	C	H	O	H	C	H	O	L	D	H
Beckett	Barbara	City Administrator	City of Winchester	M	D	H	D	H	O	H	O	H	D	L	D	H	O	M	D	H	O	H	O	L	D	M	D	L	D	M	O	L	D	M	D	L	D	H
Zaiz	Doug	Director, Public Works	City of Woodson Terrace	H	D	H	O	H	D	H	O	H	O	M	D	H		H	O	M		M	D	M	D	H	O	H	C	M	D	M	D	H	O	L	D	H

St. Louis County Action Step Priorities and Status

(The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

	5B		6A		6B		7A		7B		7C		7D		8A		8B		8C		NOTES
A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	
	H	O	L	D	L	D	L	D	H	O	H	O	M	O	L	D	L	D	L	D	
D	M	O	L	D	L	C	L	D	H	C	H	O	L	D							Continual updates
D	M	O	M	O	L	O	M	O	M	O	H	O	L	O	M	O	M	O	H	O	
D	M	D							M	O			M	D	H	C	H	C	M	D	
P	H	C	L	D	L	D	H	D	H	O	H	O	M	O							
D	M	O	L	D	L	D	L	D			H	D	M	O	L	D	L	D	L	D	
D	H	D		C		C			H	C			H	O	L		L		L		
O	H	D					H	D	H	O	H	D	H	O							
O	L	D	M	C	L	C	M	O	M	O	H	O	M	O	H	O	H	O	H	O	
O	L	D	M	C	L	C	L	D	M	O	H	O	M	O							
O	H	O	M	O	M	O	M	O	M	O	M	O	M	O							
O	H	O	L	D	L	D	M	O	M	O	H	O	H	O							
D	H	D	M		H	O	H	D	H	O	M	D	M	D							
D	L	D	M	O	H	O	L	D	H	O	H	O	L	D							
O	H	C	L	D	L	C	L	D	H	C	M	O	L	O	L	D	L	D	L	D	
D	M	O	M	C	H	O	H	D	H	O	H	O	M	O	M	D	M	D	M	D	
	H		H		L		O	M		L		H		O	H				O		
			L	C	L	C			L	C			L	D							
O	H	O	H	O	H	O	M	D	H	O	H	O	M	D	M	D	L	D	M	D	
O	H	O	H	C	H	C	M	O	H	C	H	C	M	O	H	C	H	C	H	C	
O	M	O	L	D	H	O	M	D	H	O	L	D	M	O	L	D	L	D	L	D	
O	L	D	H	O	H	C	H	O	H	O	H	O	H	O	H	O	H	O	H	O	
O	M	D	H	O	H	C	M	D	M	O	M	O	H	O	L	D	L	D	L	D	
O	H	O	M	D	H	C	H	O	M	D	H	O	M	D	L	D	L	D	L	D	

FRANKLIN COUNTY ACTION STEP PRIORITIES AND STATUS

(The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

LNAME	FNAME	TITLE	MUNICIPALITY	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	4A	4B	4C	4D	4E	5A	5B	6A	6B	
				P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A
Cook	Abe	Director	Franklin County	H	O	L	O	M	O	H	O	H	O	H	D	H	D	M	O	H	O	M	O	M	O
Hulsey	Stephanie	Program Administrator	Franklin County	H	O	L	D	M	O	M	O	H	O	H	D	H		H	O	H	O	M	O	M	O
Russell	Rost	City Administrator/EMD	City of Union	H	O	H	D	H	O	H	O	H	O	H	D	H	O	H	O	H	O	H	O	M	D

FRANKLIN COUNTY ACTION STEP PRIORITIES AND STATUS

(The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

7A		7B		7C		7D		8A		8B		8C		NOTES
P	A	P	A	P	A	P	A	P	A	P	A	P	A	
H	D	H	O	H	O	H	O	H	O	H	O	H	O	
H	O	H	O											
L	D	H	C	H	D	L	D	H	O	H	O	H	O	

