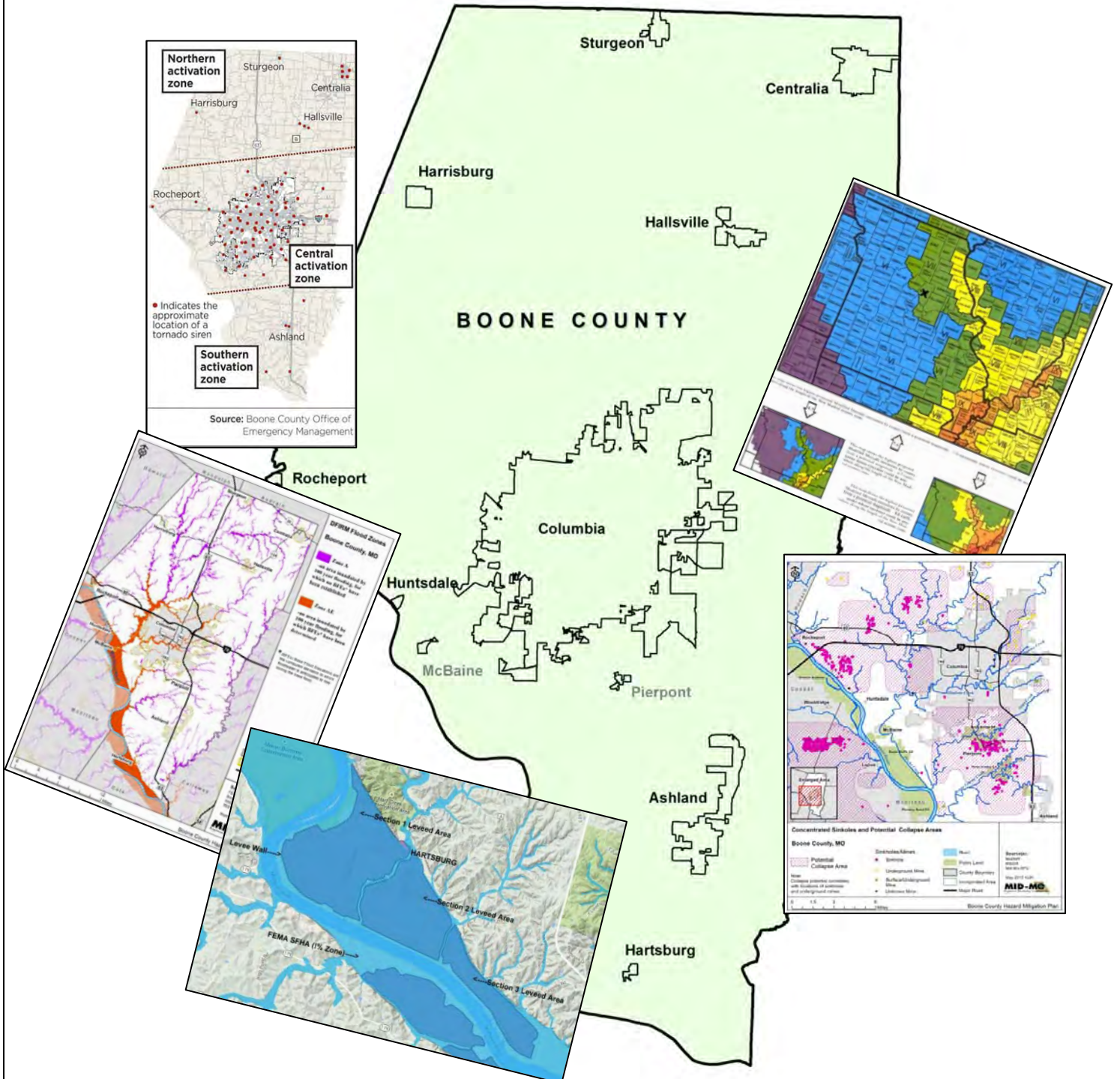


Boone County Hazard Mitigation Plan 2015



Cover Illustrations (surrounding outline map of Boone County and its jurisdictions, counterclockwise from upper left):

Outdoor Warning Siren Activation Zone Map (p. 77),

DFIRM Flood Zones, Boone County, MO (p. 141)

USACE National Levee Database map for Hartsburg area (p. 171),

Concentrated Sinkholes and Potential Collapse Areas (southern Boone Co., p. 228)

Highest Projected Modified Mercalli Intensities by County (p. 216)

The planning process for the update of the Boone County Hazard Mitigation Plan was led by the Mid-Missouri Regional Plan Commission through a contractual agreement with the MO State Emergency Management Agency and Boone County.

Mid-Missouri Regional Planning Commission

206 East Broadway, P.O. Box 140

Ashland, MO 65010

Phone: (573) 657-9779

Fax: (573) 657-2829



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“Across the United States, natural, manmade, and other disasters have led to increasing numbers of deaths, injuries, property damages, and disruptions of business and government services. This can take an immense toll on people, businesses and government, especially in these challenging economic times. The time, money and effort to respond to and recover from disasters divert public resources and attention from other important programs.

Hazard mitigation is defined by the Federal Emergency Management Agency (FEMA) as any action taken to eliminate or reduce the long-term risk to human life and property from hazards and their effects. This is crucial to the residents, businesses, and governments of Missouri.

Hazard Mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage, reconstruction, and repeated damage.”

- Missouri State Hazard Mitigation Plan, 2013

Executive Summary

Hazard mitigation focuses on anticipating and lowering risks to lives and property. Natural hazards are taking an increasing toll on lives and property in the United States. The number of FEMA declared Presidential Disasters across the nation has increased drastically over the past two decades. The year 2011 (when an EF-5 tornado devastated the Missouri town of Joplin) set a record with 242 disaster declarations. The cost of these disasters has also increased in recent years, in part because of increased population and a larger built environment but also because of the magnitude of many recent disasters. Hazard mitigation, the cornerstone of emergency management, seeks to address these issues.

Hazard mitigation can save lives and property; it also makes good economic sense. A 2005 study conducted by the National Institute of Building Science found that every dollar spent on mitigation activities saves four dollars in post-disaster recovery costs. Hazard mitigation is a good business practice for both the public and private sectors.

The Plan: Boone County and its jurisdictions have had a FEMA approved hazard mitigation plan in place since 2005; the plan, and the mitigation strategy within it, is updated every five years as required by federal law. For the 2015 update, the Boone County plan has been enhanced to an All Hazards Mitigation Plan. In addition to profiling eleven natural hazards, the plan now also profiles eleven technological/human-made hazards which are potential threats. A risk assessment is included for each potential hazard.

The risk assessment (Sections 4 and 5) indicates the natural hazards posing the greatest threat to Boone County as a whole are: tornado, thunderstorm, severe winter weather, and an earthquake of significant magnitude at the New Madrid Seismic Zone. Flood, levee failure, and dam failure are of particular concern for certain jurisdictions. Land subsidence/sinkhole development is of growing concern for some jurisdictions as development proceeds at a rapid pace.

The technological/human-made hazards posing the greatest potential threat are a public health emergency, utility service disruption, unwanted intruder incident which turns into an active shooter event, cyber attack, and terrorism.

Mitigation Currently in Place: Much progress in mitigation has been made in Boone County since the first plan was written in 2005; many mitigation activities are in place in the regular operations of the county, its communities, educational institutions, and special districts. However, much remains to be done.

A number of mitigation actions have been completed since the 2010 update of the plan: the Villages of Harrisburg and Huntsdale joined the NFIP (National Flood Insurance Program), new Flood Insurance Rate Maps (FIRMS) were adopted by jurisdictions, and the Boone County Storm Water Master Plan was completed.

2015 Mitigation Strategy: The current mitigation strategy, found in Section 6.1 of the plan, lays out a series of actions to be focused on during the coming five years. Each of the actions has been analyzed as to applicable jurisdiction(s), the agency or department which will lead the effort, and the means of implementing and financing the action. All of these decisions were made by jurisdictional representatives participating as members of the hazard mitigation planning committee.

Not every action in the overall mitigation strategy applies to each jurisdiction. For example, “Continue to supply updated GIS base map information...” is an action carried out by Boone County with the help of the City of Columbia. Other jurisdictions do not need to do anything with this action, although they do benefit from it. An example of an action particular to only one jurisdiction is “Replace 2, 3, and 4 inch water lines with 6 inch lines...” this action is specific to the City of Sturgeon. An example of an action applicable to many jurisdictions is “Develop Continuity of Operations Plan (COOPs)”; this is an important action which many of the jurisdictions will be undertaking to address their own particular circumstances.

Each participating jurisdiction in the plan has resolved to execute some of the specific actions outlined in the strategy. Section 6.3 of the plan contains a subsection for each participating jurisdiction which outlines the actions for which that jurisdiction is responsible. Government officials can easily find their jurisdiction in Section 6.3 in order to thoroughly familiarize themselves with the tasks ahead.

While it is to be hoped that many of the mitigation actions in the strategy will have been completed before the next five-year update, nothing in the plan is legally binding on the participating jurisdictions.

The 2015 countywide mitigation strategy is shown in its entirety below, organized by the five major mitigation goals. (Actions continuing from the 2010 plan are in italics while new actions for 2015 are in regular text.)

Goal 1: Mitigation Planning - Mitigate the effects of future natural, technological, and human-made hazards throughout the County through public and private action.

- *Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.*
- Continue to participate as a partner in FEMA's RISKMap process.
- *Continue with monthly testing of warning systems in compliance with procedures set out by the Office of Emergency Management.*
- *The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.*
- *Encourage the local water district to have adequate fire flow.*
- Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.
- Conduct a survey of generator needs of critical infrastructure in Planning Area; include information on sizing, hookup, and fuel storage.
- Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.

- Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.
- Develop Continuity of Operations Plans (COOPs).
- Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.
- *Encourage underground utilities where feasible.*
- *Review and formalize relationships with cooling and warming centers in each community.*
- Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.
- Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).

Goal 2: Mitigation Policy - Develop policies that limit the impact of natural, technological, and human-made hazards on lives and property.

- *Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.*
- *Add sinkhole regulations to stream buffer/storm water ordinance.*
- *Develop policy and enforcement regulations concerning burning permits.*
- *Review building codes every two/three years for possible update.*
- *Develop regulations for roads on dams.*

Goal 3: Mitigation Programs - Implement cost effective and feasible mitigation programs to protect lives and property of Boone County jurisdictions.

- *Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).*
- *Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.*
- *Mitigate the effects of flooding on public infrastructure.*
- *Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.*
- *Ensure evacuation plans are adequate for nursing homes and special needs populations.*
- *Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.*
- *Evaluate and maintain emergency preparedness plans.*
- *Conduct emergency preparedness exercises periodically throughout the year.*
- *Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.*
- *Encourage shelters to have alternative heating sources.*
- *Acquire generators and power transfer hookup equipment.*
- *Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.*

- Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
- Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.
- Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.
- Enhance alert and warning capabilities.

Goal 4: Public Awareness - Increase public awareness of natural, technological, and human-made hazards in order to make the public a greater partner in hazard mitigation planning.

- *Continue to educate the public on all hazards.*
- Promote the purchase and use of NOAA radios.
- Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.

Goal 5: Future Development - Promote hazard-proof development in the jurisdictions of Boone County.

- Target Repetitive Loss Properties for flood buyout.
- Acquire properties susceptible to flood damage when buyout grants are available.

Funding and Funding Issues: Some actions in the current mitigation strategy can be put in place given minimal resources and some staff time. However, there are some very important mitigation activities which require major funding. For example, there is a serious lack of tornado safe rooms in the jurisdictions and tornadoes/high winds are one of the greatest threats in the area. More generators and power transfer hookups are also needed to mitigate power outages that often accompany damaging winds or severe winter storms. (Severe winter storms occur almost every year and have been responsible for five Presidential Disaster Declarations since 2002.)

The Federal Emergency Management Agency (FEMA) has both pre-disaster and post-disaster mitigation grant programs to help local jurisdictions with mitigation projects. These programs are outlined in Section 6.5 of the plan. The jurisdictions participating in the plan are eligible to apply for funding from these programs; a 25% local match is typically required for the funds received.

Unfortunately, there has been a severe decline in recent years in the amount of pre-disaster federal money available. This creates the unfortunate situation where most federal funding for local mitigation projects becomes available after a disaster has occurred - if a Presidential Disaster Declaration is declared. At that point, 20% of the total federal cost of the disaster is awarded to the state to be used for mitigation projects.

Given the current state of federal funding assistance, the 2015 hazard mitigation planning committee recognized the pressing need to establish reliable and sustainable sources of local funding for mitigation projects. An action has been included in the current mitigation strategy to

strategize and establish such local funding sources; these local funding pools could be used both for projects and for local matches if/when federal funds become available.

Planning Process: A plan is only as good as the planning process which developed it. Boone County and its jurisdictions undertook a thorough update of this hazard mitigation plan over a nine month period in 2014-15.

The update was completed with the active participation of nineteen jurisdictions in Boone County (the county itself, nine communities, six school districts, two colleges, and one university). Representatives from these jurisdictions comprised the hazard mitigation planning committee which met for seven general sessions. In addition, meetings were held with other established committees in Boone County and with individuals particularly knowledgeable on specific topics. The draft plan was presented at two public meetings, and published on the website of the Mid-MO Regional Planning Commission, to allow for input from the general public.

The plan will be evaluated and maintained on a yearly basis with the help of the planning committee; the next complete update will be undertaken in five years.

The ultimate test of a plan is the action taken on the roadmap presented. It is to be hoped that many of the mitigation actions in this plan will have been completed before the next five-year update. Action on the strategy in this plan will help to ensure a greater, and more cost-effective, level of protection for the citizens and property of Boone County and its jurisdictions.

The Boone County Hazard Mitigation Plan can be found online at:
www.mmrpc.org/reports-library/hazard-mitigation-reports/.

Plan Adoption

Requirement §201.6(c)(5):	<i>For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.</i>

The participating jurisdictions adopted the plan following FEMA’s “approval pending adoption”. Adoption resolutions and adoption letters (school districts and institutes of higher learning) are included in this section.

CERTIFIED COPY OF ORDER

STATE OF MISSOURI

} ea.

October Session of the July Adjourned

Term. 20 15

County of Boone

In the County Commission of said county, on the

1st

day of October

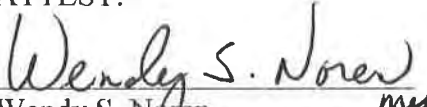
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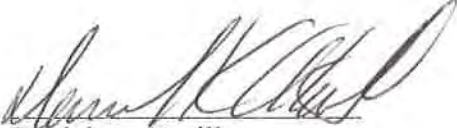
the following, among other proceedings, were had, viz:

Now on this day the County Commission of the County of Boone does hereby adopt the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation Plan as described in the attached executive summary with detailed descriptions available in the archive section of the Boone County Commission office and on the Boone County web site at <http://showmeboone.com/commission/common/pdf/2015BooneCoHazardMitigationPlan.pdf> until such time it is replaced by a subsequent Hazard Mitigation Plan.

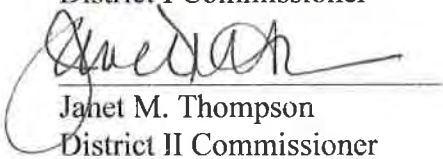
Done this 1st day of October, 2015.

ATTEST:


Wendy S. Noren
Clerk of the County Commission


Daniel K. Atwill
Presiding Commissioner


Karen M. Miller
District I Commissioner


Janet M. Thompson
District II Commissioner

The following resolution was adopted by Boone County, Missouri on

OCTOBER 1, 2015.

RESOLUTION NO. 461-2015

WHEREAS, the Boone County Hazard Mitigation Plan is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, Boone County participated in the preparation of the Boone County Hazard Mitigation Plan; and

WHEREAS, the citizens of Boone County have been afforded an opportunity to comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, Boone County has reviewed the Plan and affirms that the Plan will be updated no less than every five years

NOW THEREFORE, BE IT RESOLVED by the County Commission that Boone County adopts the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

ADOPTED this 1ST day of October, 2015 at the meeting of the County Commission.

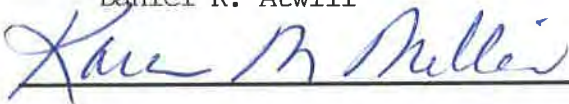


Name Daniel K. Atwill

Position Presiding Commissioner

Date

10/1/15

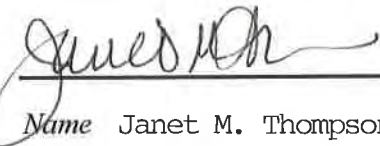


Name Karen M. Miller

Position District I Commissioner

Date

10/1/15



Name Janet M. Thompson

Position District II Commissioner

Date

10/1/15

RESOLUTION NO. 10-06-2015

WHEREAS, the Boone County Hazard Mitigation Plan is multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, the City of Ashland participated in the preparation of the Boone County Hazard Mitigation Plan; and

WHEREAS, the citizens of the City of Ashland have been afforded an opportunity to comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, the City of Ashland has reviewed the Plan and affirms that the Plan will be updated no less than every five years.

NOW THEREFORE, BE IT RESOLVED by the Board of Aldermen that the City of Ashland adopts the Boone County Mitigation Plan as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions of the Plan.

ADOPTED this 6th day of Oct., 2015 at the meeting of the Board of Aldermen.

Fred Klapp 3rd Ward Alderman 10-5-15

Name Position Date
Tim Calver 2nd Ward Alderman 10-6-15

Name Position Date
Steve D. Campbell Ward I Alderman 10/6/2015

Name Position Date
Gene Scherer Mayor 10/6/2015

Name Position Date
John B. 3rd Ward Alderman 10/6/2015

Name Position Date
George Elliott Ward 1 Alderman 10/6/2015

Name Position Date
Jan O. Fenn Alderman Wd. 2 10-6-15

Name Position Date

A BILL TO CREATE A RESOLUTION ENTITLED:

“A RESOLUTION ADOPTING THE BOONE COUNTY MISSOURI HAZARD MITIGATION PLAN OF 2015 AS THE HAZARD MITIGATION PLAN FOR THE CITY OF CENTRALIA, MISSOURI.”

WHEREAS, the Boone County Missouri Hazard Mitigation Plan of 2015 is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and

WHEREAS, the City of Centralia, Missouri participated in the preparation of the Boone County Missouri Hazard Mitigation Plan of 2015; and

WHEREAS, the citizens of the City of Centralia, Missouri have been afforded an opportunity to comment and provide input on the Plan and the mitigation action therein; and

WHEREAS, the City of Centralia, Missouri has reviewed the Plan and affirms that the Plan will be updated no less time than every five years,

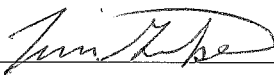
NOW THEREFORE BE IT RESOLVED BY THE BOARD OF ALDERMEN OF THE CITY OF CENTRALIA, MISSOURI, as follows:

SECTION 1. The City of Centralia, Missouri hereby adopts the Boone County Missouri Hazard Mitigation Plan of 2015 as this jurisdiction’s Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

SECTION 2. All Motions or Resolutions in conflict herewith are hereby replaced.

SECTION 3. This resolution shall take effect and be in full force and effect from and after the date of its passage and approval.

PASSED AND APPROVED by the Board of Aldermen of the City of Centralia, Missouri, this 28th day of September 2015.



Mayor, Tim Grenke

ATTEST:



City Clerk, Heather Russell

Introduced by McDavid Council Bill No. R 176-15

A RESOLUTION

adopting the 2015 Boone County Hazard Mitigation Plan.

WHEREAS, the Boone County Hazard Mitigation Plan (hereinafter "the Mitigation Plan") is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements of 44 CFR § 201.6; and

WHEREAS, City of Columbia staff members participated in the preparation of the Mitigation Plan; and

WHEREAS, the citizens of Columbia have been afforded an opportunity to comment and provide input on the Mitigation Plan and the mitigation actions therein; and

WHEREAS, the Mitigation Plan has been reviewed by City staff members who affirm that the Mitigation Plan will be updated no less than every five (5) years.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF COLUMBIA, MISSOURI, AS FOLLOWS:

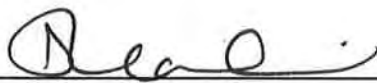
SECTION 1. The City Council adopts the 2015 Boone County Hazard Mitigation Plan as the hazard mitigation plan of the City of Columbia, Missouri.

SECTION 2. The City of Columbia resolves to consider implementation of pertinent precepts of the Mitigation Plan by incorporation into other community plans and mechanisms where appropriate.

SECTION 3. The City of Columbia will evaluate and review the Mitigation Plan regularly or after a disaster as well as complete a mandated five-year update submitted to the State Emergency Management Agency and the Federal Emergency Management Agency for review.

ADOPTED this 2nd day of November, 2015.

ATTEST:



City Clerk



Mayor and Presiding Officer

APPROVED AS TO FORM:



City Counselor

Permanent Record
Filed in Clerk's Office

The following resolution was adopted by the City of Hallsville, Boone County, Missouri on October 12, 2015.

RESOLUTION NO. 2015-5

WHEREAS, the Boone County Hazard Mitigation Plan is a multi-jurisdiction hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and

WHEREAS, the City of Hallsville participated in the preparation of the Boone County Hazard Mitigation Plan; and

WHEREAS, the citizens of the City of Hallsville have been afforded an opportunity to comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, the City of Hallsville has reviewed the Plan and affirms that the Plan will be updated no less than every five years.

NOW, THEREFORE BE IT RESOLVED by the Board of Aldermen that the City of Hallsville adopts the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

Cheri T. Reisch 10-12-15
Cheri T. Reisch Mayor Date

Mickey Nichols 10-12-15
Mickey Nichols Alderman, Ward 1 Date

Thomas Pauley 10-12-15
Thomas Pauley Alderman, Ward 1 Date

Darren Maher 10-12-15
Darren Maher Alderman, Ward 2 Date

Alderman, Ward 2 Date

HARRISBURG

The following resolution was adopted by the City of Harrisburg, Boone County, Missouri
on July 20, 2015.

RESOLUTION NO. B-31-15

WHEREAS, the Boone County Hazard Mitigation Plan is a multi-jurisdictional hazard
mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, the City of Harrisburg participated in the preparation of the Boone County Hazard
Mitigation Plan; and

WHEREAS, the citizens of the City of Harrisburg have been afforded an opportunity to
comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, the City of Harrisburg has reviewed the Plan and affirms that the Plan will be
updated no less than every five years

NOW THEREFORE, BE IT RESOLVED by the Board of Trustees that the City of Harrisburg
adopts the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation
Plan, and resolves to execute the actions in the Plan.

ADOPTED this 20th day of July, 2015 at the meeting of the Board of Trustees.

<u>Susan Bell</u>	<u>Trustee</u>	<u>7-20-15</u>
Name	Position	Date

<u>[Signature]</u>	<u>Trustee</u>	<u>7-20-15</u>
Name	Position	Date

<u>[Signature]</u>	<u>Trustee</u>	<u>7-20-15</u>
Name	Position	Date

<u>Bill Mays</u>	<u>Trustee</u>	<u>7-20-15</u>
Name	Position	Date

<u>Gregory Wellbe</u>	<u>Trustee</u>	<u>7-20-15</u>
Name	Position	Date

The following resolution was adopted by the Village of Hartsburg, Boone County, Missouri
on 11-4-15.

RESOLUTION NO. 11-4-15

WHEREAS, the Boone County Hazard Mitigation Plan is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, the Village of Hartsburg participated in the preparation of the Boone County Hazard Mitigation Plan; and

WHEREAS, the citizens of the Village of Hartsburg have been afforded an opportunity to comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, the Village of Hartsburg has reviewed the Plan and affirms that the Plan will be updated no less than every five years

NOW THEREFORE, BE IT RESOLVED by the City Council that the Village of Hartsburg adopts the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

ADOPTED this 4th day of November, 2015 at the meeting of the Board of Trustees.

<u>Vincent L. Barner</u>	<u>TRUSTEE</u>	<u>11-4-15</u>
Name	Position	Date

<u>Don A. Reale</u>	<u>TRUSTEE</u>	<u>11-4-15</u>
Name	Position	Date

<u>Carsten Z. Hilgediek</u>	<u>Clerk</u>	<u>11-4-15</u>
Name	Position	Date

<u>Robert A. Veneke</u>	<u>Trustee</u>	<u>11-4-15</u>
Name	Position	Date

<u>Robert F. Brown</u>	<u>Chair/Board of Trustee</u>	<u>11-4-15</u>
Name	Position	Date

**The following resolution was adopted by the City of Huntsdale, Boone County, Missouri on
Tuesday / January 19th 2016**

RESOLUTION NO. 5

WHEREAS, the Boone County Hazard Mitigation Plan is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

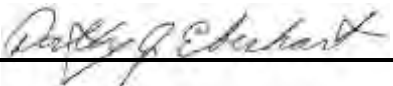
WHEREAS, the City of Huntsdale participated in the preparation of the Boone County Hazard Mitigation Plan; and

WHEREAS, the citizens of the City of Huntsdale have been afforded an opportunity to comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, the City of Huntsdale has reviewed the Plan and affirms that the Plan will be updated no less than every five years

NOW THEREFORE, BE IT RESOLVED by the City Council that the City of Huntsdale adopts the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

ADOPTED this **19th** day of **January , 2016** at the meeting of the City Council.