JEFFERSON COUNTY ACTION STEP PRIORITIES AND STATUS

(The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

LNAME	FNAME	TITLE	MUNICIPALITY	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	4A	4B	4C	4D	4E	
				P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A
Cox	Richard	Building Commissioner	City of Crystal City	M	D	M	O	M	O	L	D	H	C	H	O	H	O	M	D	M	D
Robinson	Warren	Director of Emergency Mgt.	Jefferson County	H	O	M	O	H	O	M	O	L	D	H	O	H	O	M	C	M	O
King	Brenda	Alderwoman	City of Hillsboro	H	O	H		M	O	H		H		M		H		H		M	
Tulgetake	Mark	Chief of Police	City of Herculanum	H	O	H	D	H	O	H	O	H	D	L	D	H	C	H	C	H	O
Marmaduke	Gery	City Administrator	City of Herculanum	M	D	M	D	M	O	M	O	L	D	L	D	H	O	L	O	L	O
Dews	David	City Manager	City of Desoto	H	O	H	D	M	D	H	O	H	O	L	C	H	C	H	O	M	O
Welch	Hapy	City Administrator	City of Festus	L	D	L	D	H	O	M	O	L	O	L	D	H	O	L	D	M	O
Clemens	Matt	Building Official	City of Festus	M	D	M	D	H	O	M	D	M	D	L	D	H	O	H	O	M	O
Baur	Kenneth	Captain, Police Dept.	City of Herculanum	H	O	H	D	H	O	H	D	H	D	H	C	H	C	H	O	M	D

JEFFERSON COUNTY ACTION STEP PRIORITIES AND STATUS

(The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

5A		5B		6A		6B		7A		7B		7C		7D		8A		8B		8C		NOTES
P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	
M	O	L	O	H	O	H	C	H	O	H	O	H	O	M	O	L	O	L	O	L	O	
H	O	H	O	H	C	H	O	H	D	H	O	H	O	H	O	H	O	H	O	H	O	
M		L		H	O	M	C	L		M	O	H		H		H		H		H		
M	O	M	O	M	O	M	O	H	D	M	O	H	O	M	O	L	D	L	D	L	D	
M	D	M	D	L	O	M	O	L	D	M	O	H	O	M	O	M	O	M	D	L	O	
H	O	H	O	L		M	O	L	D	M	O	M	O	H	O	H	D	H	D	H	D	
L		M	O	H	O	H	O	L	D	H	C	L	O	L	O	L	O	L	O	L	O	
M	D	M	D	L	D	H	O	L	D	H	O	L	D	M	O	L	D	L	D	L	D	
M	O	M	O	M	O	M	O	H	D	M	O	H	O	M	O	L	D	L	D	L	D	





OTHER PARTNER ACTION STEP PRIORITIES

LNAME	FNAME	TITLE	OTHER	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	4A	4B	4C	
				P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A
Slonaker	Katie	Disaster Specialist	American Red Cross	H	O	M	O	M	O			M	O						
Marler	Brian	Systems Analyst, STARRS	EWG	H	O	H	O	L	D	M	D	H	O	M	O	L	O	M	D
Hicks	John	Transportation Analyst	St. Louis County Highways & Traffic	M	O	H	O	H	O	H	O	H	O	M	O	M	D	H	O
Boyles	Craig	Disaster Response Coordinator	St. Louis County Highways & Traffic									H	O	H	O			M	O