Name **Dorthy J. Eberhart** Position Alderman Date



Name Debby Lancaster Position Alderman Date



Name Ana C. Lopez Position Alderman Date

The following resolution was adopted by the City of Rocheport, Boone County, Missouri on

RESOLUTION NO. 001

WHEREAS, the Boone County Hazard Mitigation Plan is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and,

WHEREAS, the City of Rocheport participated in the preparation of the Boone County Hazard Mitigation Plan; and

WHEREAS, the citizens of the City of Rocheport have been afforded an opportunity to comment and provide input on the Plan and the mitigation actions therein; and

WHEREAS, the City of Rocheport has reviewed the Plan and affirms that the Plan will be updated no less than every five years

NOW THEREFORE, BE IT RESOLVED by the City Council that the City of Rocheport adopts the Boone County Hazard Mitigation Plan as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

ADOPTED this 2nd day of November, 2015 at the meeting of the City Council.

<u>[Signature]</u>	<u>Mayor</u>	<u>11-2-15</u>
Name	Position	Date

Name	Position	Date

Name	Position	Date

Name	Position	Date

Name	Position	Date

A BILL TO CREATE A RESOLUTION ENTITLED:

"A RESOLUTION ADOPTING THE BOONE COUNTY, MISSOURI HAZARD MITIGATION PLAN OF 2015 AS THE HAZARD MITIGATION PLAN FOR THE CITY OF STURGEON, MISSOURI."

WHEREAS, the Boone County, Missouri Hazard Mitigation Plan of 2015 is a multi-jurisdictional hazard mitigation plan prepared in accordance with FEMA requirements at 44 C.F.R. 201.6; and

WHEREAS, the City of Sturgeon, Missouri participated in the preparation of the Boone County, Missouri Hazard Mitigation Plan of 2015; and

WHEREAS, the citizens of the City of Sturgeon, Missouri have been afforded an opportunity to comment and provide input on the Plan and the mitigation action therein; and

WHEREAS, the City of Sturgeon, Missouri has reviewed the Plan and affirms that the Plan will be updated in no less time than every five years.

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF ALDERMEN OF THE CITY OF STURGEON, MISSOURI, as follows:

SECTION 1. The City of Sturgeon, Missouri hereby adopts the Boone County, Missouri Hazard Mitigation Plan of 2015 as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

SECTION 2. All Motions or Resolutions in conflict herewith are hereby replaced.

SECTION 3. This resolution shall take effect and be in full force and effect from and after the date of its passage and approval.

PASSED by the City of Sturgeon, Missouri Board of Aldermen and APPROVED by the City of Sturgeon, Missouri Mayor this 6th day of October 2015.



Gene Kelly, Mayor

ATTEST:



DeAnna Jacobs, City Clerk

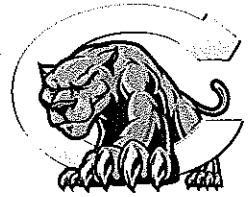
CENTRALIA R-VI SCHOOL DISTRICT

Darin Ford
Superintendent

darin.ford@catnet.gen.mo.us
www.centralia.k12.mo.us

1399 E. Highway 22, Suite B
Centralia, Missouri 65240

phone: 573-682-3561
fax: 573-682-2181



November 24, 2015

Susan Galeota
Mid-MO RPC
206 E. Broadway PO Box 140
Ashland, MO 65010

Dear Susan,

I am pleased to inform you that the Centralia R-VI School District officially adopted the Boone County Hazard Mitigation Plan by School Board action on October 12, 2015.

We are happy to be a part of this important collaboration.

Sincerely,

A handwritten signature in dark ink, appearing to read 'D. R. Ford'. The signature is fluid and cursive, with a large, sweeping 'F' at the end. It is positioned above a horizontal line that spans the width of the page.

Darin R. Ford
Superintendent
Centralia R-VI Schools



COLUMBIA PUBLIC SCHOOLS

Dr. Peter Stiepleman
Superintendent of Schools

Neil C. Aslin Administration Building
1818 W. Worley Street (573) 214-3416
Columbia, Missouri 65203

Linda D. Quinley
Chief Financial Officer & Chief Operations Officer

January 25, 2016

Ms. Susan Galeota
Mid-MO RPC
PO Box 140
Ashland, MO 65010

Re: Adoption of Boone County Hazard Mitigation Plan 2015

Ms. Galeota,

As a part of the participating jurisdictions of Boone County, Columbia Public Schools adopts the Boone County Hazard Mitigation Plan as referenced in the online plan document at:

<http://www.mmrpc.org/reports-library/hazard-mitigation-reports/>

Sincerely,

Linda D. Quinley
Chief Financial Officer &
Chief Operations Officer

tld



HALLSVILLE SCHOOL DISTRICT

421 E. HIGHWAY 124
HALLSVILLE, MO 65255

PHONE (573) 696-5512

FAX (573) 696-3606

JOHN ROBERTSON
SUPERINTENDENT

October 21, 2015

Susan Galeota
Mid-MO RPC
206 E. Broadway
P. O. Box 140
Ashland, MO 65010

The Hallsville R-IV School District Board of Education officially adopted the Boone County Hazard Mitigation Plan 2015 at its Board of Education meeting held October 21, 2015.

John Robertson
Superintendent

BOARD OF EDUCATION

SUSAN DALY, PRESIDENT
JON BEQUETTE, VICE PRESIDENT
GREG COTTON, TREASURER
JUDY GEORGE, BOARD SECRETARY

DAVID ATTON, MEMBER
STEVE KOHRYOHANN, MEMBER
SHANDA NICHOLS, MEMBER
PAUL PRIVO, MEMBER



HARRISBURG R-VIII SCHOOL DISTRICT

Home of the Bulldogs

November 4, 2015

Ms. Susan Galeota
Mid-MO RPC
206 E Broadway, PO Box 1140
Ashland, MO 65010

Re: Adoption of Boone County Hazard Mitigation Plan 2015

Dear Susan,

The purpose of this letter is to inform you that the Harrisburg R-VIII Board of Education formally adopted the Boone County Hazard Mitigation Plan at its October 12, 2015 meeting. A copy of the Board minutes is enclosed. Please don't hesitate to contact me if you need additional information.

Our school district appreciates the time and effort put into the development of this plan. We are thankful for being allowed to be part of the process.

Sincerely,

Lynn Proctor
Superintendent

Enclosure



Christopher Felmlee
Superintendent of Schools
303 North Main Street
Ashland, MO 65010

Telephone: 573-657-2147
Fax: 573-657-5513
Email: cfelmlee@ashland.k12.mo.us

October 21, 2015

Susan Galeota
Regional Planner
Mid-Missouri Regional Planning Commission
206 E. Broadway, PO Box 140
Ashland, MO 65010

Dear Mrs. Galeota,

Please use this letter as official documentation that the Southern Boone County R-I School District has formally adopted the Boone County Hazard Mitigation Plan on October 19, 2015 during the District's regular school board meeting.

Thank you very much for your time and the opportunity to be a part of the team that made revisions and updates to the countywide plan.

Please feel free to call me if I can be of assistance, or if you have questions or concerns.

Respectfully,

A handwritten signature in black ink, appearing to read "Chris Felmlee", is written over the word "Respectfully,".

Christopher Felmlee
Superintendent of Schools
Southern Boone School District

Sturgeon R-V Schools

210 W Patton Street

Phone (573) 687-3515

Fax (573) 687-2116

Sturgeon, Missouri 65284

Board of Education

Tim Parkinson- Pres.

Mike Guilford-V. Pres.

Kevin Smith-Treas.

Heather Dougherty- Mbr.

Misty Doss-Mbr.

Charles King-Mbr.

Denise Flaspholer-Mbr.

Peggy Leerhoff- Sec.

Superintendent

Shawn C. Schultz

High School Principal

Becky Schafer

K-8 Principal

Brandee Brown

K-12 Curr. Director

Jeff Carr

Special Education

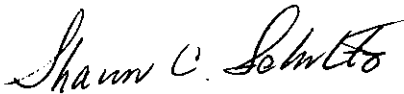
Director- Penny Fadler

11/17/2015

Dear Mrs. Galeota:

I want to take a moment of your time to inform you that the Sturgeon R-V School board recently adopted the Boone County Hazard Mitigation Plan. This plan was adopted by the school board on November 12, 2015 at the November regular school board meeting. If you have any questions please feel free to call me. Thank you for your time.

Yours in Education



Shawn C. Schultz

Sturgeon R-V School Superintendent



1001 Rogers Street
Columbia, MO 65216
(573) 875-8700
www.ccis.edu

October 28, 2015

Ms. Susan Galeota
Mid-Missouri Regional Planning Committee
PO Box 140
Ashland, MO 65010

RE: Adoption of Boone County Hazard Mitigation Plan 2015

Dear Ms. Galeota:

Based on our involvement in the planning process, and after thoughtful review of the resulting document, Columbia College formally adopts the Boone County Hazard Mitigation Plan. Please contact my office if you need additional information.

Respectfully,

Dr. Scott Dalrymple, President
Columbia College

Office of the President

October 22, 2015

Mid-Mo Regional Planning Commission
P.O. Box 140
Ashland, MO 65010

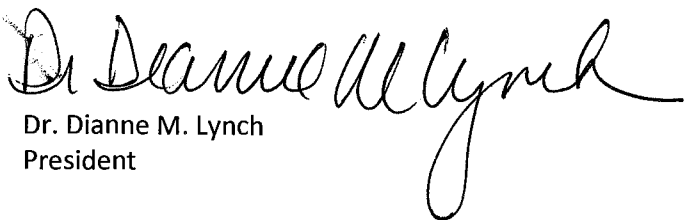
RE: Boone County Hazard Mitigation Plan

Dear Sir or Madam,

Stephens College is glad to have participated in the mandated 5-year update of the Boone County Hazard Mitigation Plan. We further recognize that this plan serves as a valuable resource for the county, communities and educational districts and institutions that it serves in the event of a natural hazard incident.

Stephens College adopts the Boone County Hazard Mitigation Plan to serve as its Hazard Mitigation Plan in the event of a natural hazard incident and will continue to assist and participate in future updates of the plan.

Sincerely,



Dr. Dianne M. Lynch
President



University of Missouri

MU Operations

305 Jesse Hall
Columbia, MO 65211

OFFICE 573-882-4097

EMAIL muvcadmin@missouri.edu

October 5, 2015

Edward J. Siegmund, Executive Director
Mid-MO Regional Planning Commission
206 E. Broadway
PO Box 140
Ashland, MO 65010

Subject: Boone County Hazard Mitigation Plan

Dear Mr. Siegmund

The Mid-MO Regional Planning Commission recently led an effort to prepare a new Boone County Hazard Mitigation Plan, dated July 20, 2015. This plan was prepared in accordance with FEMA requirements at 44C.F.R.201.6.

The University of Missouri participated in the preparation of this plan, has reviewed this plan and has been afforded an opportunity to comment and provide input on the plan and the mitigation actions therein. Further, the University of Missouri affirms that it will participate in efforts to update this plan no less than once every five years.

As a result, I am confirming that the University of Missouri adopts the Boone County Hazard Mitigation Plan as its Hazard Mitigation Plan and intends to execute the actions committed to in this plan.

Sincerely,

A handwritten signature in black ink, appearing to read 'Gary L. Ward', written over a horizontal line.

Gary L. Ward
Vice Chancellor for Operations and Chief Operating Officer

Log of Post-Adoption Changes to Plan

[illegible]

List of Major Acronyms Used in Plan

ACS – American Community Survey
ARES® - Amateur Radio Emergency Service
BCA – Benefit Cost Analysis
BCFPD – Boone County Fire Protection District
BEJC – Boone County Joint Communications
BCRSD – Boone County Regional Sewer District
BEC – Boone Electric Coop
CDC – Centers for Disease Control and Prevention
CFR – Code of Federal Regulations
CDBG – Community Development Block Grant
COOP – Continuity of Operations Plan
CSIP – Comprehensive School Improvement Plan
DDoS - Distributed Denial of Service
DED – Department of Economic Development
DHSS - Department of Health and Senior Services
DNR – Department of Natural Resources
EAP – Emergency Action Plan
ECC – Emergency Communications Center
EF – Enhanced Fujita
EHS – Environmental Health and Safety
EMD – Emergency Management Director
EMS – Emergency Medical Services
EOC – Emergency Operations Center
EOP - Emergency Operations Plan
EPA – Environmental Protection Agency
FAA – Federal Aviation Administration
FBI – Federal Bureau of Investigation
FCC – Federal Communications Commission
FDA – Food and Drug Administration
FEMA - Federal Emergency Management Agency
FIRM - Flood Insurance Rate Map
FMA – Flood Mitigation Assistance
GETS – Government Emergency Telecommunications Service
GIS – Geographic Information System
HAZUS/HAZUS-MH - Risk assessment software program for analyzing potential losses from floods, hurricane winds and earthquakes
HMEP – Hazardous Materials Emergency Plan
HMGP – Hazard Mitigation Grant Program
IT – Information Technology
LEPC - Local Emergency Planning Committee
MCED – Moniteau County Emergency Dispatch
MDFS - Missouri Division of Fire Safety
MEERTS - Missouri Environmental Emergency Response Tracking System
Mid-MO RPC – Mid-Missouri Regional Planning Commission

MMI - Modified Mercalli Intensity Scale
 MoDNR – Missouri Department of Natural Resources
 MoDOT – Missouri Department of Transportation
 MRED – Moniteau County Regional Economic Development Council
 MSA – Metropolitan Statistical Area
 MSBA – Missouri School Board Association
 MSHSAA - Missouri State High School Activities Association
 MU – University of Missouri
 MULES – a law enforcement computer data network used by the Missouri Highway Patrol
 MURR – University of Missouri Research Reactor
 MUSIC – Missouri United School Insurance Council
 NAWAS – National Warning System
 NCDC – National Climatic Data Center
 NDMC - National Drought Mitigation Center
 NFIP – National Flood Insurance Program
 NMSZ - New Madrid Seismic Zone
 NOAA - National Oceanic and Atmospheric Administration
 NPSTC - National Public Safety Telecommunications Council
 NWS – National Weather Service
 OEM – Office of Emergency Management
 OMB - U.S. Office of Management and Budget
 PDM - Pre-Disaster Mitigation
 PDSI - Palmer Drought Severity Index
 PHHS – Public Health and Human Services
 PHMSA – Pipeline and Hazardous Materials Safety Administration
 POD – Point of Dispersion
 PSJC – Public Safety Joint Communications
 PWD – Public Water District
 PWSD – Public Water Supply District
 RHSOC – Regional Homeland Security Oversight Committee
 RSMo – Revised Statutes of Missouri
 SAME – Specific Area Message Encoding
 SEMA - State Emergency Management Agency
 SNS – Strategic National Stockpile
 SoVI™ - Social Vulnerability Index
 SPI - Standardized Precipitation Index
 STAPLEE – a prioritization tool using Social, Technical, Administrative, Political, Legal, Economic, and Environmental factors for analysis
 TSA – Transportation Safety Administration
 USACE – United States Army Corps of Engineers
 USDA - U.S. Department of Agriculture
 USGS - United States Geological Survey
 USFWS – United States Fish and Wildlife Service
 WD – Water District
 WUI – Wildland Urban Interface

Section 1: Introduction and Planning Process

1.1 PURPOSE

The Boone County Hazard Mitigation Plan is designed as a resource for county and municipal governments, residents, developers, organizations, and others interested in controlling the potentially disastrous effects of natural hazards in Boone County. Each year natural hazards take a great toll in the United States. Boone County is not immune; it is subject to numerous natural hazards which can threaten life and property. A well-conceived mitigation strategy, developed through an inclusive and thoughtful planning process, is an important step in protecting citizens and reducing loss.

The Federal Emergency Management Agency (FEMA) defines mitigation as “sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects.” A 2006 study by the Institute for Building Science found that \$4 was saved in post-disaster response and recovery for every \$1 spent on pre-disaster mitigation.

The Boone County Hazard Mitigation Plan was developed by the communities and citizens of Boone County, their elected officials and public servants. The process was carried out by identifying the natural hazards that impact Boone County and its residents, assessing the probability of occurrence and severity posed by each hazard, identifying the most vulnerable areas, and evaluating all possible mitigation actions which might be effective. Potential mitigation actions were assessed and prioritized based on the perceived need, probable outcome, potential for being executed, and benefit related to cost.

The plan was developed in accordance with FEMA’s Mitigation Planning regulations under Code of Federal Regulations (CFR), Title 44, Part 201.6, *Local Mitigation Plans*. Relevant requirements from CFR §201.6 are highlighted throughout the plan.

Multiple jurisdictions within Boone County participated in the development of this plan. Having a current and approved hazard mitigation plan makes each of the participating jurisdictions eligible to apply for FEMA pre-disaster mitigation grants and the mitigation portion of post-disaster mitigation grants.

1.2 BACKGROUND

Responding to and mitigating for natural disasters has been a subject of increasing focus for the federal government in the past decades.

The process for declaring Presidential Disasters was established with the passage of the Disaster Relief Act of 1974. In 1988, the Robert T. Stafford Disaster Relief and Emergency Assistance Act created the organizational framework through which funds and assistance would be provided after a Presidential Disaster Declaration; FEMA was designated to coordinate the relief efforts.

In 1993, FEMA created the Mitigation Directorate to oversee hazard mitigation. This established mitigation as the cornerstone of emergency management.

The Disaster Mitigation Act of 2000 further defined activities related to disaster relief and mitigation; one of its provisions encourages development of hazard mitigation measures, including land use and construction regulations.

1.3 HISTORY OF THE BOONE COUNTY HAZARD MITIGATION PLAN

In November 2003, a “current and approved” hazard mitigation plan became a FEMA eligibility requirement for local jurisdictions applying for pre-disaster mitigation grants and the mitigation portion of post-disaster grant funds.

Due to this change in FEMA grant requirements, the Missouri State Emergency Management Agency (SEMA) contracted with the Missouri Council of Governments for the Regional Planning Commissions to direct hazard mitigation planning for interested counties within their respective regions. Boone County, a member of the Mid-Missouri Regional Planning Commission (Mid-MO RPC), contracted with the Mid-MO RPC to facilitate the development of a hazard mitigation plan for the county.

A Project Steering Committee was formed to oversee the planning and writing of the original Boone County Hazard Mitigation Plan in 2004. The initial plan was approved by FEMA and adopted by the participating jurisdictions in the spring of 2005.

The required 5-year update of the plan was undertaken in the spring of 2009 and the updated plan was approved by FEMA on November 8, 2010. Participation in the planning process within the county increased significantly; the updated plan included 14 “participating jurisdictions” adopting the mitigation plan as their own. In addition to Boone County, this included 8 incorporated communities, 4 school districts, and the University of Missouri-Columbia.

Maintenance of Hazard Mitigation Plan 2010 -2015

The Boone County Hazard Mitigation Plan 2010 was written to be a working document to guide participating jurisdictions in the county in the work of mitigating potential hazards. To this effect, the plan has been publicly available on the website of the Mid-MO RPC (www.mmrpc.org) since it was approved and adopted in 2010.

The maintenance plan in the 2010 document called for an annual monitoring and review of the plan to be facilitated by the Mid-MO RPC. This monitoring and review was carried out in early 2012 and again in the spring of 2013.

The process was as follows: The mitigation representative of each participating jurisdiction was sent an email with an attachment of the mitigation actions for the jurisdiction; a request was made for comments on the status of the actions and any other information regarding changes or development in the jurisdictions which might bear on hazard mitigation. Research was done by staff of the Mid-MO RPC on hazard events taking place since the last monitoring. After receiving responses from the participating jurisdictions, an addendum summary of the monitoring and review was included in the plan.

In addition to the yearly monitoring, the plan is available on the websites of the Columbia/Boone County Office of Emergency Management and the Mid-MO RPC. The Mid-MO RPC also disseminates information regarding mitigation grants when funding becomes available.

Nine of the mitigation actions included in the 2010 mitigation strategy have been implemented or completed at this time. A table of these completed mitigation actions is included in Section 6 of this plan (Figure 6.1). Many of the 2010 actions have been kept in the 2015 mitigation strategy either because they have not yet been completed or because they are ongoing actions which the committee wanted to highlight in the overall plan (Figure 6.3)

1.4 PARTICIPATING JURISDICTIONS

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

Planners from the Mid-MO RPC (Plan Author) developed the following criteria for a jurisdiction to qualify as a participating jurisdiction in this multijurisdictional plan:

1. Participation in planning meetings via either direct representation or by designated representative from outside the jurisdiction
2. Completion of a survey regarding capabilities, vulnerable assets, and future development
3. Development of plans for administration and implementation of mitigation actions for which the jurisdiction takes the lead
4. Formal adoption of the plan by resolution

The completion of the above criteria by jurisdictions participating in the 2010 and 2015 update planning processes are shown in Figure 1.1.

Figure 1.1

Multi-jurisdictional Plan Participants						
Jurisdiction	2010 Part. Juris.	2015 Planning Process				2015 Part. Juris.
		Meetings	Survey	Actions	Adoption	
Boone County	✓	✓	✓	✓	✓	✓
City of Ashland	✓	✓	✓	✓	✓	✓
City of Centralia	✓	✓	✓	✓	✓	✓
City of Columbia	✓	✓	✓	✓	✓	✓
City of Hallsville	✓	✓	✓	✓	✓	✓
Village of Harrisburg	✓	✓	✓	✓	✓	✓
Village of Hartsburg	✓	✓	✓	✓	✓	✓
Village of Huntsdale	-	✓	✓	✓	✓	✓
City of Rocheport	✓	✓	✓	✓	✓	✓
City of Sturgeon	✓	✓	✓	✓	✓	✓
Centralia R-VI School District	✓	✓	✓	✓	✓	✓
Columbia Public Schools	✓	✓	✓	✓	✓	✓
Hallsville R-IV School District	-	✓	✓	✓	✓	✓
Harrisburg R-VIII School District	-	✓	✓	✓	✓	✓
Southern Boone R-I School District	✓	✓	✓	✓	✓	✓
Sturgeon R-V School District	✓	✓	✓	✓	✓	✓
Columbia College	-	✓	✓	✓	✓	✓
Stephens College	✓	✓	✓	✓	✓	✓
University of Missouri	✓	✓	✓	✓	✓	✓

1.5 THE UPDATE PROCESS

Requirement §201.6(c)(1):	<i>[The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.</i>

A Hazard Mitigation Plan must be updated and adopted by the participating jurisdictions every five years to be considered current. The update of the Boone County Hazard Mitigation Plan was directed by planners from Mid-MO RPC (Plan Author) as specified in a Memorandum of Agreement (MOA) with the Missouri State Emergency Management Agency (SEMA).

The general update planning process was as follows:

1. Letter to all jurisdictions asking for a resolution of participation in update planning process and appointment of representative to sit on planning committee (June 2014)
2. Preliminary discussions with SEMA re: update (July 1, 2014)
3. Preliminary discussions with Boone County Emergency Management re: update (Sept. 18, 2014)
4. MOA for update finalized and signed (Oct. 1, 2014)
5. Planning Committee meetings (Nov. 2014- May 2015)
6. Survey to officials of participating jurisdictions on capabilities, vulnerable assets, and future development (January 2015)
7. Public Presentation #1 (March 11, 2015)
8. Implementation strategies for mitigation actions within jurisdictions (April – May 2015)
9. Public Presentation #2 (May 13, 2015)
10. Final plan drafting and review (May-June 2015)
11. Draft of update submitted to SEMA (June 2015)
12. First participating jurisdiction adopts plan (July 2015)
13. Final plan submitted to FEMA (via SEMA) for approval (August 2015)
14. Other participating jurisdictions adopt plan (August-Sept. 2015)

Planning Committee

The planning representatives for each jurisdiction are shown in Figure 1.2.

Figure 1.2

Jurisdictional Planning Representatives		
Jurisdiction	Planning Representatives	Position
Boone County	Josh Creamer	Emergency Management/BCFPD
	Jason Warzinik	GIS
	Ryland Rodes	Resource Management, Planning Division, Planner
	Derin Campbell	Resource Management, Engineering Division, Chief Engineer
	Chet Dunn	Public Works, Maintenance Operations Manager
	Rebecca Estes	Dept. of Public Health & Human Services, Sr. Planner
	Scott Shelton	Director, 911/Joint Communications
City of Ashland	Josh Hawkins	City Administrator
	Lyn Woolford	Police Chief
City of Centralia	Matt Harline	City Administrator
City of Columbia	Steve Hunt	Public Works, Engineering Supervisor
	Rachel Bacon	Community Development, Planner
	Tyler Avis	Community Development, GIS Aide
	Mike Parks	Columbia Regional Airport, Operations Supervisor
City of Hallsville	Darren Maher	Alderman
Village of Harrisburg	Reggie Wilhite	Board of Trustees, Chair
Village of Hartsburg	Bob Brown	Mayor
Village of Huntsdale	Debby Lancaster	Mayor
City of Rocheport	Josh Creamer/Scott Olsen	Emergency Mgmt/BCFPD
City of Sturgeon	Gene Kelly	Mayor
Centralia R-VI School District	Darin Ford	Superintendent
	Alyson Brooks	School Resource Officer
Columbia Public Schools	John White	Coordinator of Safety and Security
Hallsville R-IV School District	John Robertson	Superintendent
Harrisburg R-VIII School District	Lynn Proctor	Superintendent
Southern Boone School District	Chris Felmlee	Superintendent
Sturgeon R-V School District	Shawn Schulz	Superintendent
Columbia College	Bob Klausmeyer	Director of Campus Safety
Stephens College	Tony Coleman	Director of Campus Security
University of Missouri	Eric Evans	Emergency Management Coordinator

The City of Rocheport was represented at the planning committee meetings by the Office of Emergency Management; a letter designating this representation is included in Appendix A. In addition to the Planning Committee, the following made significant contributions to the update of the plan: Kenny Mohr, Chief Appraiser, Boone County Assessor's Office; Doug Westhoff, Chair, Boone County Local Emergency Planning Committee (LEPC); Jack Crawford, Assistant Director, Environmental Health and Safety (EHS), University of Missouri; and Tom Wellman, City of Columbia Dept. of Public Works, Storm Water Utility.

The lead planner for the update was Susan Galeota, Regional Planner at the Mid-MO RPC; Katrina Thomas, Regional Planner/GIS Specialist at the Mid-MO RPC provided mapping services.

Planning Committee Meetings

Regular meetings of the Planning Committee were held from November 2014 through May 2015. A brief summary of each meeting is shown in Figure 1.3. Meeting announcements and sign-in sheets are included in Appendix A.

All hazard mitigation planning meetings were open to the public and public notice was provided in accordance with Missouri’s “Sunshine Law” (Revised Statutes of Missouri 610.010, 610.020, 610.023, and 610.024.) Notice of each meeting was posted at the Roger B. Wilson Boone County Government Center in Columbia, the Mid-MO RPC in Ashland, and on the website of the Mid-MO RPC (www.mmrpc.org).

Figure 1.3		
Planning Meetings		
Meeting	Agenda	Meeting Date
1	General introduction: Overview and history of Boone County Hazard Mitigation Plan; participating jurisdiction requirements/benefits; issues FEMA would like to see addressed in update.	Nov. 14, 2014
	Discussion and consensus on: inclusion of technological/human-made hazards and restructuring parts of plan to enhance organization.	
	Brainstorming: outreach to neighboring counties/communities, agencies, businesses, nonprofits, etc;	
2	Review of mitigation actions from 2010 plan.	Dec. 9, 2014
3	Review of update progress; overview of maps included in update; jurisdictional surveys distributed to representatives.	Jan. 13, 2015
	Discussion of new hazards to be included in plan: Utility Disruption, Active Shooter, Cyber Attack.	
4	Discussion of new hazards to be included in plan: Public Health Emergencies, Nuclear Incident, Transportation Incident, Telecommunications Disruption	Feb. 27, 2015
5	Discussion of new hazards to be included in plan: Terrorism, Mass Casualty/Fatality Events	March 17, 2015
	Discussion/review of new actions for technological/human-made hazards	
	STAPLEE, Benefit/Cost reviews and prioritization of all mitigation actions	
6	Brainstorm possible actions needed if widespread, destructive disaster occurred in planning area.	April 7, 2015
	Review mitigation strategy to determine applicable jurisdictions and appropriate leads for all actions.	
7	Discussion of inclusion of climate change effects on hazards; review of overall vulnerability and maintenance of plan; discussion of funding possibilities/challenges; review of submission, approval, and adoption process	May 5, 2015

Summary of Update

The Planning Committee made the following general decisions regarding the update of the plan:

1. Technological and human-made disasters would be included in the updated plan to make it an all hazards mitigation plan. This will allow all mitigation planning to be done within the same planning process and documented in the same plan.
2. The effect of climate change on hazards profiled would be considered in the update.
3. Certain sections of the plan would be reorganized for better flow and organization of the material.

A general description of changes and updates made to the plan are shown in Figure 1.4.

Figure 1.4					
General Review and Update of Plan by Section					
Description	Revised	Section (2010)	Pages (2010)	Section (2015)	Pages (2015)
Section 1: Introduction and Planning Process Changes: Update of process, participants, etc.	Yes	1	3-17	1	31-44
Section 2: Planning Area Profile and Capabilities Changes: Section restructured for ease of use.	Yes	2	18-51	2	45-66
Section 3: Risk Assessment Changes: This section has been divided into three sections: The asset information from Section 3.3 (2010 plan) is Section 3 (2015 plan). The natural hazard profiles and vulnerability summaries are now Section 4. A risk assessment of technological/human-made hazards has been added to the plan as Section 5.	Yes	3	52-192	3	67-128
				4	129-284
				5	285-342
Section 4: Mitigation Strategy Changes: Strategy updated; this is now Section 6.	Yes	4	193-300	6	343-426
Section 5: Plan Maintenance Process Changes: This is now Section 7.	Yes	5	301-308	7	427-430
Section 6: Maps Changes: Section eliminated; maps integrated throughout plan	Yes	6	309-330	not applicable	not applicable
Appendices Changes:	Yes	App.	331-405	Appendices	

Data Gaps Identified in 2010 Plan

Dam Failure

2010 Plan: “Information from the mapping of the high hazards dams in the county should be completed before 2015. Emergency Action Plans (EAPs) may have been written for some, or all, of the regulated dams in the county by this time. The following sites may be helpful in obtaining current information on the progress of this work: DNR’s Dam Safety Program (<http://www.dnr.mo.gov/env/wrc/damsft/damsfthp.htm>) and DamSafetyAction.org).”

2015 Update: According to an April 2015 conversation between the Mid-MO RPC Lead Planner and Glenn Lloyd, Civil Engineer and Dam Safety Inspector with the Dam Safety Program of the MO Department of Natural Resources (DNR), EAPs for 345 out of the 397 regulated high hazard water dams in the state have been completed.; this number includes most of the required EAPs in the planning area. More detailed information is not currently available but will become available sometime in 2016 when the statewide data is finalized.

Flood

2010 Plan: “HAZUS mapping is not currently available for Huntsdale. If this becomes available, it should be incorporated into the 2015 update.”

2015 Update: In 2010, MO SEMA provided the HAZUS maps used in the flooding section. The decision was made to forego HAZUS data and maps for the 2015 update of the plan (except when incorporating HAZUS analysis from the *MO State Hazard Mitigation Plan*). This decision was made because it was found that the previously used HAZUS data was very inaccurate at the local level. While HAZUS has been updated, and may be more locally accurate at this point, staff time and resources are not currently available to even explore the issue. The decision was made to include flood maps from the FEMA National Flood Hazard Layer online system and FIRMettes instead of the HAZUS maps for the 2015.

Levee Failure

2010 Plan: “There are some data gaps in assessing vulnerability to levee failure which, while not critical to gaining an overall perspective on vulnerability, would increase accuracy if available. Inundation information is not readily available for areas protected by levee districts and areas protected by non-district or private levees are not known.”

The US Army Corps of Engineers, working with the FEMA and other federal, state, and local agencies, assembled a Regional Interagency Levee Task Force (ILTF) in 2008 to provide a uniform approach across the area impacted by flooding in the Midwest. Data is currently being updated and made more available through this task force. The following website may be helpful in providing the most current information on levee failure during the 2015 update: <http://www.iwr.usace.army.mil/iltf/index.cfm>.”

2015 Update: While the above referenced link is no longer viable, the most recent USACE mapping and inspection data for the major levees in the planning area has been included in the plan. Information on non-district and private levees is still not available.

Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;*

Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process;*

Outreach to Local Emergency Planning Committees

Outreach was made to the following committees:

1. Boone County Health and Medical Emergency Committee – RPC planner attended Dec. 17, 2014 meeting to discuss the mitigation plan and the inclusion of public health emergencies as a threat in the plan. The committee was receptive to assisting with planning needs.
2. Boone County Local Emergency Planning Committee – RPC planner attended Jan. 28, 2015 quarterly meeting to discuss mitigation plan and the inclusion of hazardous materials release and transportation incidents as threats in the plan. The committees agreed to review and give input on these sections.
3. Region F Emergency Management Director (EMD) meeting – RPC planner attended Feb. 17, 2015 meeting to discuss the mitigation plan and the inclusion of technological/human-made hazards to make it an all-hazards mitigation plan. Discussion was opened up for any input from the EMDs of the region on the Boone County plan.

Public Meetings for Comment and Input

All hazard mitigation planning meetings were open to the public and public notice was provided in accordance with Missouri’s “Sunshine Law” (Revised Statutes of Missouri 610.010, 610.020, 610.023, and 610.024.)

The following two presentations/meetings were held with the specific purposes of raising public awareness of the hazard mitigation plan update process and seeking public comment and input:

1. Public Presentation/Meeting - March 11, 2015, Boone County Fire Protection District headquarters in Columbia. This first presentation/meeting was held after the preliminary work was done on incorporating technological and human-made disasters into the plan.

2. Public Presentation/Meeting – May 13, 2015, County Commission Chambers, Roger B. Wilson Boone County Government Center in Columbia. This second meeting was held after a draft of the updated mitigation strategy had been completed.

The public presentations/meetings were advertised with a press release put out by the Boone County Emergency Management Agency; this was sent to numerous media outlets and agencies in Boone County and the surrounding area. In addition, the meetings were announced on the front page of the Mid-MO RPC website and posted at both the Mid-MO RPC in Ashland and the Roger B. Wilson Boone County Government Center in Columbia.

It was emphasized at the meetings that the current draft of the update is always available online at: www.mmrpc.org (Library Section).

The meetings received widespread media coverage which, while not always entirely accurate, served to increase the awareness of the plan and planning process. Prior to the first public presentation, a live interview with the lead planner was carried on a radio station in adjacent Audrain County to the north; stories after the first public presentation were carried on the 6 o'clock news (KOMU-TV Columbia), KBIA public radio (Columbia), and the Columbia Tribune newspaper. An extensive article on the hazard mitigation plan was published on the front page of the Columbia Tribune after the second presentation.

Documentation of the public presentations/meetings is included in Appendix A.

Comments Received from the Public

The Boone County Commission received a memo from Mr. Ted Craig (Appendix A) providing input on various issues in the plan. The RPC planner followed up with Mr. Craig and Stan Shawver, Director of Resource Management for Boone County, regarding the issues raised in the memo. The main points are discussed below:

1. Boone County should require mobile home parks to have storm shelters.

There have been no applications for new mobile home parks in Boone County in a very long time, according to Stan Shawver. Land is expensive in the county and it would be surprising if a new mobile home park wanted to locate in Boone County. However, if this would happen, the developer would need to obtain a conditional permit from the county and providing adequate tornado safe room space would be a reasonable requirement which could be included in the permit.

2. Boone County should implement a plan for post earthquake inspection of bridges on county maintained roads.

Boone County has a bridge engineer on staff who could quickly train other staff to conduct preliminary bridge assessments. Ultimately, MoDOT will be responsible for the inspection of Boone County bridges after an earthquake event affecting the county.

3. The difference between land subsidence from failed sewer and water lines and actual sinkholes should be clearly delineated in the plan.

This is clearly covered in the plan.

4. Mine subsidence is not mentioned in the plan and needs to be.

The plan does include a map showing potential subsidence areas for both sinkholes and underground mines obtained from MoDNR data layers. More textual information regarding mining in Boone County has now been included in the text of the plan; this information was provided by Mr. Craig who has a background in geology.

5. The future potential for fracking in northern Boone County. This was not mentioned in the original memo sent to the County Commission but came up during the follow-up phone conversation. This issue has been noted and discussed in Section 7.2 so that it can be followed up on during the 2020 update of the hazard mitigation plan.

Requirement §201.6(b):	<i>In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.</i>

Many existing plans, studies, and reports were consulted in the development of this plan. These include:

- *2040 Long-Range Transportation Plan*, Columbia Area Transportation Study Organization (CATSO), 2014
- *A Study of Active Shooter Incidents in the United States Between 2000 and 2013*, Federal Bureau of Investigation
- *Atlas of Missouri Ecoregions*, Missouri Department of Conservation
- *Bonne Femme Watershed Plan (2007)*
- *Boone County Emergency Operations Plan (2012)*
- *Business Continuity Plan (2013)*, Columbia/Boone County Public Health and Human Services
- *Columbia Imagined, 2013*
- *Communicating Before and After a Nuclear Power Plant Incident (June 2013)*, FEMA
- *Comprehensive Economic Development Strategy for the Mid-MO Region (2009)*, Mid-MO Regional Planning Commission
- *Hazard Vulnerability Analysis*, Columbia/Boone County Public Health and Human Services
- *Hinkson Creek Watershed Management Plan*
- *Long Range Transportation Plan (LRTP)*, Missouri Department of Transportation
- *Missouri Drought Plan (2002)*, Missouri Department of Natural Resources
- *Missouri – Region F Regional Communication Interoperability Plan (R-CIP)(2015)*
- *Missouri State Hazard Mitigation Plan (2013)*, Missouri State Emergency Management Agency (SEMA)
- *National Climate Assessment 2014*, U.S. Global Change Research Program (GlobalChange.gov)
- *Pandemic Influenza and Highly Infection Respiratory Disease Response Plan for Boone County Missouri (2006)*, Columbia/Boone County Public Health and Human Services
- *Public Health Emergency Response Plan (2013)*, Columbia/Boone County Public Health and Human Services
- *Regional Transportation Plan (2009)*, Mid-MO Regional Planning Commission
- *Situation Reports (online)*, Missouri SEMA
- *Source Water Protection Plan, City of Columbia Missouri, 2013*
- *Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications (April 2005)*, Center for Catastrophe Preparedness and Response & Robert F. Wagner Graduate School of Public Service, New York University

Section 2: Planning Area Overview

2.1 GEOGRAPHY, GEOLOGY AND ECOLOGY

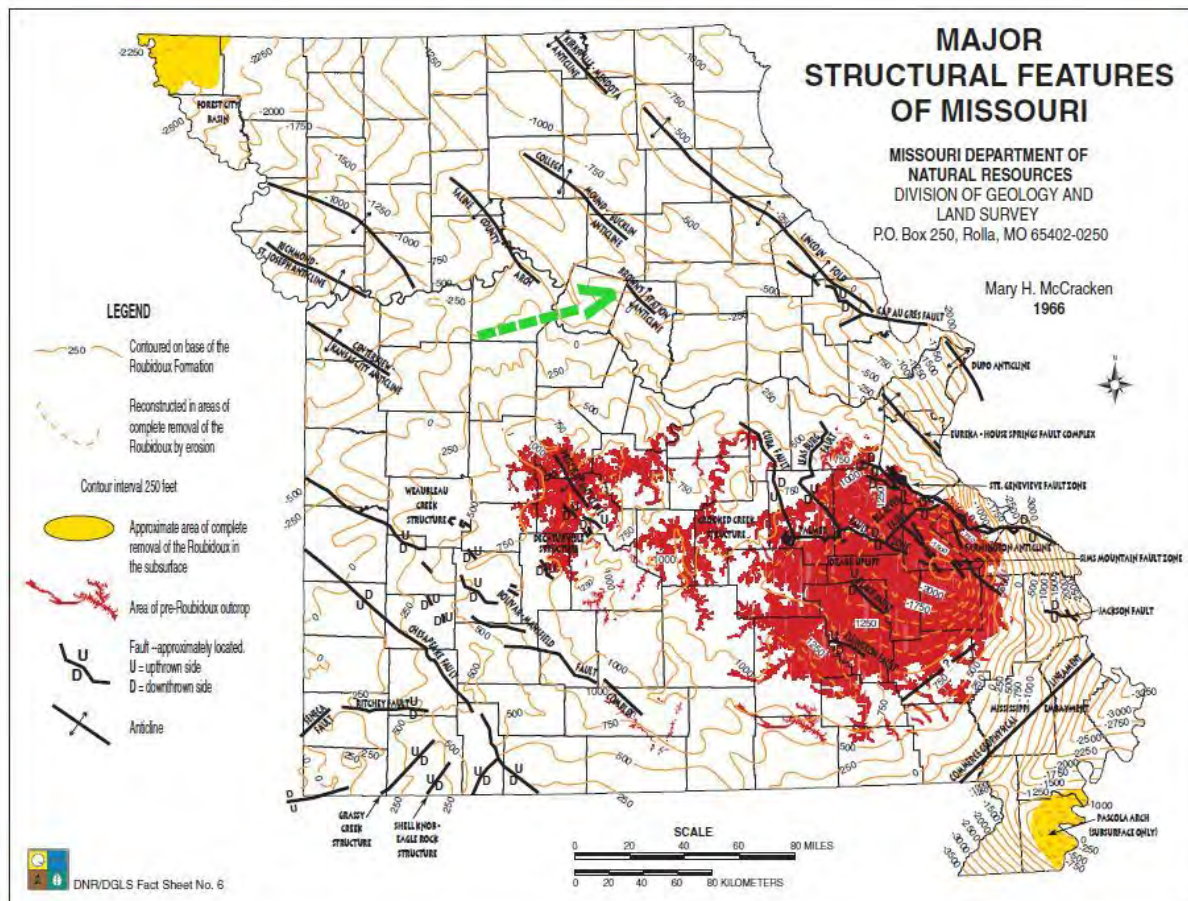
Boone County is located in central Missouri with an area covering 685 square miles. It is located midway between Kansas City to the west and St. Louis to the east. The City of Columbia is the county seat and largest population center. The incorporated communities in the county are: Ashland, Centralia, Columbia, Hallsville, Harrisburg, Hartsburg, Huntsdale, McBaine, Pierpont, Rocheport, and Sturgeon (Figure 2.1).

Figure 2.1



Geologically, Boone County has been shaped by both the Ozark Uplift in the southeastern part of the state and glaciations from the north. The Browns Station Anticline is the one major structural feature found in Boone County; it extends across the northern part of the county (Figure 2.2).

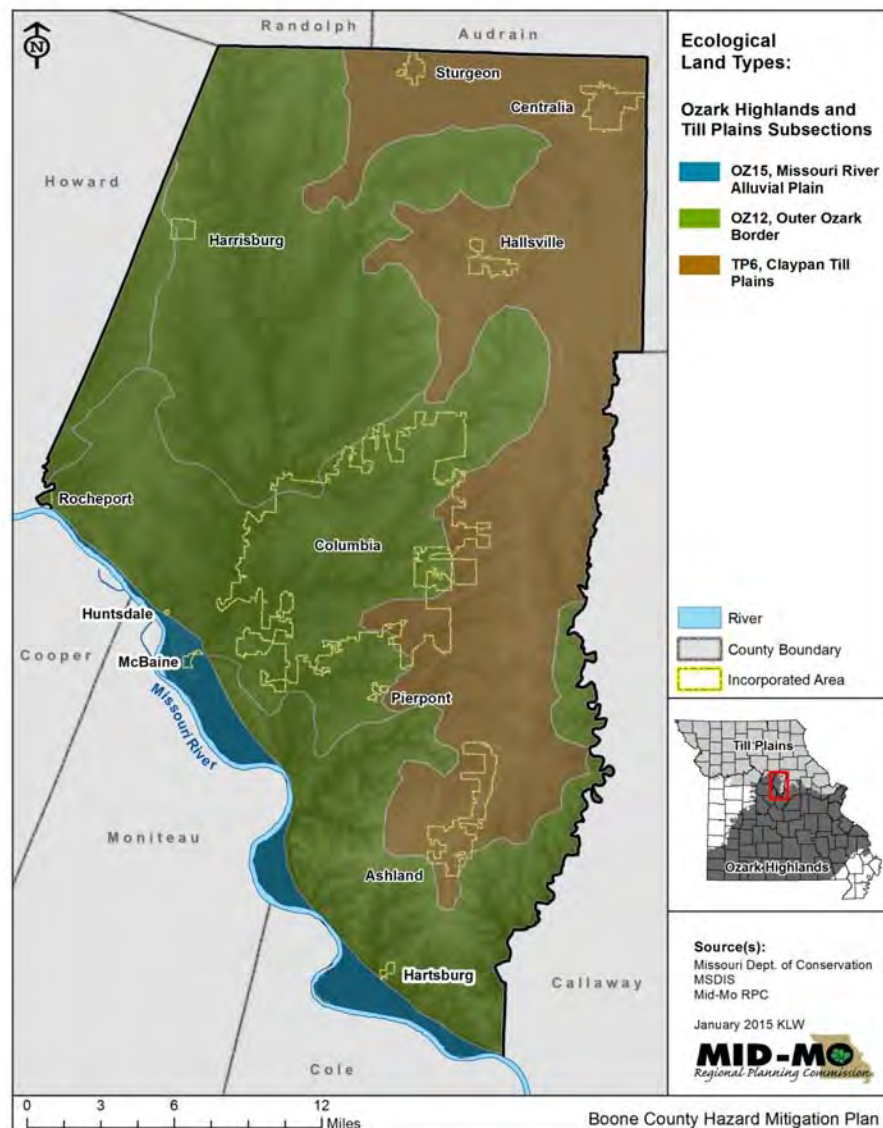
Figure 2.2



The geology of the planning area has implications for the hazards analyzed in this plan. Of particular concern is the New Madrid Seismic Zone (NMSZ) in the southeastern part of the state.

Boone County consists of three main ecological land types according to the MO Department of Conservation's *Atlas of Missouri Ecoregions* (Figure 2.3): the Claypan Till Plains, the Outer Ozark Border of the Ozark Highlands, and the Missouri River Alluvial Plain.

Figure 2.3



Claypan Till Plains

The distinguishing feature of the Claypan Till Plains is the presence of well-developed claypan soils on a flat glacial till plain. Most of the surface is flat or gently rolling with local relief less than 100 feet. Bedrock exposures are rare. This area was formerly prairie, for the most part, with narrow belts of timber along streams. Most of the subsection is now farmland and primarily cropland.

Outer Ozark Border

The Outer Ozark Border consists of a belt of deeply dissected hills (relief mostly 200-350 feet) and bluff lands bordering the Missouri River. Slopes are steep and bedrock exposures are common. Loess, occasionally very thick,

mantles the uplands of the entire subsection. The area was historically timbered in oak savanna and woodland, oak and mixed-hardwood forests, and occasional prairie and glade openings.

Karst plains are also present. Karst is defined by the United States Geological Survey (USGS) as “terrain with distinctive landforms and hydrology created from the dissolution of soluble rocks, principally limestone and dolomite. Karst terrain is characterized by springs, caves, sinkholes, and a unique hydrogeology that results in aquifers that are highly productive but extremely vulnerable to contamination.” This land type will be touched on again in the land subsidence and sinkhole hazard profile in Section 4.5.

Current land use in the Outer Ozark Border is extremely varied and includes row crops, improved pasture, and densely wooded valleys. Urbanization pressures from Columbia are great.

Missouri River Alluvial Plain The Missouri River Alluvial Plain consists of the Missouri River channel and its adjoining alluvial plain. During the last half of the 20th Century, the river was narrowed, its banks were stabilized, and most of its islands were eliminated. Soils in the area are deep and loamy. Pre-settlement vegetation was mostly bottomland forest dominated by riverfront species including willow, cottonwood, sycamore, elm, silver maple, and hackberry. The alluvial plain is subject to flooding, although many bottoms have some degree of levee protection. Today land use is chiefly row crops.

The Missouri River's relationship to Boone County deserves special attention because the river is the defining physical feature in Mid-Missouri and it surrounds the southwestern border of the county.

The Missouri River drains approximately one sixth of the United States and is the longest river in the country. Flood control structures, power plants, and other engineering projects have profoundly changed the course of the river.

Flood control structures, power plants, and other engineering projects have profoundly changed the course of the river since Lewis and Clark first traversed it in the early 1800s. In recent years debates over the future of the Missouri River have taken place among the seven states through which it runs. Commercial river traffic, recreational use, environmental concerns, managing river levels to comply with the needs of endangered species, and the preservation of sacred and historical sites along the river and floodplain are all issues which make the management of the river a sensitive balancing act.