ST. LOUIS CITY ACTION STEP PRIORITIES AND STATUS

LNAME	FNAME	TITLE	DEPT.	MUNICIPALITY	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	4A	
					P	A	P	A	P	A	P	A	P	A	P	A	P	A
Russell	Valerie	Executive Assistant II	Human Services	City of St. Louis	M	O	M	O	M	O	H	O	M	C	M	O	H	
Curtis	Pat	Emergency Response Planner	Dept. of Health	City of St. Louis	M	O	M	O	M	O	H	D	H	O	H	O	M	C
Sondermann	Jim	Special Assistant to Water Commissioner		City of St. Louis	O				M	O	M	O						
Minder	Anthony	Planning Specialist		City of St. Louis	H	O	H	O	H	O	L	D	H	D	H	O	H	O
Arras	Michael	Deputy Chief of Special Operations		City of St. Louis	O		L	O	M	O	L	O	O		M	O	L	
Dupuis	Paul	Emergency Management Specialist		City of St. Louis	M	O	M	O	L	D	H	O	L	D	H	O	L	D

ST. LOUIS CITY ACTION STEP PRIORITIES AND STATUS

																NOTES																
4B	4C		4D		4E		5A		5B		6A		6B		7A		7B		7C		7D		8A		8B		8C					
P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	
				H		H		M	O	M	O			H	O	H	D	H	D	H	O	H	D									
				H	D			M	O	H	O					H	O			H	O	H	O									
		H								H	O	L	C	M	O					H	O											
M	D	H	D	M	D	H	D	M	D	H	O	H	C	M	C	H	O	H	O	H	O	H	O	H	O	H	O	H	O	H	O	
									O		O		O		O	H		H		H		H		L		L		L				
H	O			M	O	H	C			H	O			L	D	L	D	H	O	H	O	M	O	O								

**ST. CHARLES COUNTY ACTION STEP PRIORITIES AND STATUS**  
 (The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

LNAME	FNAME	TITLE	MUNICIPALITY	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	4A	4B	4C															
				P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A														
Bird	Gary	Battalion Chief	City of St. Charles	M	O	M	D	L	O	H	O	L	D	L	D	H	O	M	C	L	D	L	D	H	O	M	O	M	O	L	O		
Whipple	Jan	Land Use Manager	City of St. Charles	M	D	H	O	M	C	H	O	M	O	M	D	H	O	H	O	M	O	L	D	M	D	H	O	M	C	H	D	H	C
Jaggie	Jason	Planning Manager	City of St. Charles	M		H		M		M		H		H		M		M		L		H	C	H		M							
Daly	Rick	Fire Chief	City of St. Charles	M	O	M	D	L	O	H	O	L	D	L	D	H	O	H	O	M	C	L	D	L	D	H	O	M	O	M	O	L	O
Hickey	Lt. Tim	Director Emergency Management	City of St. Peters	M	O	O	D	M	C	H	O	L	D	L	D	H	O	H	O	L	O	L	D										
Stowers	Andrew	EM Coordinator	City of O'Fallon	M	C	M	C	M	C	M	C	M	O	L	D	H	O	H	O	H	O	M	C	H	O	M	C	L	D	L	D	L	D
McCaine-Obenland	Ina	Ops & training Coordinator	St. Charles County	M	O	L	D	M	O	H	O	L	D	L	D	H	O	H	O	M	O	L	D	L	D	H	O						

ST. CHARLES COUNTY ACTION STEP PRIORITIES AND STATUS

(The priorities of the County Emergency Manager also represent the municipalities not listed separately.)

														NOTES											
4D	4E		5A		5B		6A		6B		7A		7B		7C		7D		8A		8B		8C		
P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A
M	O	L	O	L	O	L	O	M	C	M	O	M	D	M	O	M	O	L	O	L	D	L	D	L	D
H	O	L	C	L	D	M	D	H	C	H	C			H	O	H	C	H	D	H	D	M	D	H	D
M		H		M		H		L		L		H	O	H	O	H	O	H		L		L		L	
M	O	L	O	L	D	L	O	M	C	M	O	M	D	M	O	M	O	L	O	L	D	L	D	L	D
				M	C	M	C	L	D	L	D	L				H	O	H	O						
M	O			L	D	L						H	O	M	O	H	O	H	O						
		H	C	M	O	M	O					L				H	O	M	O				M	O	