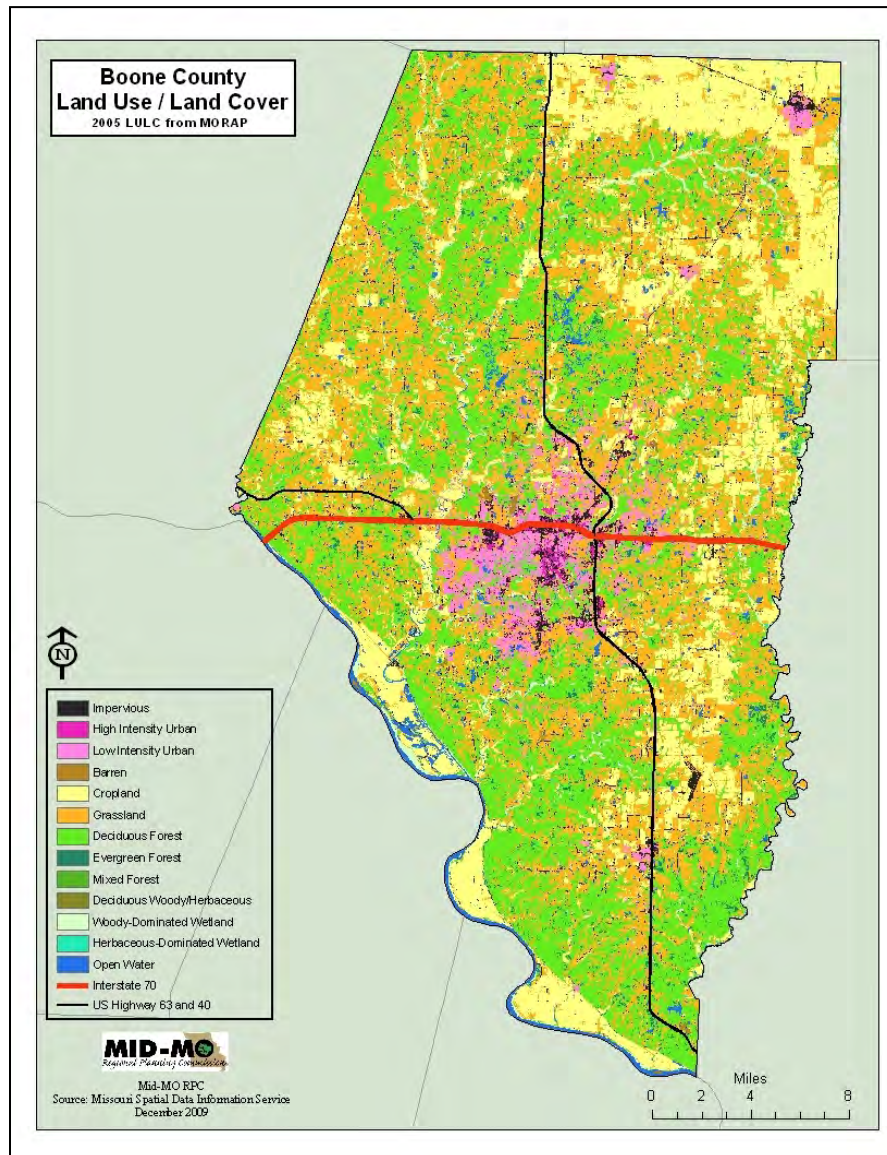
In both 1994 and 1995 the Missouri River was listed as one of the “10 Most Endangered Rivers in the Country” by American Rivers, a river conservation group (<http://www.americanrivers.org/>). This “Most Endangered” list does not reflect rivers in the worst condition; rather, it seeks to highlight rivers “confronted by decisions in the coming year that could determine their future.” The Missouri River was chosen for the list in the mid-1990s because of dam, channelization, navigation, and agricultural runoff issues.

The flooding of the river in 2011 brought the controversy over its management into sharp focus. Record snowfalls in the Rockies combined with heavy spring rains to result in record water releases from six reservoirs on the river. Flooding occurred along the river from Montana to Missouri. The U.S. Army Corps of Engineers came under sharp criticism for not releasing water earlier in the season so the reservoirs would be able to accommodate the snow melt and rains. Meetings were held throughout the Missouri River Basin where local frustration was voiced over species protection and recreation being prioritized over flood control in river management decisions.

Current Land Use

There is still significant deciduous forest in the western and southern parts of Boone County. This is interspersed with some grassland and cropland. Cropland predominates in the northernmost area of the county, in some eastern parts of the county, and in some areas along the Missouri River (Figure 2.4).

Figure 2.4



2.2 CLIMATE

Boone County lies in a Humid Temperate climate and is vulnerable to northern pressure systems in the winter and strong pressure and storm systems from the Gulf of Mexico and the Great Plains region of the central United States. While Boone County does have extreme variations in weather at times, there is a seasonal pattern.

The National Climatic Data Center (NCDC) releases “climate normals”, or averages of three decades of climate variables, every 10 years. Monthly temperature and precipitation data for the period 1981-2010 at the Columbia Regional Airport (1981-2010), located in southern Boone County, are shown in the accompanying charts (Figures 2.5-2.6).

During this period, the mean annual temperature was 54.6°F. The mean annual precipitation was 42.62 inches with a mean annual snowfall of 18.4 inches. The average January minimum temperature was 20.9°F and the average July maximum temperature was 87.6°F. The wettest months were May-September with 62.3 % of the annual precipitation occurring during these months.

Figure 2.5

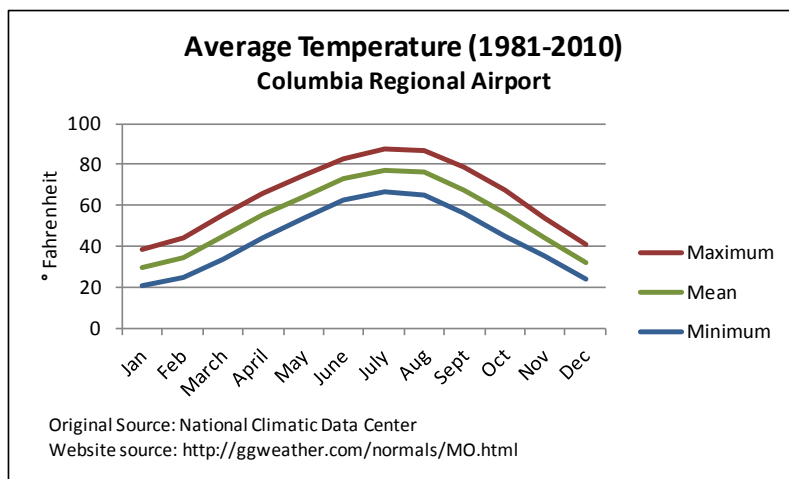
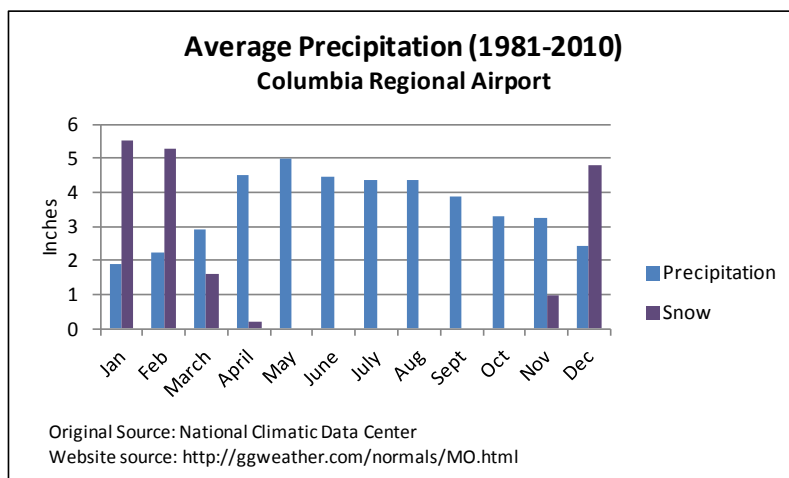


Figure 2.6



2.3 HISTORY

Boone County, presently the most populous county in central Missouri, was established in 1821. The county was named for Daniel Boone, one of the most popular icons of early American settlement.

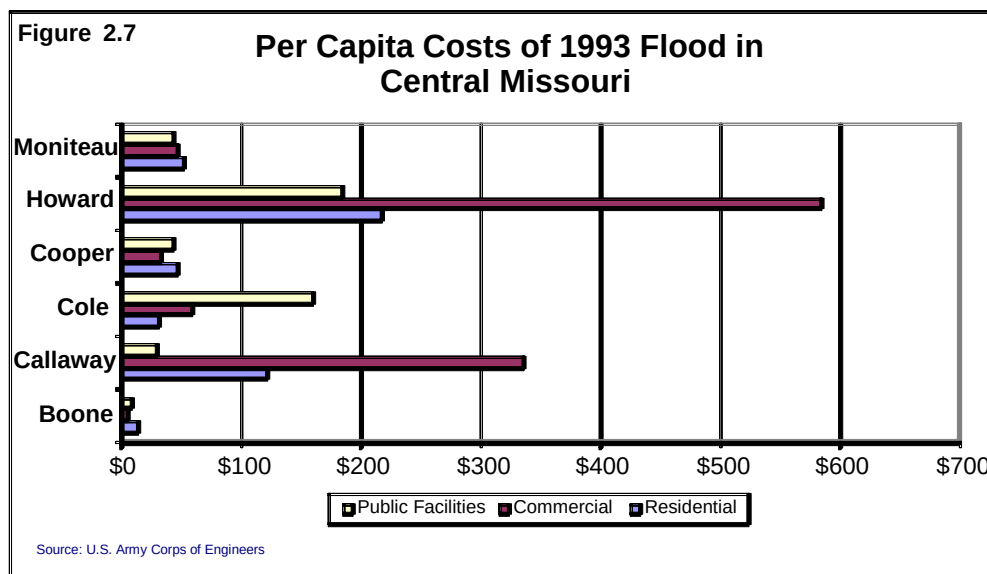
Boone County did not rise to a level of prominence in the state until the University of Missouri, the first public university west of the Mississippi, was established in Columbia in 1839. Nine hundred Boone County citizens won the bid for the university by pledging \$117,921 in cash and land. The location of the university in Columbia has meant increased development for Boone County ever since. The university continues to attract students from all over the state, country, and world to study and work in the region.

2.4 HAZARD HISTORY

Boone County has been impacted by numerous natural hazards in the past including floods, tornadoes, thunderstorms, severe winter weather, and extreme heat.

A brief overview of the more recent natural hazard events in the county will be discussed here; more extensive history will be given with each Hazard Profile in Section 3 of the plan.

The historic Missouri River Floods of 1993 and 1995 caused extensive damage in several areas of the county. Boone County fared better than other counties in the mid-Missouri region in terms of direct loss (Figure 2.7). However, Boone County is an economic and social center in the region; when surrounding counties and cities are impacted by a natural hazard; Boone County feels an associated impact.



In 1998 a tornado destroyed part of the Southridge subdivision in Columbia (Figure 2.8). There was no loss of life but property destruction was significant resulting in an approximate six million dollar loss, according to statistics from the Missouri Climate Center.

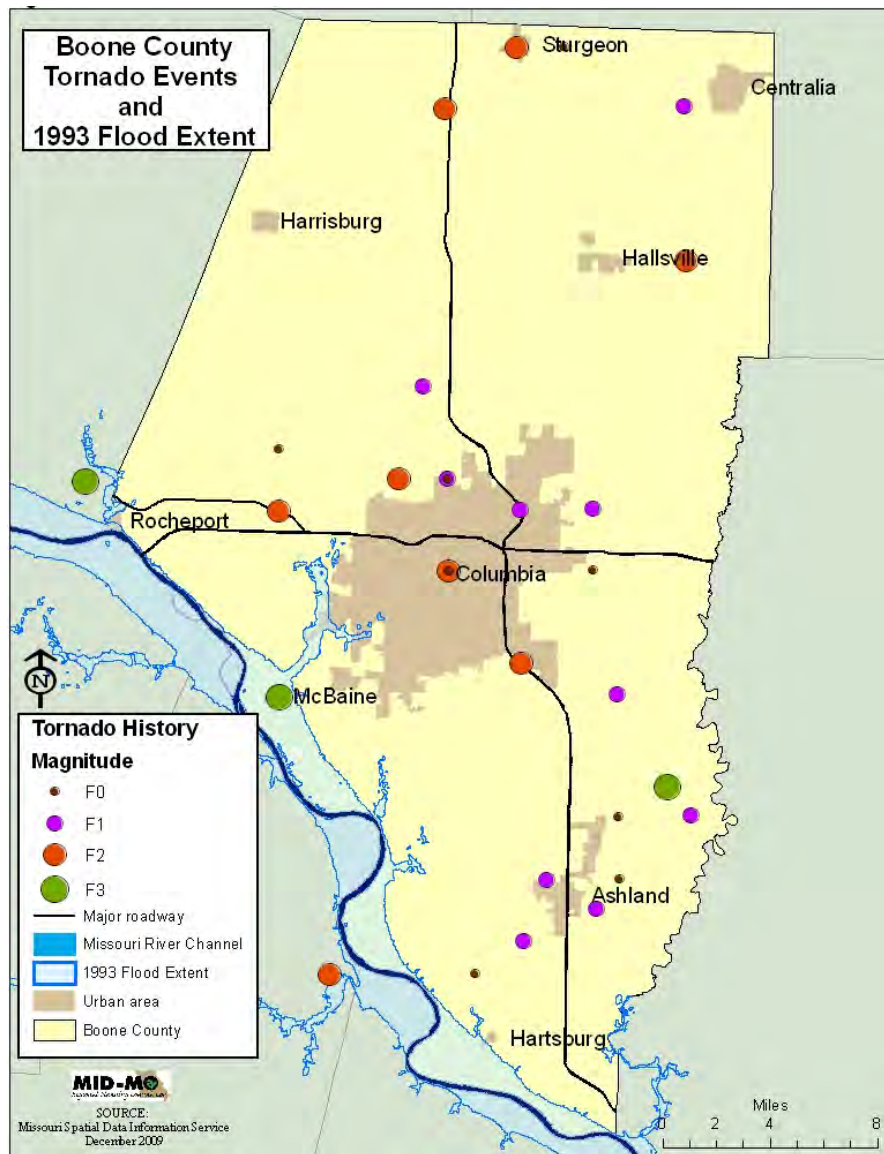
Figure 2.8



Source: www.gocolumbiamo.com

Historic tornado events and the extent of the 1993 flood in Boone County are shown in Figure 2.9.

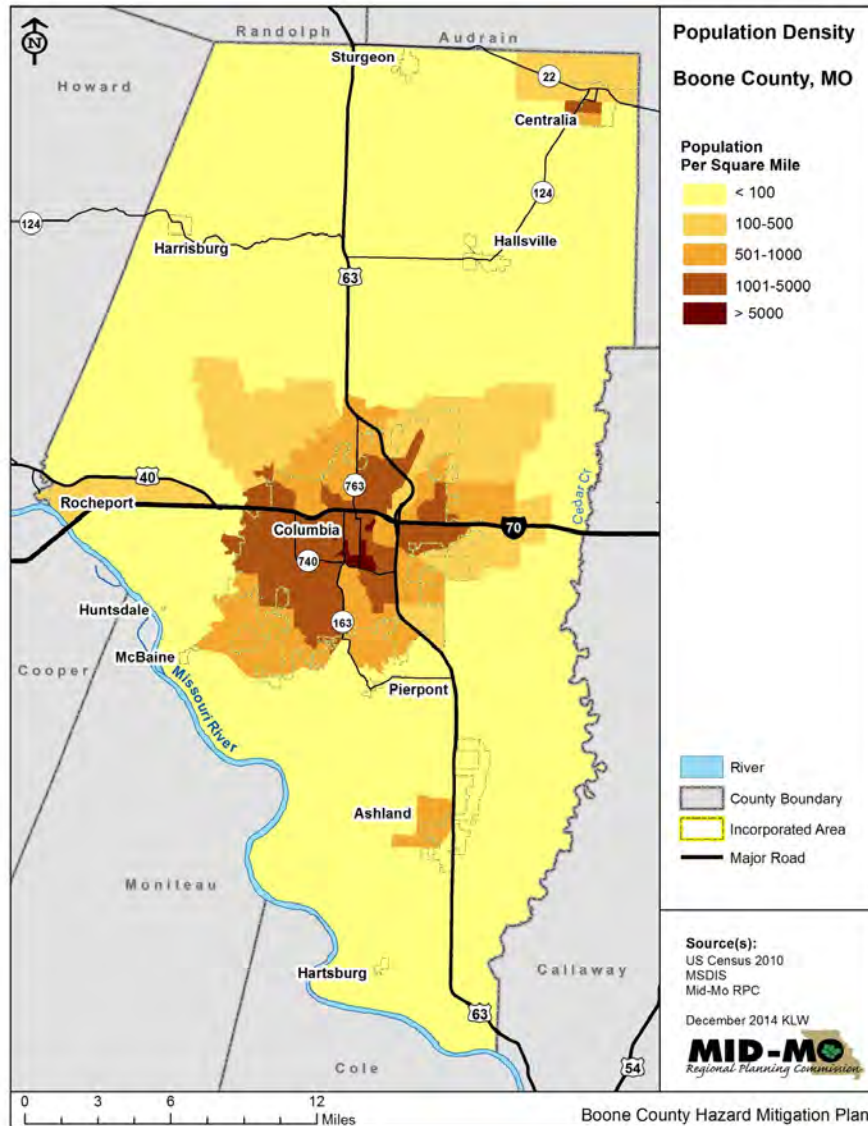
Figure 2.9



2.5 POPULATION, HOUSING AND POVERTY

A mapping of Boone County's population (2010 Census) by block group clearly illustrates that the population is centered in and around City of Columbia (Figure 2.10).

Figure 2.10



The 2010 Census indicated a rapid rise in population since the 2000 census; the population increased by 20% with a 23% increase in housing units.

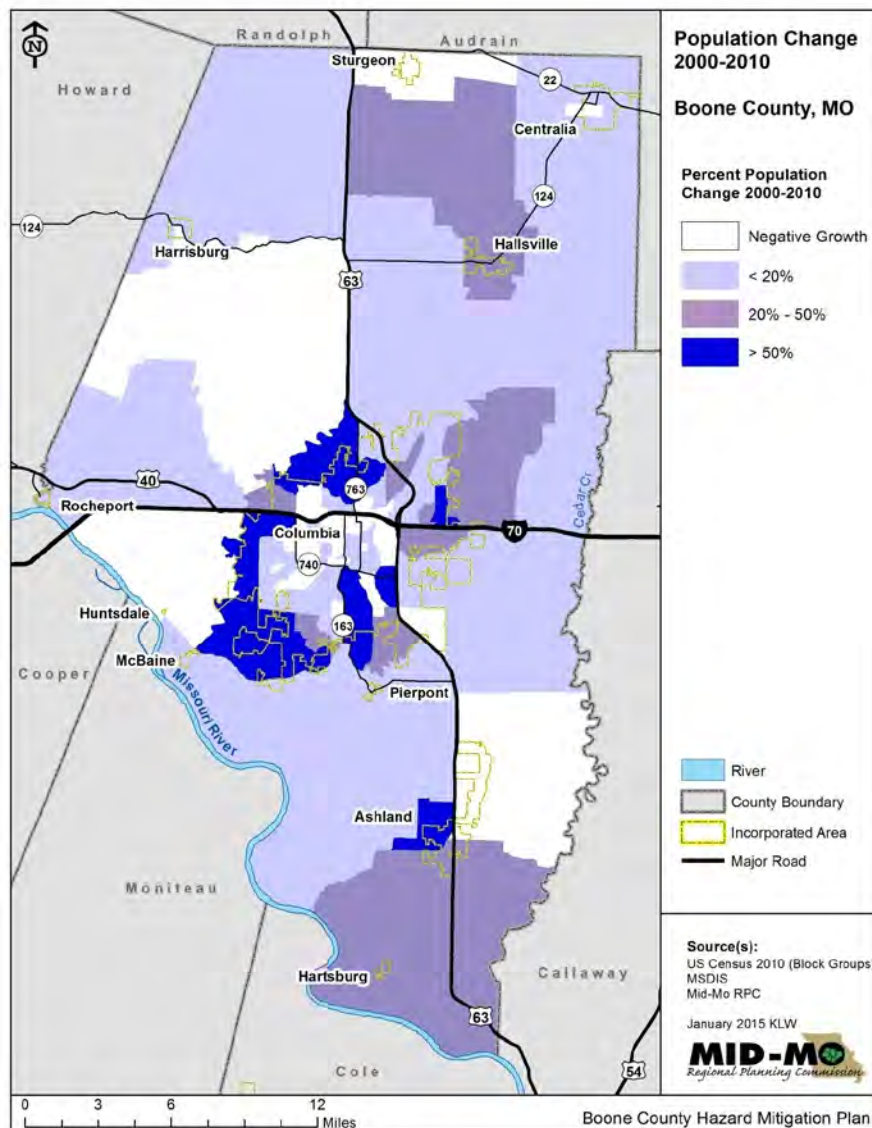
An inspection of the data in Figure 2.11 indicates that the vast majority of both the population and housing increase was within the incorporated communities; unincorporated Boone County only saw a population growth of 1% with a housing unit increase of 6%.

The highest growth rate by far was in the City of Ashland which came close to doubling both population and housing. The City of Hallsville had a 52% increase in its population.

Figure 2.11

Change in Population and Housing 2000-2010							
	Population				Housing Units		
	2010	2000	% Change		2010	2000	% Change
Boone County (total)	162,699	135,454	20%		69,551	56,678	23%
Boone County (unincorporated)	43,377	42,841	1%		18,130	17,169	6%
Ashland	3,707	1,869	98%		1,530	820	87%
Centralia	4,027	3,774	7%		1,755	1,648	6%
Columbia	108,500	84,531	28%		46,758	35,916	30%
Hallsville	1,491	978	52%		615	439	40%
Harrisburg	266	184	45%		121	86	41%
Hartsburg	103	108	-5%		59	59	0%
Huntsdale	31	26	19%		15	na	-
McBaine	10	17	-41%		7	12	-42%
Rochepoint	239	208	15%		128	122	5%
Sturgeon	872	944	-8%		401	407	-1%
na - not available							
Source: U.S. Census Bureau; na-not available							

Figure 2.12



A mapping of the population change between the two censuses (again by block group) indicates, and gives more insight into, specific areas of population growth and decline (Figure 2.12). Certain areas of central Columbia actually lost population during the period while there were very high rates of growth in southwest and north Columbia and the adjacent areas of unincorporated Boone County.

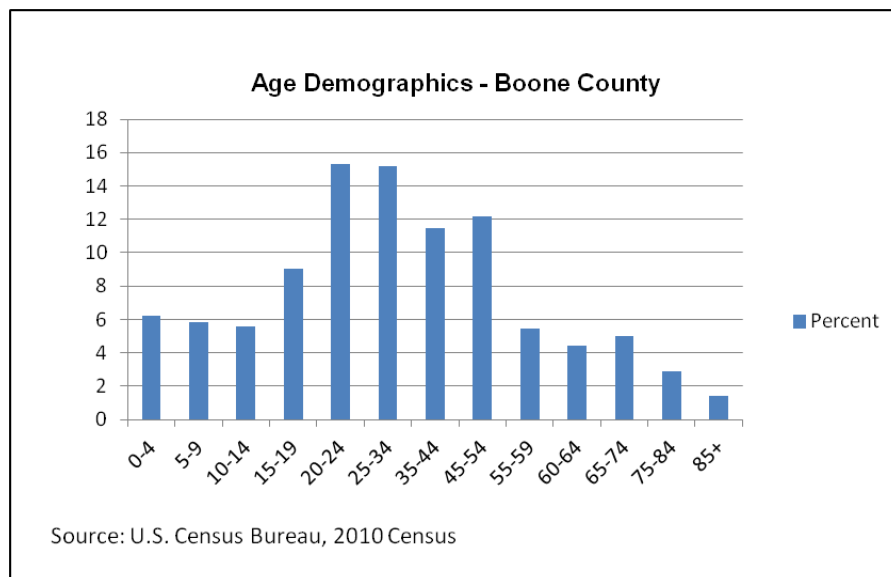
Currently, a number of economic development projects are occurring along the Highway 63 corridor between Columbia and the City of Ashland. Given the past level of growth in the two cities, the level of commuting in the Mid-Missouri region, and the fact that the Highway 63

corridor connects with Jefferson City (the state capital) to the south, it can be expected that this area will see a strong growth in population in the coming years. This growth will be made possible by the loss in the agricultural land in the area.

Vulnerable Populations

Some sectors of the population are more vulnerable in general to the threat of hazardous events. Children need the help and guidance of adults, especially in extraordinary circumstances, and this is also true for some older citizens. The 2010 Census showed 12% of the county's population under the age of 10 and over 9 % as 65 years and older (Figure 2.13.)

Figure 2.13



Those living in group quarters (Figure 2.14) are especially vulnerable in that they may need to be evacuated. Some of the elderly are grouped in specific facilities; this is also true for the seriously ill in hospitals and those recovering from health emergencies in nursing facilities. These critical facilities are listed and mapped in Section 3.1 (Figures 3.x-3.x). In addition, there are large numbers of students living in group quarters in Columbia because of the colleges and University.

Figure 2.14

Housing in Group Quarters - Boone County		
	Population	% of Total
Total Group Quarters	8,998	5.5
Institutionalized Group Quarters	1,273	0.8
Correctional Institutions	382	0.2
Nursing Homes	751	0.5
Other Institutions	140	0.1
Non Institutionalized Group Quarters	7,725	4.7
College Dormitories (includes college quarters off campus)	7,387	4.5
Military Quarters	0	0
Other	338	0.2

Source: 2010 US Census

The poor are also a vulnerable population. Poor housing conditions or lack of any housing, lack of reliable transportation and inadequate insurance can all contribute to heightening the impacts of a hazard worse for those living in poverty. Approximately 20% of the population in the planning area is below the poverty threshold, according to estimates from the American Community Survey 2009-2013 (Figure 2.15).

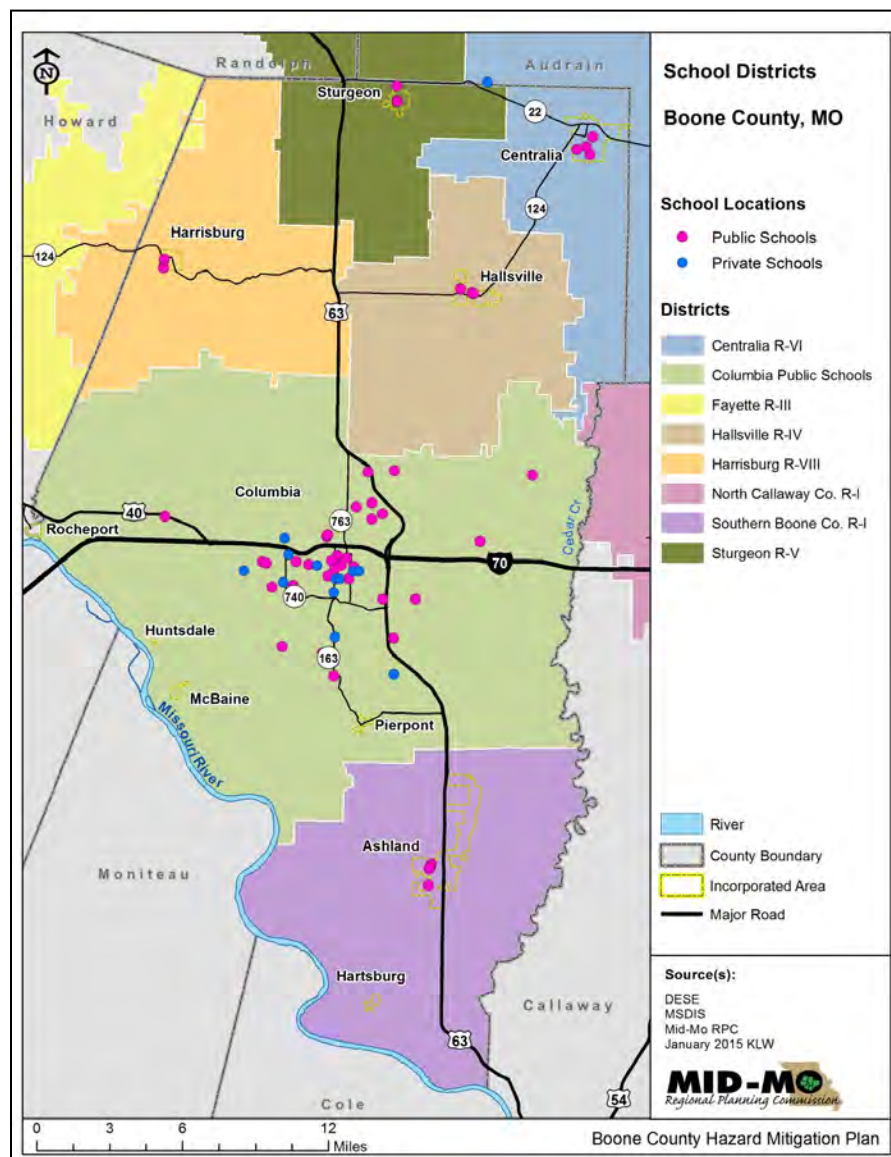
In addition, over half of those living in poverty in Boone County had a “poverty ratio” of less than 0.5. Poverty ratio is a measure calculated by dividing income by a specific poverty threshold based on age and size of family. This means that approximately 16,444 people in Boone County could double their incomes and still be below the poverty threshold.

Figure 2.15		
Poverty Status Over Last 12 Months - Boone County		
Subject	Number	%
Persons for whom poverty status is determined	156,278	
Persons below poverty	31,187	20.0
Poverty ratio under 0.5	16,444	10.5
Poverty ratio in 0.5 to 0.99	14,743	9.4
Persons under 18 for whom poverty status is determined	34,092	
Persons under 18 in poverty	5,961	17.5
Persons aged 18 to 64 for whom poverty status is determined	107,032	
Persons aged 18 to 64 in poverty	24,257	22.7
Persons over 65 for whom poverty status is determined	15,154	
Persons over 65 in poverty	969	6.4
Persons in families for whom poverty status is determined	110,476	
Persons in families in poverty	11,136	10.1
Unrelated individuals for whom poverty status is determined	45,802	
Unrelated persons in poverty 15 years and over	20,051	43.8
Source: American Community Survey, 2009-13		

2.6 EDUCATION

Students are a vulnerable population in that they are dependent on others for hazard information and safety precautions during the school day. A mitigation plan must take this into account. Often, this has been done by building schools out of floodplains and having safe areas within the school where the students can assemble in the event of a disaster. School buildings also have the potential to be built or reinforced to tornado safe room specifications and some school facilities may be used to assist with wider sheltering needs during or after a disaster.

Figure 2.16



There are six public school districts in the planning area (Figure 2.16). As of the 2013-14 school year, there were approximately 23,275 students and 2,251 certified teachers in these public school districts. There are also approximately 2,000 students served by private schools in the County, according to Private School Review.

There are also three major residential institutions of higher learning in Boone County, all located in Columbia: Columbia College, Stephens College, and the University of Missouri.

All public schools districts, both colleges, and the University of Missouri are

participating jurisdictions in this mitigation plan; detailed information on each is found in Section 3.3.

2.7 EMPLOYMENT AND INCOME

There are a high number of well-paying jobs available in Boone County in sectors such as government, higher education, and the medical field which draw workers from the surrounding counties. The vast majority of these jobs are located in Columbia, the urban core for the Columbia, Missouri Metropolitan Statistical Area (MSA).

A metro area consists of a core urban area of 50,000 or more population, the county or counties containing the core urban area, and any adjacent counties which have a high degree of social and economic integration with the urban core, as measured by commuting to work. (Metropolitan statistical areas are geographic entities defined by the U.S. Office of Management and Budget (OMB) for use by Federal statistical agencies in collecting, tabulating, and publishing Federal statistics.) The Columbia MSA is grouped with Audrain and Randolph Counties to the north to form a Combined Statistical Area (CSA).

The major, non-retail employers with the range of personnel employed are shown in Figure 2.17.

Figure 2.17			
Major Employers in Boone County			
Employer	Employees	Employer	Employees
University of Missouri	5000 & up	Boyce & Bynum Pathology Laboratories	250-499
University Hospitals & Clinics	2500-4999	ABC Laboratories, Inc.	250-499
Columbia Public Schools	1500-2499	Columbia Insurance Group	250-499
Boone Hospital Center	1500-2499	Schneider Electric: Square D	250-499
City of Columbia	1000-1499	Boone County Government	250-499
Shelter Insurance Companies	1000-1499	Midway USA	250-499
State Farm Insurance Companies	1000-1499	Boone County National Bank	250-499
U.S. Department of Veterans Affairs	1000-1499	Tribune Publishing Company	250-499
MBS Textbook Exchange	750-999	Watlow, Inc.	250-499
Veterans United Home Loans	750-999	MFA, Inc.	250-499
Columbia College	750-999	VA Mortgage Center	200-249
Hubbell Power Systems	750-999	Frito-Lay/Quaker Oats	200-249
IBM	750-999	Dana Corporation	200-249
Joe Machens Dealerships	750-999	CenturyLink	200-249
State of Missouri	750-999	Woodhaven	200-249
Kraft Foods	500-749	Mid-MO Mental Health Center	200-249
Emery Sapp & Sons, Inc.	250-499	3M	200-249
U.S. Postal Service	250-499	Missouri Employers Mutual Insurance	200-249
Source: missouricore.com; www.columbiaredi.com (2008, 2010 and 2011 data sets)			

Agriculture

Agriculture continues to be important in the economy of the planning area. However, agricultural land is being lost to development. A comparison of the 2012 and 2007 Agricultural Censuses (Figure 2.18) indicates 18,024 acres of farmland (7.0%) and 151 farms (11.4%) lost during that 5-year period. Over 240,000 acres (approximately 55%) of the county remains agricultural land.

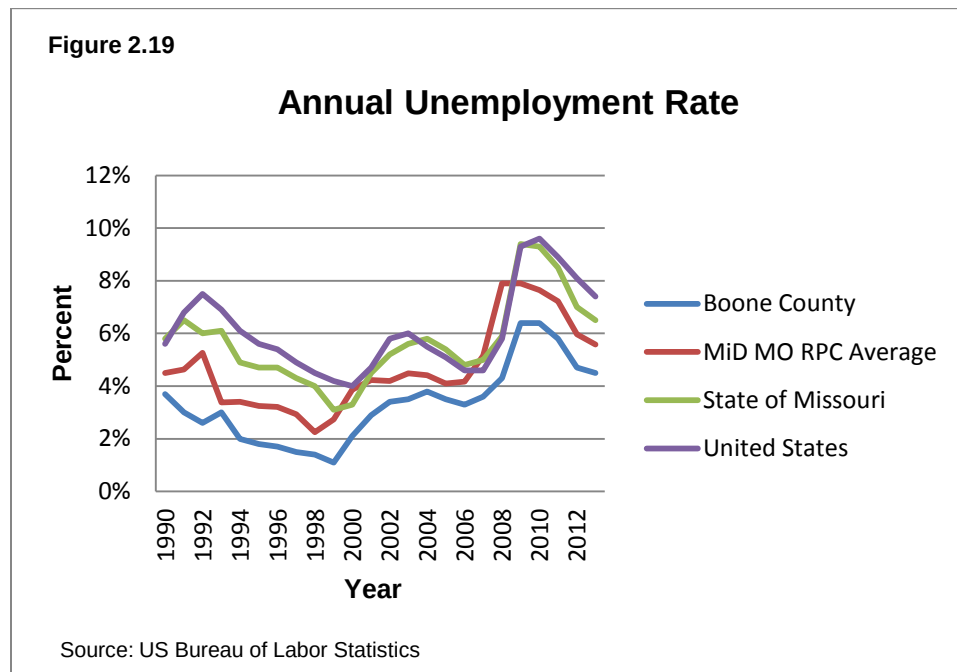
Soybeans, corn, and wheat are the top three individual crops in the county. Other crops consist of hay, sorghum, berries, fruit and nut trees, and garden vegetables. Cattle and calves and hogs and pigs are the major livestock in production.

Total agricultural sales in the County for 2012, the year of the last agricultural census, were over \$52 Million dollars.

Figure 2.18			
Agricultural Overview - Boone County			
	2012	2007	Change
Approx. land area (acres)	438,739	438,739	
Land in farms (acres)	240,710	258,734	-7.0%
Percentage in farms	54.9%	59.0%	-6.9%
Number of farms	1,171	1,322	-11.4%
Avg size of farm (acres)	206	196	5.1%
Estimated market value-land & buildings	\$877,218,000	\$725,812,000	20.9%
Avg value per farm	\$749,119	\$549,026	36.4%
Avg value per acre	\$3,644	\$2,805	29.9%
Total sales	\$52,185,000	\$45,523,000	14.6%
Average sales per farm	\$44,564,000	\$34,435,000	29.4%
Source: USDA Census of Agriculture 2007, 2012			

Unemployment

The unemployment rate in Boone County is consistently lower than the average of the Mid-Missouri region, the state of Missouri and the national average unemployment (Figure 2.19).



Income

The breakdown of household income and benefits (Figure 2.20) reflects both the multitude of well-paying jobs in the county as well as the relatively high poverty rate.

Figure 2.20

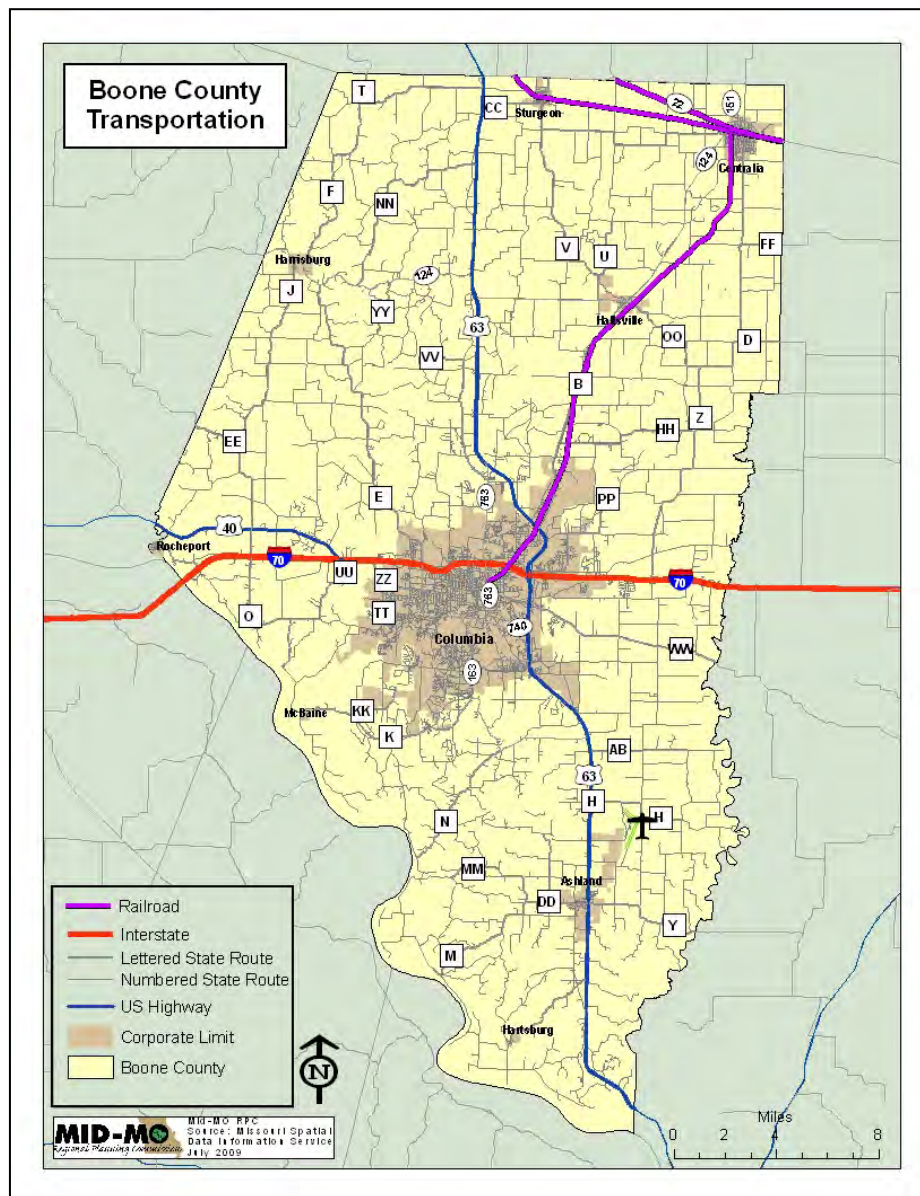
Household Income and Benefits - Boone County

Income and Benefits	#	%
Total households	65,649	100.0
Less than \$10,000	6,823	10.4
\$10,000 to \$14,999	3,877	5.9
\$15,000 to \$24,999	7,355	11.2
\$25,000 to \$34,999	6,529	9.9
\$35,000 to \$49,999	9,035	13.8
\$50,000 to \$74,999	11,742	17.9
\$75,000 to \$99,999	7,659	11.7
\$100,000 to \$149,999	7,548	11.5
\$150,000 to \$199,999	2,688	4.1
\$200,000 or more	2,393	3.6
Median household income = \$48,627		
Source: American Community Survey, 2009-13		

2.8 TRANSPORTATION AND COMMUTING PATTERNS

Boone County is crossed by two major highway systems and has a regional airport (Figure 2.21). Easy accessibility to and from the population center of Columbia, and the proximity of the State Capital at Jefferson City in adjacent Cole County, results in a sizeable commuting population within, and to and from, the planning area.

Figure 2.21



Roadways

Interstate 70 crosses the county from east to west. This system connects the metropolitan areas of St. Louis and Kansas City and is a major route of transport across the United States.

U.S. Highway 63, which runs north-south, intersects I-70 in Columbia. Highway 63 is also a major route for transporting goods and provides commuters access to work in both Columbia and Jefferson City to the south (Cole County). US Highway 63 also provides access to the Columbia Regional Airport.

Airports

Boone County has one airport, the Columbia Regional Airport, located east of Highway 63 between Ashland and Columbia.

The Columbia Regional Airport is owned and operated by the City of Columbia. An airport advisory board composed of thirteen members (seven appointed by the Columbia City Council) exists to make a continuous study of airport needs and of aviation in the area. The advisory board makes recommendations to the Council for the development and use of the airport. The governing bodies of Boone County, Jefferson City, Fulton and Ashland may also appoint one member to the Board. Airport operations are administered by the Airport Manager.

Regionally, there are airports located in Boonville (Cooper County), Fulton (Callaway County), and Jefferson City. Jefferson City Memorial Airport is located in Callaway County, across the Missouri River from the main part of Jefferson City (Cole County).

Railroads

There is no passenger rail service in the planning area; however, Amtrak passes through adjacent Cole and Moniteau Counties with a station located in Jefferson City.

The City of Columbia owns the Columbia Terminal Railroad (COLT), a freight railway between Columbia and the City of Centralia; the COLT passes through the City of Hallsville. The Department of Water & Light is in charge of operations.

The Norfolk Southern and Kansas City Southern pass through the northeastern part of Boone County and the City of Centralia (Figure 2.20).

Public Transportation

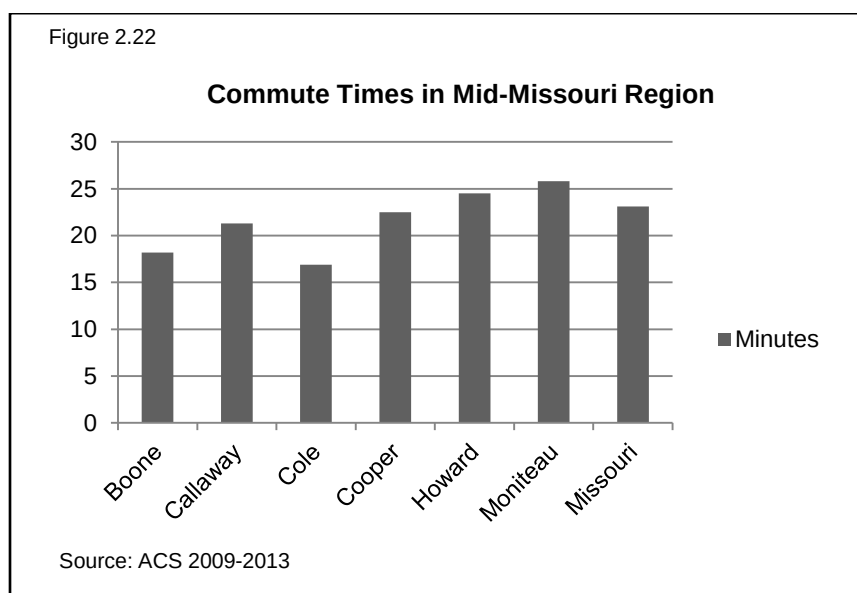
OATS, Inc., a private not-for-profit corporation, provides transportation on scheduled days within Boone County and the city of Columbia; it also provides connections to neighboring counties. OATS predominantly serves the elderly and disabled, but will serve anyone needing transportation. OATS operates in 87 counties in Missouri.

The City of Columbia operates Columbia Transit, a bus system which serves the city and the University of Missouri campus. Routing on the system was majorly overhauled in 2014 to better meet the needs of the community.

Commuting Patterns

Boone County is a center for jobs in the central Missouri region. There is a daily influx of workers into the planning area, especially to jobs in Columbia where the main campus of the University of Missouri is located. The vast majority of Boone County residents work within the county. Data from the American Community Survey (2006-2010 Five-Year Average) indicated that only 9.2% of Boone County residents commuted outside their place of residence. This was the lowest percentage in the Mid-MO RPC region; only Cole County, where the state capitol is located, came close with 11.7%. The other four counties in the region had 39.4% to 52.4% of workers commuting to other counties.

The average commute time for Boone County residents is lower than the state average and the second lowest in the Mid-Missouri region (Figure 2.22). Only neighboring Cole County to the south has a lower commute time.



In addition to the population of workers entering the planning area, many people travel to Columbia to shop, receive medical care, and conduct other types of business. Emergency management and mitigation planning must take this mobile and shifting population into account.

Section 3: Planning Area Assets and Capabilities

The jurisdictions in the planning area have many human and material assets at risk from hazards. At the same time, these human and material assets provide a wide array of capabilities for mitigating, responding to and recovering from damage and loss.

An overview of the critical infrastructure in the planning area begins this section.

This is followed by a profile of each participating jurisdiction which includes:

- key demographic and governing information
- assessed property values from the Boone County Assessor's Office
- counts and value of property owned by the jurisdiction, to the extent available
- any changes since 2010 with potential relevance to hazard mitigation planning
- any plans for future development with potential relevance to hazard mitigation planning
- any other information deemed relevant

3.1 CRITICAL FACILITIES OVERVIEW

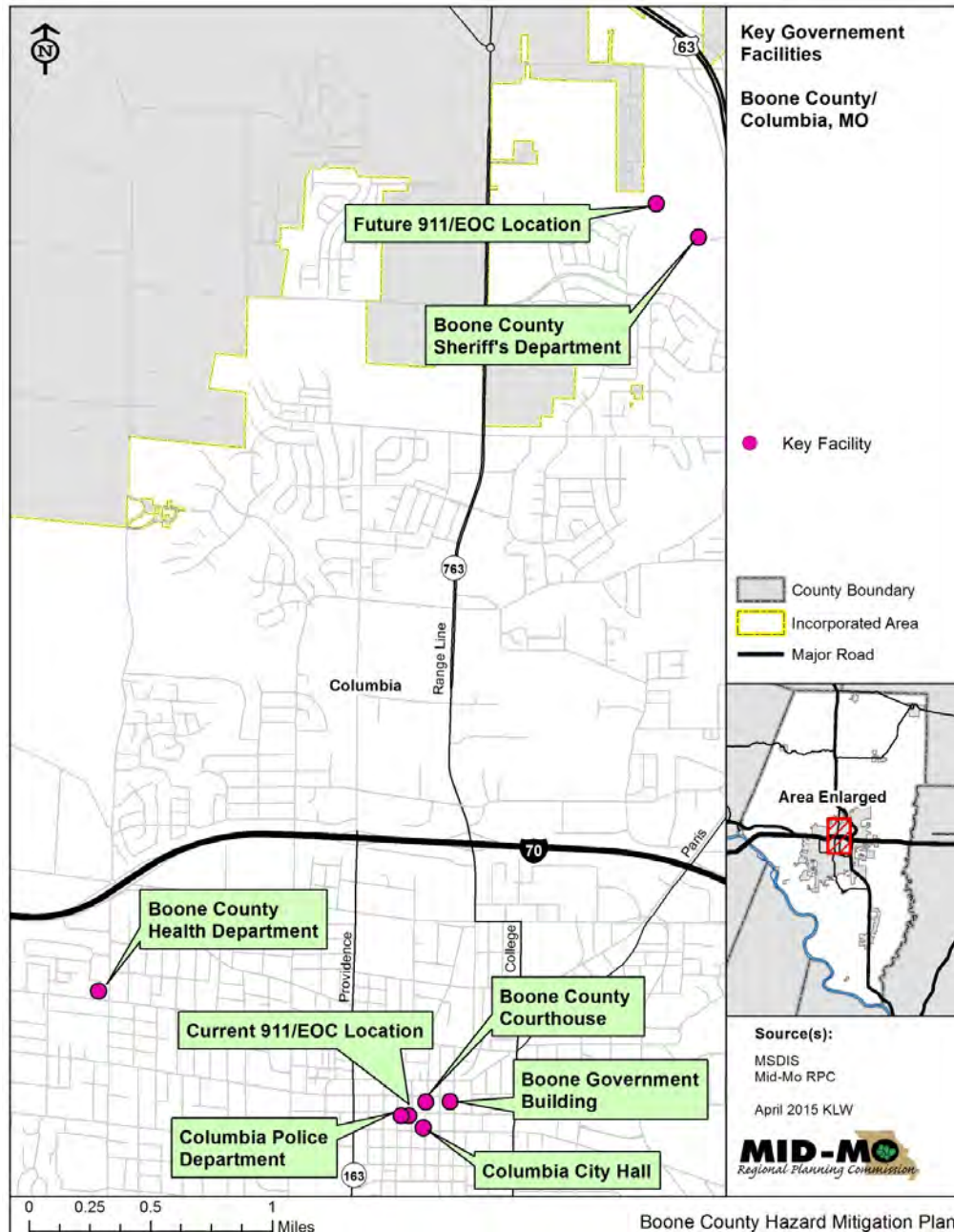
Critical facilities are defined by FEMA as "... all manmade structures or other improvements that, because of their function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed, damaged, or if their functionality is impaired."

Critical facilities commonly include all public and private facilities that a community considers essential for the delivery of vital services and for the protection of the community (Figures 3.1-13). The adverse effects of damaged critical facilities can extend far beyond direct physical damage. Disruption of health care, fire, and police services can impair search and rescue, emergency medical care, and even access to damaged areas.

GOVERNMENT

The jurisdictions of Boone County, Ashland, Centralia, Columbia, Hallsville, Harrisburg, Hartsburg, Rocheport and Sturgeon all own buildings critical to the functioning of their jurisdictions. The City of Columbia is the county seat; both city and county buildings, including the Emergency Operations Center which serves the entire county, are located there (Figure 3.1).

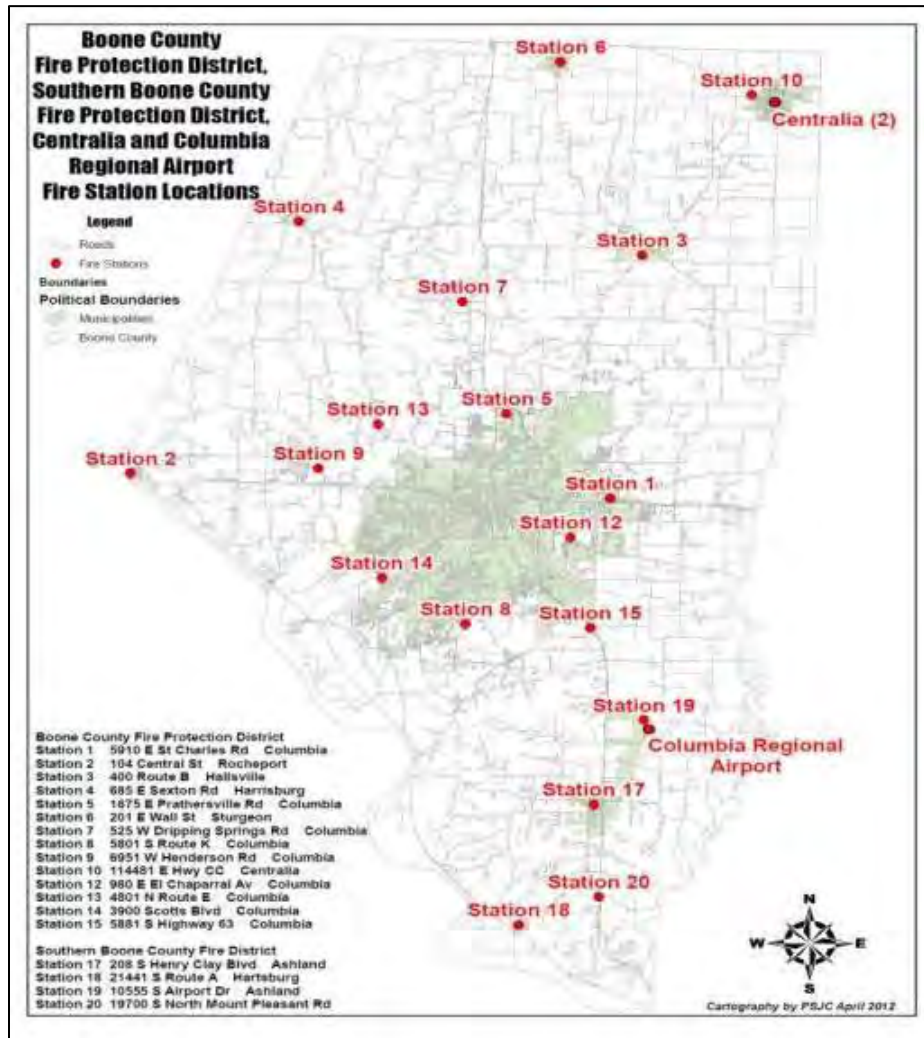
Figure 3.1



FIRE PROTECTION

There are two fire districts serving Boone County: the Boone County Fire Protection District and the Southern Boone County Fire Protection District (Figure 3.2).

Figure 3.2



The **Boone County Fire Protection District**, the third largest fire department in Missouri, is governed by a five-member board of directors elected by the public. Full service is provided for six communities and 532 square miles of unincorporated areas in the county. Boone County Fire District provides service to certain portions of the City of Columbia (recently annexed areas), per preexisting territorial agreements. The District provides fire, rescue and medical services and has a Hazardous Materials Division, a State Homeland Security Regional

Response Team, a FEMA Urban Search and Rescue Team, a Type II wildfire team, and a dive rescue unit.

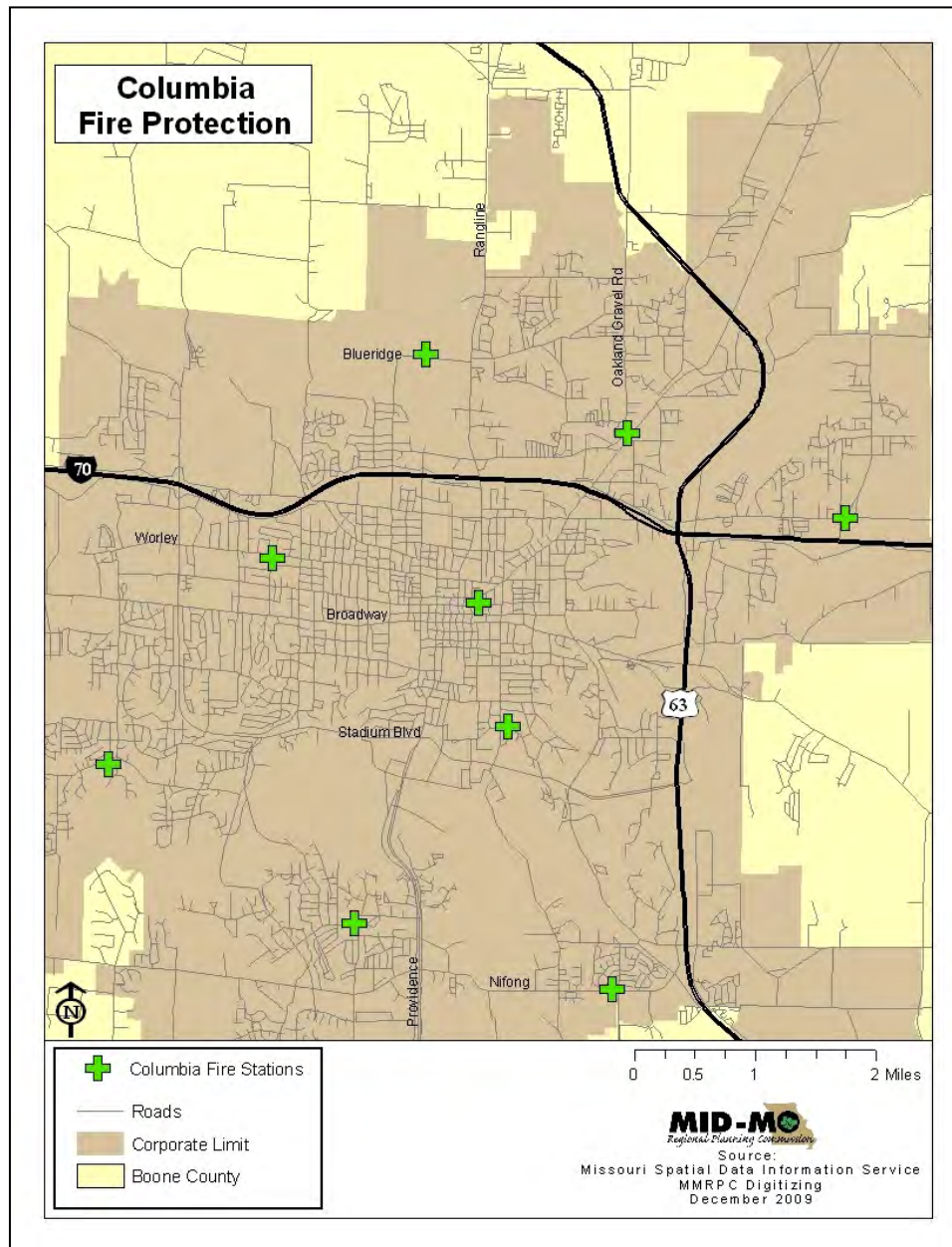
The Southern Boone County Fire Protection District is governed by a three-member elected body and serves the southern one-third of the county. It has a limited hazardous materials response capability. The district protects an area of 100 square miles and a population of approximately 10,000 from four stations located in southern Boone County.

The Columbia Regional Airport Public Safety Department responds to incidents on airport property with assistance provided, as needed, by the Columbia Fire Department, the Southern Boone County Fire Department, and the Boone County Fire Protection District.

The Cities of Centralia and Columbia both support their own fire departments. The Centralia Fire Department provides service within the corporate limits but has limited response capability to hazardous material incidents and emergency medical calls.

The Columbia Fire Department is a full career fire department operating out of eight stations (Figure 3.3) with approximately 126 firefighters. It supports a hazardous materials team with response equipment tailored to the scene of an emergency incident.

Figure 3.3



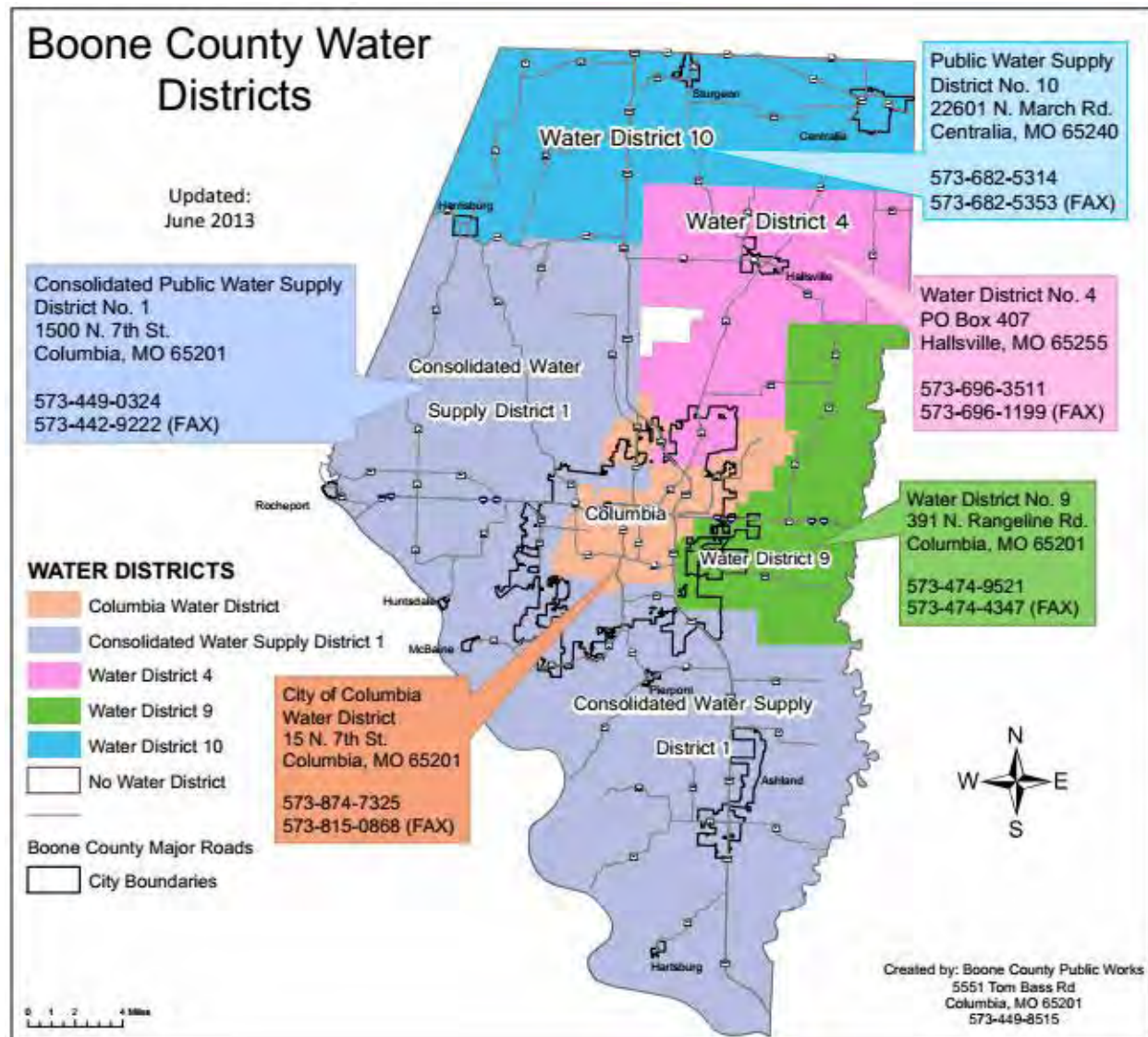
PUBLIC WATER SUPPLY DISTRICTS

Four Water Districts are responsible for distributing water throughout the County except in locations served by a municipality (Figure 3.4). Each water district is governed by an elected board.

The Cities of Ashland, Columbia, Centralia, Hallsville, Harrisburg, and Sturgeon all have their own water departments/districts.

Protecting water supply infrastructure from floodwaters is a critically important mitigation task. Connection of water supplies and/or cooperative agreements between districts and departments can be important for ensuring adequate water for fire fighting and in times of drought. The City of Columbia has cooperative water agreements with PWSD #9 and the University of Missouri.

Figure 3.4



WASTEWATER FACILITIES

Boone County Regional Sewer District (BCRSD)

The Sewer District consists of a four-member board and a County Commissioner who are responsible for wastewater quality within Boone County, except for those facilities operated by a municipality or private entity. The BCRSD now owns and operates the wastewater treatment facility for the Village of Rocheport; this was previously owned by the village.

The majority of the BCRSD system is gravity sewers. The Sewer District operates and maintains the following treatment/reclamation facilities:

- 14 mechanical plants
- 19 aerated lagoons
- 5 non-aerated lagoons
- 3 re-circulating sand filters
- 1 drip irrigation system

The BCRSD works with the City of Columbia which provides wholesale treatment for some of the subdivisions in the Sewer District's territory.

Municipal Wastewater Systems

The following municipalities all provide their own wastewater treatment: Ashland, Centralia, Columbia, Hallsville, Hartsburg, Harrisburg, and Sturgeon.

MEDICAL FACILITIES

There are numerous medical and healthcare facilities located in the planning area (Figures 3.5-3.6). Medical facilities in the City of Columbia serve not only the planning area and region but also patients from all over Missouri; the University Hospital is a Level 1 Trauma Center.

The nursing homes and some of the medical facilities house vulnerable populations. The *Boone County Emergency Operations Plan* clearly outlines procedures to ensure that these facilities are warned of impending hazard events in a timely manner.

Figure 3.5

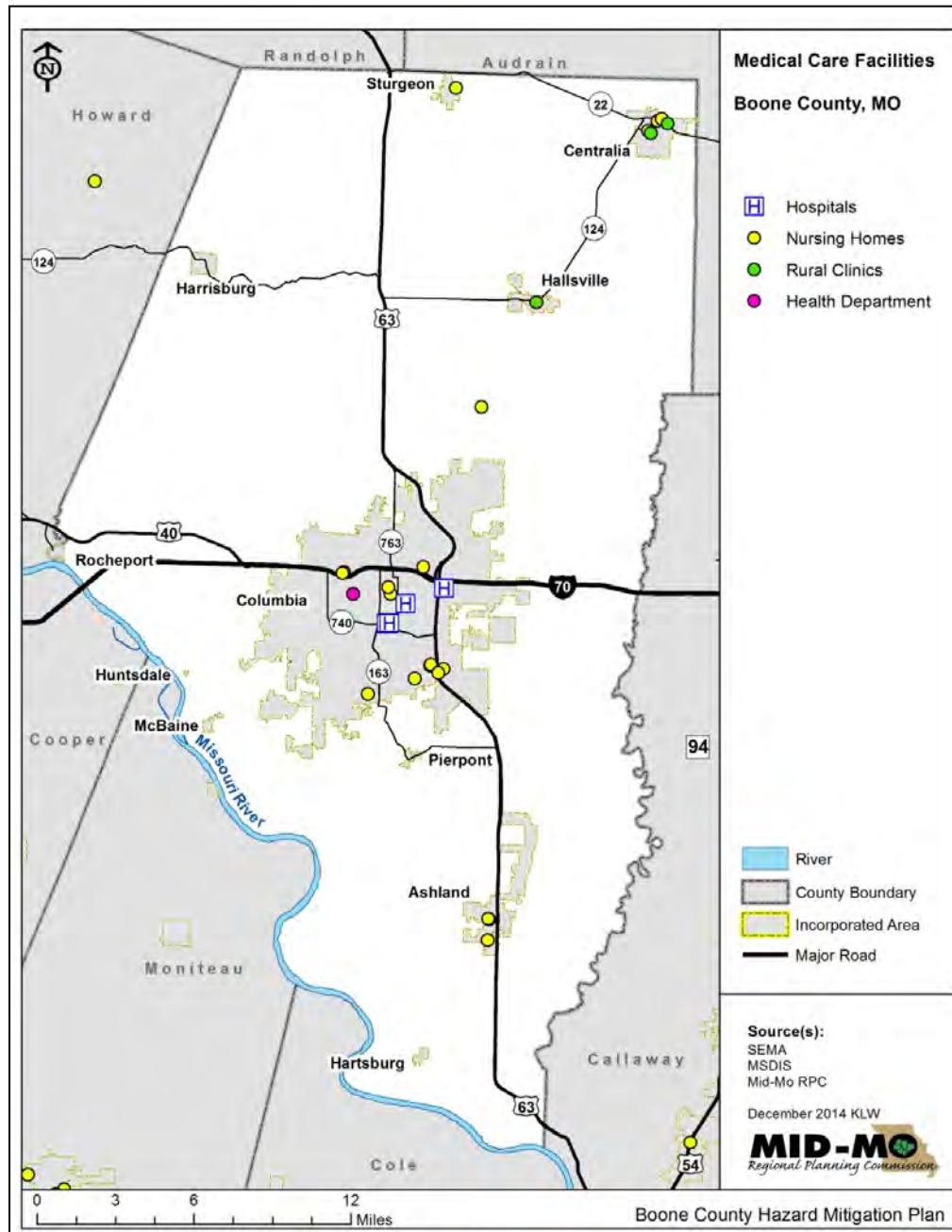


Figure 3.6		
Critical Medical Facilities		
Type of Facility	Location	Beds
Level 1 Trauma Center		
University Hospital	Columbia	
Hospitals		
Boone Hospital Center	Columbia	397
Harry S. Truman Memorial Veterans Hospital	Columbia	na
Landmark Hospital of Columbia, LLC	Columbia	42
Rusk Rehabilitation Center (joint venture: HealthSouth & University of MO)	Columbia	60
University of Missouri Hospitals	Columbia	
University Hospital	Columbia	247
Missouri Psychiatric Center	Columbia	57
Women's and Children's Hospital	Columbia	na
Clinics and Health Centers		
Centralia Medical Clinic	Centralia	
Centralia Family Health Clinic	Centralia	
Family Health Center	Columbia	
J.W. "Blind" Boone Community Center	Columbia	
University of Missouri Clinics	Columbia	
Nursing Home Facilities		
Ashland Healthcare	Ashland	60
Ashland Villa-Assisted Living	Ashland	72
Bluegrass Terrace	Ashland	16
Bristol Manor of Centralia	Centralia	12
Heritage Hall Nursing Center	Centralia	60
Stuart House, The	Centralia	27
Bluff Creek Terrace-Assisted Living	Columbia	48
Bluffs, The	Columbia	132
Candlelight Lodge Retirement Center	Columbia	112
Columbia Healthcare Center	Columbia	97
Columbia Manor Care Center	Columbia	52
Daybreak Residential Treatment Center	Columbia	14
Harambee House	Columbia	15
Hillcrest Residential Care	Columbia	33
Lenoir Gardens	Columbia	30
Lenoir Health Care Center	Columbia	122
Lenoir Manor	Columbia	60
Parkside Manor	Columbia	120
South Hampton Place	Columbia	100
Tiger Place	Columbia	112
Sturgeon Rest Home	Sturgeon	20
Source: Missouri Department of Health and Senior Services Information Technology Services Division; hospital websites		

OFFICE OF EMERGENCY MANAGEMENT

The Boone County Office of Emergency Management (OEM) is in charge of emergency management for the County and all its jurisdictions, with the exception of the Villages of McBaine and Pierpont (which are not participating jurisdictions in the Boone County Hazard Mitigation Plan). Due to staffing changes, personnel from the Boone County Fire Protection District have been directing the OEM since 2012. Boone County is currently in the process of hiring a permanent emergency management director.

Personnel of the OEM play a critical role in hazard mitigation due to their strong network of connections, awareness of hazard threats, wide-ranging experience of all facets of emergency management, and work with public education.

Emergency Operations Plan (EOP)

Boone County has a comprehensive Emergency Operations Plan (EOP) which was updated by the OEM in October 2012. The EOP consists of specific directions for local governments to undertake in the event of an emergency. An EOP is an essential tool in helping reduce the threat of hazards. The EOP can be downloaded at: bcfdmo.com/eop/.

The following information is summarized from the EOP, Annex B: Communications and Warning with some additional information added:

Communications and Warning

Communications capabilities exist primarily with the Boone County Public Safety Joint Communications (PSJC) department currently located in downtown Columbia.

This center is the 9-1-1 public safety answering point staffed 24- hours per day to provide services for the entire Boone County area. This center also provides 24-hour dispatching for the following agencies:

- Columbia Police Department
- Boone County Sheriff's Department
- Ashland Police Department
- Hallsville Police Department
- Sturgeon Police Department
- Columbia Regional Airport Security
- Columbia Fire Department
- Boone County Fire Protection District
- Southern Boone County Fire Protection District
- all EMS services operating in Boone County, including University of Missouri (Columbia) Hospital Ambulance and Boone Hospital Center (Columbia) Ambulance

The following provide their own dispatching:

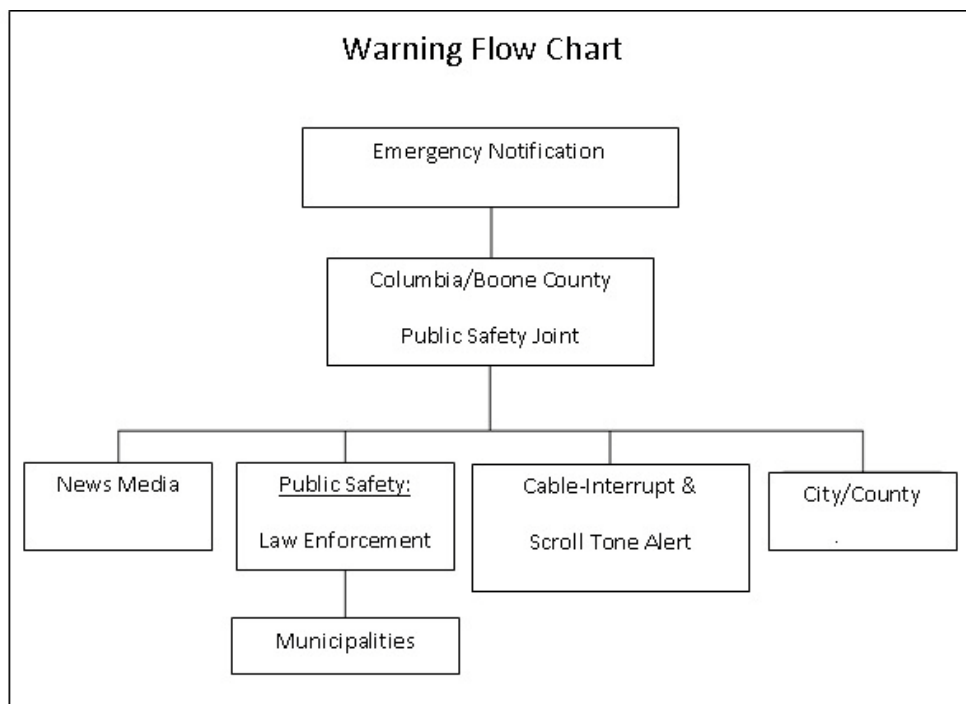
- City of Centralia Police Department
- University of Missouri (Columbia) Police Department
- Columbia College (Columbia) campus security
- Stephens College (Columbia) campus security
- Columbia Public Works Department
- Boone County Public Works Department

For both the City of Centralia and University of Missouri Police Departments, the 9-1-1 calls are first received by Public Safety Joint Communications and relayed to Centralia and the University dispatch.

In the event of a power interruption, the Columbia/Boone County PSJC Operations Center has UPS systems and a back-up generator to operate the communications equipment and the 9-1-1 dispatch. This generator is tested on a weekly basis.

Initial warning information is received from the NAWAS/MULES, Storm Sentry and NOAA weather radio located in the PSJC Operations Center. This also includes warning information from the National Weather Service office in St. Louis. The warning information, in turn, is dispersed throughout the County (Figure 3.7).

Figure 3.7

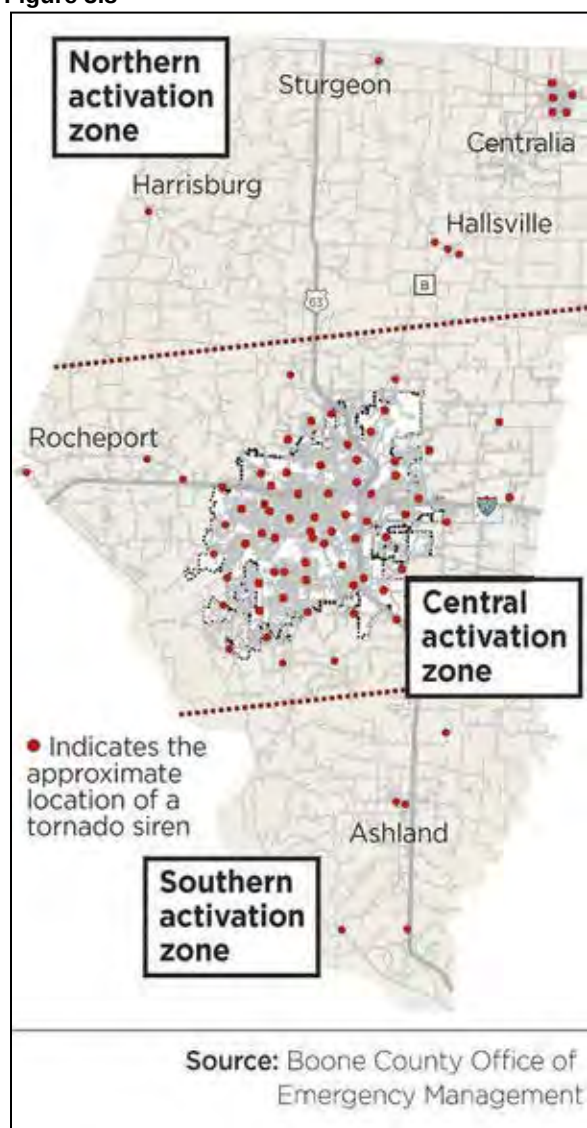


Source: Boone County Emergency Operations Plan, 2012

Sirens: There are outdoor warning sirens located throughout most of the county. They can be utilized for public warning for various types of emergencies including tornadoes, severe weather which may cause damage/injuries, terrorist attack, sustained winds of 70 mph, and other incidents which may pose a danger. Systems are in place to assure the proper functioning of these siren systems; any problems are repaired immediately.

In 2014, the OEM began discussions on implementing a zone system for activating warning sirens (Figure 3.8.). Previously, sirens would be sounded throughout the county for any event triggering a warning. The zone activation plan was put into place in 2015 with the hopes that, with targeted alerts, the public would take the sirens more seriously.

Figure 3.8



The sirens are activated through the Columbia/Boone County PSJC via a radio link. Responsibility for activating the sirens rests with the Emergency Management Director, Weather Watch Coordinator, Joint Communications Shift Supervisor, or next highest level person on duty. The decision is made based on information from the National Weather Service, surrounding jurisdictions, user agency personnel, the Missouri State Highway Patrol, and/or trained weather spotters in the field. The sirens are tested on the first Wednesday of every month at noon, weather permitting.

The outdoor warning sirens located in the City of Centralia are activated by the city but can be activated by the Office of Emergency Management, if needed.

Warning for jurisdictions or areas in the county not covered by sirens may be by electronic messages, telephone, mobile public address operations and/or door-to-door by the Boone County Sheriff's Department, municipal police departments and fire departments. Local radio and television stations will also broadcast warnings.

Special Facilities: There are several facilities in Columbia and Boone County that require special warning considerations (i.e., schools, hospitals,

nursing homes, etc.). A tone alert radio system is utilized to warn these facilities. These warning radio receivers are tested at the same time as the outdoor warning sirens. A list of these facilities is found in Annex J Appendix 2 of the EOP.

Emergency Alert System (EAS): Boone County is located in lies within the Jefferson City operational area for the nationwide Emergency Alert System (EAS) network. The EAS is jointly coordinated by the Federal Communications Commission (FCC), FEMA, and the National Weather Service (NWS).

The primary State EAS network station for this operational area is KTXY-FM, 106.9. However, in the Columbia/Boone County Emergency Operations Plan (EOP), the Columbia station KFRU-AM 1400 has been designated to broadcast EAS messages for local emergencies of specific interest to the residents of Columbia, Boone County, and its other municipalities. The Executive Official and EMD of the affected jurisdiction designate the personnel with the authority to activate the EAS system.

The following television stations also broadcast EAS weather warnings for tornadoes and other severe weather threatening the area:

- KMIZ-TV, Channel 17 (ABC), Columbia
- KOMU-TV, Channel 8 (NBC), Columbia
- KRCG-TV, Channel 13 (CBS), Jefferson City
- KNLJ-TV, Channel 25, New Bloomfield
- KMOS-TV, (PBS), CMSU, Warrensburg

The EOP includes the following sample news releases in Annex C Appendix 11:

- Suggested news release format for Emergency Public Information
- Flood evacuation ordered
- Summary Statement for Media, Hazardous Materials Incident
- Sample Media Message for Earthquake - No Information Available
- Sample Media Message for Earthquake – Update on Earthquake

The EOP gives the recommendation that contacts with the media for emergency warning information should first be sent via the listed FAX numbers; phone numbers for the media contacts area also listed.

National Homeland Security Advisory System: The Columbia/Boone County Office of Emergency Management posts the current national terrorism threat level on its web site, with links to the City of Columbia and Boone County government web sites. The Office of Emergency Management also maintains pre-formatted news releases with recommended actions for the general public to take under the various threat levels. For the threat levels and recommended protective actions, see Appendix 6 to this annex.

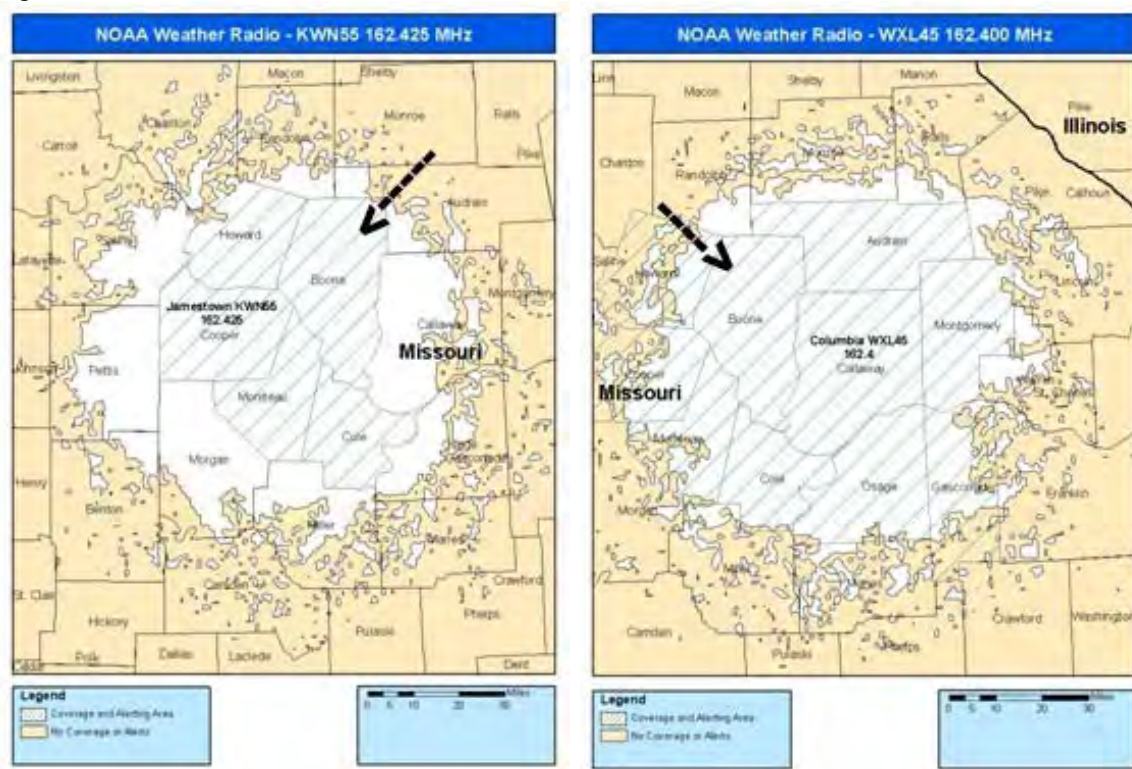
MARTI System: The Columbia/Boone County Joint Communications Center also has the capability to broadcast pre-drafted emergency messages to some 15 radio and television stations in the area which are on the MARTI network.

Cable Television: The cable services in the planning area provide the civil emergency alert

system (cable- interrupt) - a blue-screen with voice over-ride capability. Columbia/Boone County Joint Communications uses tone codes over a touch-tone phone to override its local cable service.

Weather Radio: Residents of Columbia and Boone County are within range of an area transmitter for broadcasts of the NOAA Weather Radio network, operated by the National Weather Service. Severe weather updates, including tornado and severe thunderstorm warnings, flash flood warnings, and other 24-hour weather advisories are broadcast by the NWS for the affected area. The signal is received by special weather radio units activated when a severe weather bulletin is broadcast. These receivers are available to local emergency officials, schools, and the general public from many retail/wholesale stores carrying radios. Special new models can be coded to activate only for weather warnings in the immediate area (up to eight counties). Transmitters and towers currently in Fulton (Callaway County), and Jamestown (Moniteau County) provide signal coverage for Boone and surrounding counties in Central Missouri (Figure 3.9).

Figure 3.9



Source: National Weather Service - <http://www.nws.noaa.gov/nwr/Maps/PHP/MO.php>

Missouri Uniform Law Enforcement System (MULES): MULES is a law enforcement computer data network used by the Missouri State Highway Patrol primarily for law enforcement operations. It is also used to disseminate other emergency information, such as weather conditions, flood stages, road conditions, etc. MULES terminal are located in the Public Safety Joint Communications 9-1-1 dispatch center.

National Warning System (NAWAS): NAWAS provides the framework for the Missouri Warning System. The NAWAS connects the National Warning Center (located in the North American Air Defense Command Combat Center, Colorado Springs, Colorado) with approximately 2,000 warning points across the United States. The system is used for receiving national attack warnings and for communications to other warning points in the state for natural and man-made disasters. The Missouri State Warning Point is Troop F Headquarters of the Missouri State Highway Patrol in Jefferson City, Missouri. The Alternate State Warning Point is the State Emergency Operations Center (SEOC) at SEMA. A NAWAS terminal is also located at the Columbia/Boone County Public Safety Joint Communications 9-1-1 dispatch center.

Trained weather spotters are available through the various agencies, including the Columbia Police Department and the Boone County Sheriff's Office, community citizens, and the local amateur radio operators. Weather spotter classes are hosted by the Office of Emergency Management in coordination through the National Weather Service when needed.

Local amateur radio operators can provide additional communications during an emergency/disaster.

Tests and educational programs will be conducted regularly to insure the public understands the various warnings (i.e., outdoor warning sirens).

For incidents that have reached an emergency classification, overall Direction and Control will be from the EOC within the affected area or subdivision. The line of succession for the Communications and Warning Coordinator for Columbia and Boone County is:

1. Public Safety Joint Communications Director
2. Administrative Services Manager
3. Operations Manager

Records vital to the communications and warning function should be duplicated and stored at another location.

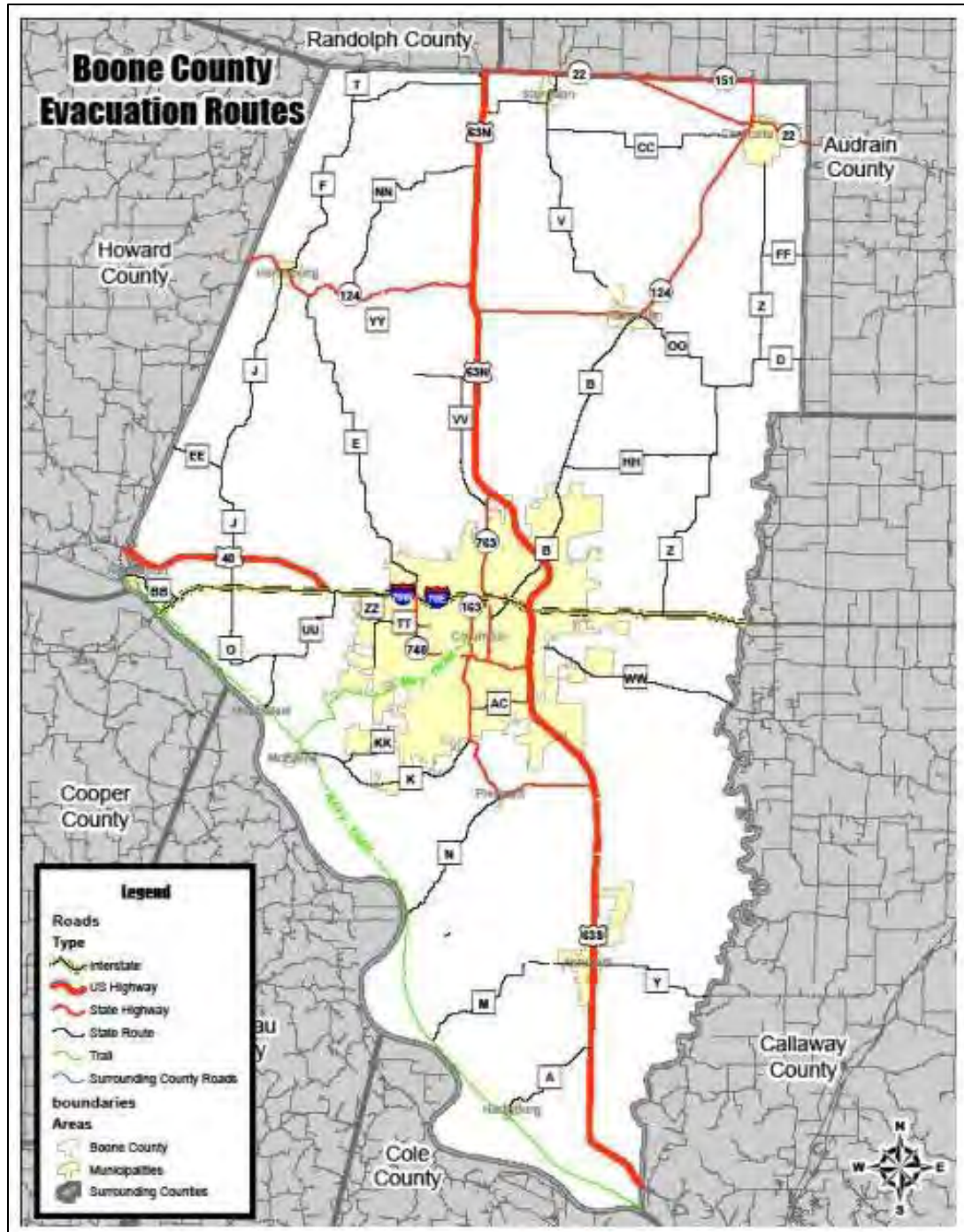
In order to maintain the ability to carry out the various communications and warning functions, the following is necessary:

- Mutual aid agreements and agreements of understanding regarding communications and warning operations should be maintained.
- Protect communications and warning equipment from lightning, wind, and electromagnetic pulse. This includes shielding equipment, attaching surge protectors, and disconnecting equipment from its power source.
- Establish priority of service restoration and line-load control on telephone equipment in the EOC and other essential facilities.

Evacuation and Sheltering

Interstate 70 (East/West) and U.S. Highway 63 (North/South) provide major routes for evacuation (Figure 3.10). State Highways 124, 163, 740, and 763 provide major connections to these federal highways. More rural areas are connected with an extensive system of State and County roads.

Figure 3.10



There is an extensive system of established shelters in the planning area (Figures 3.11-3.13). Most of these have been extensively surveyed by, and have written shelter agreements in place with, the American Red Cross.

Figure 3.11

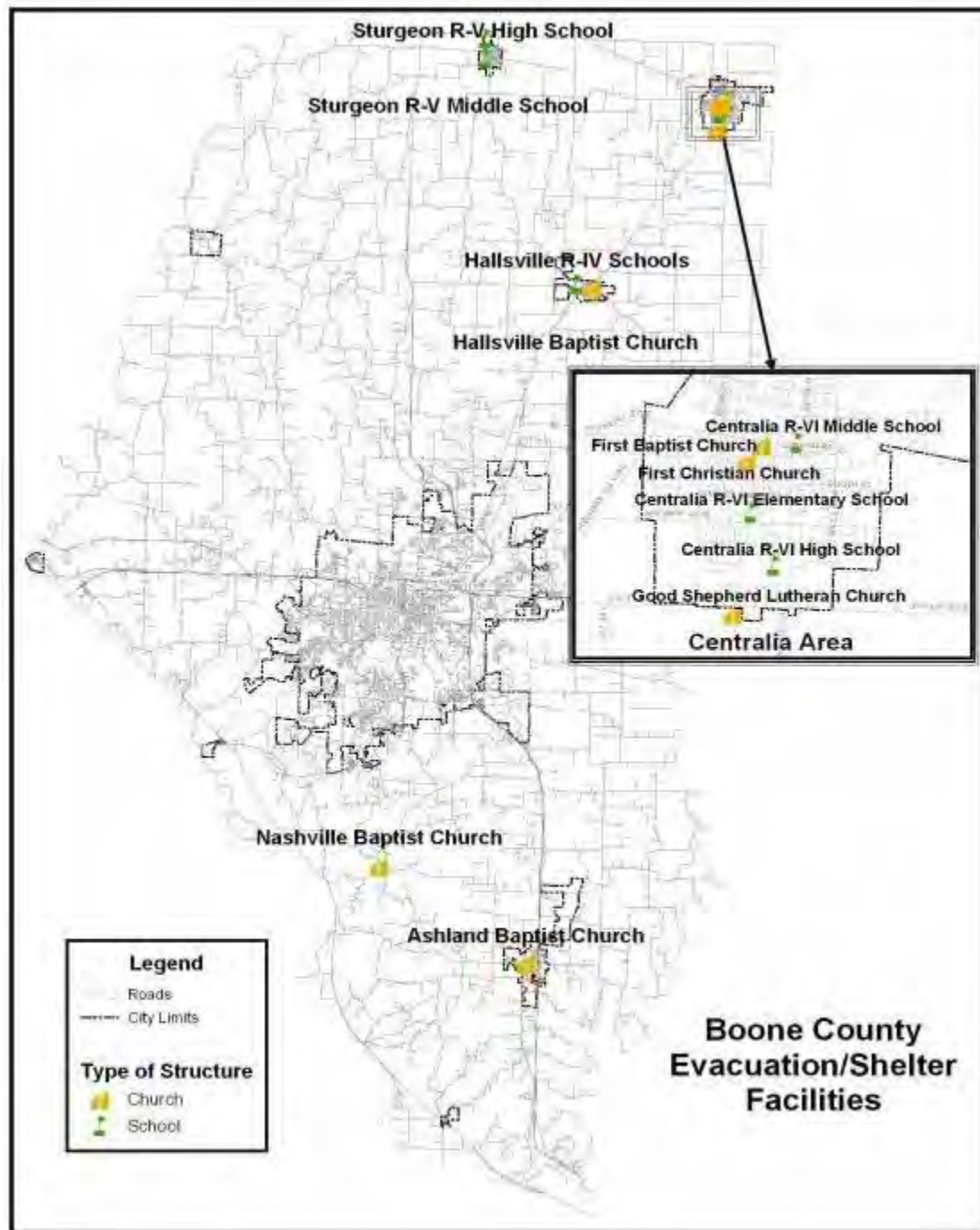


Figure 3.12

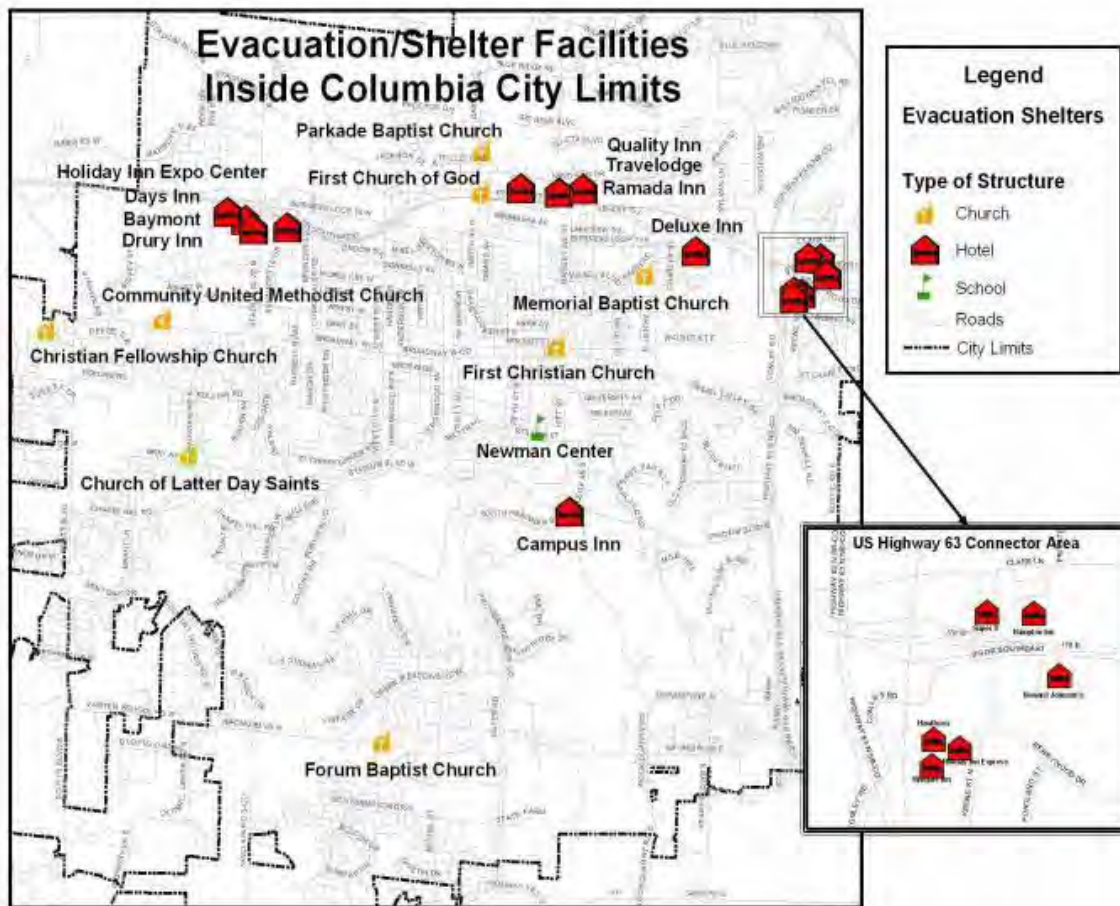


Figure 3.13**Boone County Shelters**

City	Shelter Name	Address	Shelter Agreement*	Survey**
Ashland	Nashville Baptist Church	355 W Nashville Church Rd.	08/05/2013	7/31/2013
Ashland	Primary School	803 S. Henry Clay Blvd		
Ashland	Southern Boone County R-1 High School	14520 Crump Lane		
Ashland	Southern Boone County R-1 Middle School	303 N. Main		
Centralia	Cbms Middle School	110 N. Jefferson		
Centralia	Centralia R-V1 Schools	849 S. Jefferson	11/03/2004	
Centralia	Chance Elementary	510 S. Rollins		8/16/2003
Centralia	First Baptist Church	101 S. Collier	03/02/2006	3/2/2006
Centralia	First Christian Church	229 South Rollins Street	07/23/2013	7/24/2013
Centralia	Good Shephard Lutheran Church	120 W. Gano Chance Road	03/01/2006	3/1/2006
Centralia	Holy Spirit Catholic Church	404 South Rollins Street	01/25/2010	7/22/2013
Columbia	American Legion Post 202	600 Legion Lane	04/07/2009	4/7/2009
Columbia	Broadway Christian Church	2601 W. Broadway	05/09/2012	5/9/2012
Columbia	Calvary Baptist Church	606 Ridgeway Ave.		
Columbia	Christian Chapel	3300 S. Providence Road		6/28/2013
Columbia	Christian Fellowship Church	4600 Christian Fellowship Rd	02/11/2009	6/14/2013
Columbia	Christian Fellowship Church (The 5000)	1400 Christian Fellowship Rd	02/11/2009	6/14/2013
Columbia	Columbia Benevolent Organization/Elks Lodge 594	4747 East Elk Park Dr	07/15/2013	7/10/2013
Columbia	Community United Methodist Church	3301 West Broadway	03/03/2009	
Columbia	Fairview Road Church Of Christ	201 S. Fairview Rd	03/10/2009	3/10/2009
Columbia	Fairview United Methodist Church	3200 Chapel Hill Rd	04/03/2006	10/21/2011
Columbia	First Baptist Church	1112 E. Broadway	06/03/2010	6/3/2010
Columbia	First Christian Church	101 North 10th Street	02/10/2006	6/19/2013

Figure3.13 (cont.)**Boone County Shelters**

City	Shelter Name	Address	Shelter Agreement	Survey*
Columbia	First Church Of God	1610 N. Garth Av.	11/04/1999	9/20/1999
Columbia	Forum Blvd Christian Church	3900 Forum Blvd	04/07/2009	4/7/2009
Columbia	Grace Bible Church Of Columbia	601 Blue Ridge Road	02/19/2009	2/19/2009
Columbia	Memorial Baptist Church	1634 Paris Road	02/02/2006	6/20/2013
Columbia	Missouri United Methodist Church	204 S. 9Th	01/16/2009	1/16/2009
Columbia	Newman Center	701 Maryland Ave	03/10/2009	3/10/2009
Columbia	Open Door Baptist Church Of Columbia Mo Inc.	4838 E. Meadows Lark Ln	05/22/2009	5/22/2009
Columbia	Parkade Baptist Church	2102 North Garth Ave.	06/21/2013	6/25/2013
Columbia	Seventh Day Adventist Church	1100 College Park Dr	02/23/2006	
Columbia	The Crossing	3615 Southland Dr	02/11/2010	2/11/2010
Hallsville	Hallsville Baptist Church	115 Elizabeth St.	05/05/2010	5/5/2010
Hallsville	Hallsville Community Center	202 Rt Oo	04/12/2010	4/12/2010
Hallsville	Hallsville Community Development Association	500 E Hwy 00	05/03/2010	5/3/2010
Hallsville	Hallsville High School	421 East Hwy 124	11/09/2010	8/2/2013
Hallsville	Hallsville Intermediate School	411 East Hwy 124	11/09/2010	11/9/2010
Hallsville	Hallsville Primary School	6401 East Hwy 124	11/09/2010	8/2/2013
Hallsville	Hallsville United Methodist Church	11700 North Rt. B	05/24/2010	5/5/2010
Hallsville	Red Top Christian Church	1435 N. Route U	05/05/2010	5/5/2010
Hartsburg	American Legion Post 424	35 S 2Nd St	11/01/2010	11/1/2010
Hartsburg	Peace United Church Of Christ	121 North First Street	03/04/2010	7/23/2013
Sturgeon	Sturgeon R-V High School	23450 Fairgrounds	08/01/2013	2/11/2010
Sturgeon	Sturgeon R-V Middle & Elementary School	210 West Patton Street	07/31/2013	7/31/2013
*Date of written shelter agreement **Date of extensive facility survey by American Red Cross Source: American Red Cross, Jefferson City Office				

3.2 COUNTY AND COMMUNITIES

BOONE COUNTY

Figure 3.14 Boone County Profile	
County classification	1st class
Population (2010)*	162,699
Total housing units (2010)*	69,551
Median household income (ACS)*	\$48,627 (+/- \$1,373)
Median owner-occupied housing value (ACS)*	\$162,200 (+/- \$2,507)
Water service	Consolidated PWD No. 1; Water District 4; Water District 9; Water District 10; Columbia Water District
Electric service	Boone Electric Coop; Ameren Missouri
Sewer service	Boone Co. Regional Sewer District
Fire service	Boone County Fire Protection District; Southern Boone County Fire Protection District
Ambulance service	Boone Hospital Center; University Hospital
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No
Master plan	Yes
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes
Stormwater regulations	Yes
Floodplain regulations	Yes
NFIP member	Yes
Website	www.showmeboone.com
* Data includes incorporated communities	
Sources: County staff; US Census (2010); ACS (American Community Survey 2009-2013)	

The County Commission is the administrative authority. It is an elected three-member governing body with a District I (Southern) Commissioner, a District II (Northern) Commissioner, and a Presiding Commissioner. The Commission establishes County policy; approves and adopts the annual budget for all County operations; approves actual expenditures for each department; supervises the operations of Public Works, Planning and Zoning, Building Codes, Human Resources, Purchasing, Information Technology, and Facilities and Grounds Maintenance; ensures County-wide compliance with numerous statutory requirements; and acts as liaison with County boards, commissions, and other governmental entities.

Boone County also has the following staff positions: Assessor, Auditor, Collector, Clerk, Public Administrator, Public Attorney, Recorder, Sheriff, and Treasurer.

Figure 3.15 Boone County (unincorp.) - Property and Valuation*			
Buildings		Value	
Type and Number		Assessed	Market
Residential	15,005	\$1,476,974,605	\$7,773,550,553
Commercial	562	\$555,182,188	\$1,734,944,338
Agricultural	na	\$24,358,642	\$202,988,683
Real Property Total		\$2,056,515,435	\$9,711,483,573
Personal Property		\$457,475,324	\$1,369,686,599
Railroads and Utilities		\$34,301,686	\$107,192,769
Total		\$2,548,292,445	\$11,188,362,941
* includes valuation for Villages of Huntsdale (participating jurisdiction), McBaine, and Pierpont as these are part of the Boone Co. tax levy and not broken out separately			
Source: Boone County Assessor's Office			
County Owned Property			
Count		Value	
Buildings	46	\$135,646,846	(replacement - bldgs. & contents)
Vehicles	18	\$6,887,109	(purchase price)
Source: Boone County Human Resources - Risk Management Specialist			

Agriculture

Over half of the land area in Boone County is farmland (Figure 3.16). Any hazard impacting the agricultural sector has the potential to significantly impact the area's economy.

Figure 3.16 2012 Boone County Agricultural Overview	
Number of Farms	1,171
Land In Farms	240,710 acres (54.9% of Boone County)
Market Value of Products Sold	\$52,185,000
Crop Sales	\$34,419,000
Livestock Sales	\$17,765,000
Source: USDA Census of Agriculture, 2012	

Public Land

Boone County has several state owned land areas and one National Forest (see Figure 3.17). These public lands are important to consider when working on mitigation efforts, especially when they contain hazards such as sinkholes and high fuel loads that could cause wildfires.

Figure 3.17		
Public Land in Boone County		
Name	Responsible Agency	Acres
Rock Bridge Memorial State Park	Missouri Department of Natural Resources	2272
Mark Twain National Forest (Cedar Creek)	United States Forest Service	~19000
Three Creeks Conservation Area	Missouri Department of Conservation	1506
Eagle Bluffs Conservation Area	Missouri Department of Conservation	3706
Hinkson Woods Conservation Area	Missouri Department of Conservation	80
Green Conservation Area	Missouri Department of Conservation	328
Rocky Forks Lake Conservation Area	Missouri Department of Conservation	2234
Finger Lakes State Park	Missouri Department of Natural Resources	1128
Hartsburg Access	Missouri Department of Conservation	35
Hart Creek	Missouri Department of Conservation	658
Schnabel Woods	Missouri Department of Conservation	79
HJ Waters and CB Moss Wildlife Area	Missouri Department of Conservation	102
Lick Creek Conservation Area	Missouri Department of Conservation	300
Source: Missouri Spatial Data Information Server (MSDIS)		

Relevant Changes since 2010

In 2012, a Children's Service Fund was established in the county "to protect the well-being and safety of children and youth nineteen years of age or less and to strengthen families". The fund is financed by one-quarter of a cent sales tax increase which was passed by over 57% of the voters in the November election. A board appointed by the County Commission oversees the fund. The Boone Co. Schools Mental Health Coalition has a project which is one of many being funded with these monies. One of the goals of the project is to "train all school staff to recognize and respond appropriately to students with signs and symptoms of mental health concerns." Such training will function as mitigation for active shooter events; the Coalition's work on this will be further discussed in Section 5.8.

The Boone County Emergency Operations Plan was updated in October 2012.

Another notable change is that the E-911 Columbia/Boone County Office of Emergency Management has separated from the City of Columbia's organizational structure and is now funded through a dedicated countywide sales tax passed in April of 2013. The three-eighths-cent sales tax generates an estimated \$9.3 million per year and will finance construction of a new 911 and emergency management center that will withstand an F5 tornado. Construction is presently underway. The tax also allowed the county to hire more call-takers and to upgrade radio equipment and information technology hardware and software.

Future Development

A new facility is being built to house both Boone County 9-1-1/Joint Communications and the Boone County Office of Emergency Management; the new facility is expected to be operational in 2016. Information on the new facility is as follows:

Boone County Emergency Communications Center (ECC)

Intent: Provide a facility that would house Boone County 9-1-1/Joint Communications and the Boone County Office of Emergency Management
Location: Adjacent to the Boone County Sheriff's Department
2121 County Drive
Columbia, MO

Date of Completion: Approximately June 2016

The Boone County Emergency Communications Center (ECC) combines the 9-1-1 Communications Center and the Office Of Emergency Management functions into a single facility. The Office Of Emergency Management includes an Emergency Operations Center (EOC), and other critical incident response space and technological needs.

Boone County Joint Communications (BCJC) acts as the communication arm of the Emergency Operations Center whenever the Center is activated in the event of a natural disaster or a man-made emergency. As additional layers of responsibility, BCJC activates the early warning system; retrieves data from the National Crime Information Center (NCIC) and the Missouri Uniform Law Enforcement System (MULES) for the police departments they serve; and inputs information into the various records management systems for several public safety agencies.

Various security levels are required within the ECC. The public lobby for the ECC will be open during defined business hours and a secure reception point will be established to control public access to the ECC.

Access control to secure areas within the facility, either from staff entry points to the facility or for public cleared for entry from the lobby will be managed by card-type authorization. Use of electronic access control systems allows for zones of varying security levels to be created throughout the facility and for users to granted or denied access to these areas with relative ease.

The primary concern for this area is tornadic activity, and the ECC is to be designed for survival of an EF-5. This means wind speeds in excess of 200 mph and impacts from debris at over 150 mph. Other sources of natural disaster will not have significant cost impact. Boone County is just out of the New Madrid earthquake zone. The ECC is designed to provide an appropriate level of protection from this particular threat. The threat of flooding was eliminated through site selection.

Also, the ability to have special filters on the HVAC system to protect the staff inside from accidental chemical spills or chemical/biological attack is another factor included in the build design. Redundant systems will be in place for non interruption of power supply, back up heating and cooling, telephone, and radio transmission and reception.

ASHLAND

Figure 3.18	
Ashland Profile	
City classification	4 th class
Population (2010)	3,707
Total housing units (2010)	1530
Median household income (ACS)	\$63,279 (+/- \$6,245)
Median owner-occupied housing value (ACS)	\$151,000 (+/- \$11,065)
Water service	City of Ashland
Electric service	Boone Electric Coop; Ameren Missouri
Sewer service	City of Ashland
Fire service	Southern Boone County Fire Protection District
Ambulance service	Boone Hospital Center; University Hospital
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No
Master plan	Yes
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes
Stormwater regulations	Yes
Floodplain regulations	Yes
NFIP member	Yes
Website	www.ashlandmo.us
Sources: City staff; US Census (2010); ACS (American Community Survey 2009-2013)	

The Mayor and the Board of Aldermen are the policy making bodies in the city government. The city is divided into three wards and two Board of Aldermen members are elected from each ward for a two year term. Ashland also has the following staff positions:

- City Administrator
- City Clerk
- Public Works Director
- Police Chief

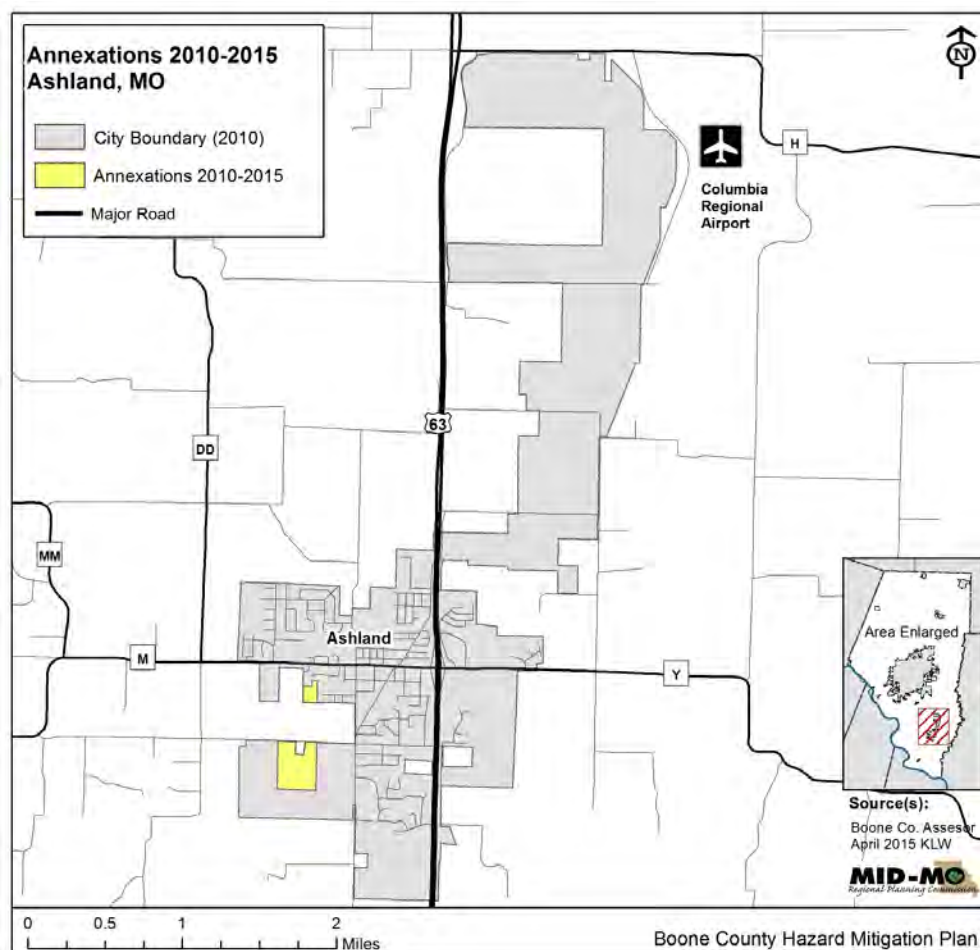
Figure 3.19

Ashland - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	1,258	\$33,530,378	\$176,475,674
Commercial	108	\$6,799,614	\$21,248,794
Agricultural	na	\$281,452	\$2,345,433
Real Property Total		\$40,611,444	\$200,069,901
Personal Property		\$9,999,134	\$29,937,527
Railroads and Utilities		\$1,192,927	\$3,727,897
Total		\$51,803,505	\$233,735,325
Source: Boone County Assessor's Office			
City Owned Property			
Count		Replacement Value	
Buildings	28	\$5,139,188	
Vehicles	18	\$442,781	
Source: City of Ashland Insurance Statement			

Relevant Changes since 2010

Ashland has experienced robust growth in the past 5 years. While data is not available for that 5-year time frame, the changes between the 2000 and 2010 Censuses give a sense of the strong growth: the city population almost doubled (98% increase) between 2000 and 2010; there was an increase of 710 housing units during that period (87% increase). The City added over 200 utility connections in the past three years. The City annexed two areas since 2010 (Figure 3.20).

Figure 3.20



Future Development Plans

Ashland continues to grow at a strong rate; there are currently 420 residential lots which are at least preliminary platted and expected to be built upon in the next ten years. Leadership strategies are focused on effectively managing growth.

The Baptist Home, a private not-for-profit retirement

community, has submitted a letter of intent to annex into City limits and connect to the Ashland sewer system. The sewer collection system will run north along U.S. Highway 63 with full intents and purposes of serving the Airport Planned Industrial and Airport Planned Commercial zoning districts. The City has also received interest from property owners outside the City limits in the H Highway/63 corridor about annexing in the future. Details remain to be worked out but it is possible that Ashland's city footprint could expand significantly in the area near the airport in the next 5-10 years.

It is not anticipated that there will be any new subdivisions proposed and annexed into the City in the next five years; however, market forces may dictate otherwise.

CENTRALIA

Figure 3.21	
Centralia Profile	
City classification	4 th class
Population (2010)	4,027
Total housing units (2010)	1755
Median household income (ACS)	\$44,625 (+/- \$6,214)
Median owner-occupied housing value (ACS)	\$87,300 (+/- \$12,145)
Water service	City of Centralia
Electric service	City of Centralia
Sewer service	City of Centralia
Fire service	City of Centralia
Ambulance service	Boone Hospital Center
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No
Master plan	Yes
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes – underground utilities required; post-development flows must mimic pre-development flows for stormwater
Stormwater regulations	No
Floodplain regulations	Yes
NFIP member	Yes
Website	www.centraliamo.org
Sources: City staff; US Census (2010); ACS (American Community Survey 2009-2013)	

The Mayor and the Board of Aldermen are the policy making bodies in the city government. Centralia also has the following offices and staff positions:

- City Administrator
- City Clerk
- Fire
- Police
- Foreman of Streets and Sanitation
- Foreman of Water and Sewer
- Line Foreman

Historic Properties

The National Register of Historic Properties lists the following properties in Centralia:

- Albert Bishop Chance House and Gardens
- Chatol

Figure 3.22			
Centralia - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	1,536	\$24,557,710	\$129,251,105
Commercial	122	\$11,537,740	\$36,055,438
Agricultural	na	\$36,681	\$305,675
Real Property Total		\$36,132,131	\$165,612,218
Personal Property		\$12,158,131	\$36,401,590
Railroads and Utilities		\$705,682	\$2,205,256
Total		\$48,995,944	\$204,219,064
Source: Boone County Assessor's Office			
City Owned Property			
Count		Value	
Buildings	7	\$11,606,043 (replacement)	
Vehicles	67	\$1,002,388 (insured)	
Source: City of Centralia Insurance Statement			

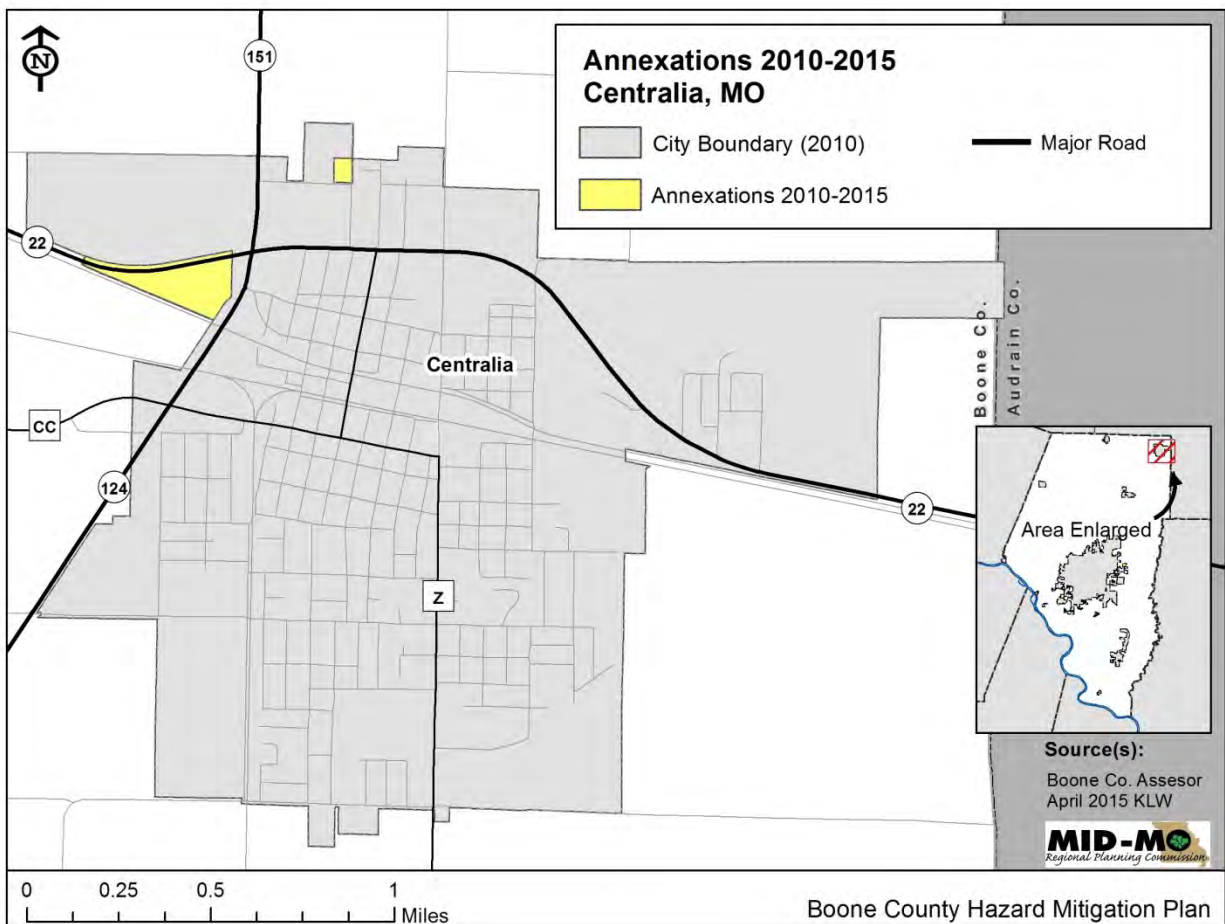
Relevant Changes since 2010

The City of Centralia has a new City Administrator who is in the process of reviewing the plans and notes of the previous Administrator.

Additional undergrounding has been accomplished and improvements to the electric grid are underway to minimize outages across town during significant, but not catastrophic, storms. In addition, a backup generator has been installed at the Fountain Street sanitary sewer lift station.

The City has annexed two areas since 2010 (Figure 3.23).

Figure 3.23



Future Development Plans

The City anticipates additional growth at the boundaries of the City with possible small annexations. In addition, there are two subdivisions on the southwest part of the City which have not been fully built out. They would likely fill out before the year 2020.

COLUMBIA

Figure 3.24 Columbia Profile	
City classification	Home rule
Population (2010)	108,500
Total housing units (2010)	46,758
Median household income (ACS)	\$43,262 (+/- \$1,306)
Median owner-occupied housing value (ACS)	\$169,800 (+/- \$3,577)
Water service	Columbia Water District
Electric service	City of Columbia
Sewer service	City of Columbia; Boone Co. Regional Sewer District
Fire service	City of Columbia; Boone Co. Fire Protection District
Ambulance service	Boone Hospital Center; University Hospital
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	In progress
Master plan	Yes
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes
Stormwater regulations	Yes
Floodplain regulations	Yes
NFIP member	Yes
Website	www.gocolumbiamo.com
Sources: City staff; US Census (2010); ACS (American Community Survey 2009-2013)	

The City of Columbia has a council/manager form of government. The mayor and 6 council members are elected by the citizens of Columbia and serve as non-paid members for 3 years with staggered terms of service. The City Manager reports to the Mayor and Council and is considered the chief administrator. Department heads for all municipal functions report to the City Manager. Columbia also has the following offices and staff positions:

- City Manager
- City Clerk
- Office of Emergency Management
- Fire
- Planning & Development
- Police
- Public Communications
- Public Safety Joint Communications (PSJC)
- Public Works

Historic Properties

There are a large number of properties in Columbia listed on the National Register of Historic Properties (Figure 3.25).

Figure 3.25 National Register of Historic Places - Columbia	
Ballenger Building	Maplewood
(Blind Boone) John W. Boone House	McCain Furniture Store
Central Dairy Building	Miller Building, Matthews Hardware, Metropolitan Building
Coca-Cola Bottling Company Building	Missouri State Teachers Association
Columbia Cemetery	Missouri Theater
Columbia National Guard Armory	Missouri United Methodist Church
Sanford F. Conley House	Missouri, Kansas, and Texas Railroad Depot
Frederick Douglass School	North Ninth Street Historic District
Downtown Columbia Historic District	Pierce Pennant Motor Hotel
East Campus Neighborhood Historic District	Sanborn Field and Soil Erosion Plots
Samuel H. Elkins and Isabel Smith House	Second Baptist Church
First Christian Church	Second Christian Church
Francis Quadrangle Historic District	Senior Hall
Gordon Tract Archeological Site	St. Paul A.M.E. Church
David Gordon House and Collins Log Cabin	Stephens College, South Campus
Greenwood	John N. and Elizabeth Taylor House
David Guitar House	Tiger Hotel
Hamilton--Brown Shoe Factory	Virginia Building
William B. Hunt House	Wabash Railroad Station and Freight House
Kress Building	Wright Brothers Mule Barn
Source: http://www.nr.nps.gov/nrloc1.htm	

Figure 3.26

Columbia - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	30,491	\$1,022,348,184	\$5,380,779,916
Commercial	3,789	\$477,511,200	\$1,492,222,500
Agricultural	na	\$6,278,850	\$52,323,750
Real Property Total		\$1,506,138,234	\$6,925,326,166
Personal Property		\$303,450,790	\$908,535,299
Railroads and Utilities		\$4,095,085	\$12,797,141
Total		\$1,813,684,109	\$7,846,658,606
Source: Boone County Assessor's Office			
City Owned Property			
	Count	Value	
Buildings	315	\$798,846,928	Replacement - bldgs. & contents
Vehicles	640	\$43,146,460	Insured value
Source: City of Columbia Insurance Statement			

Relevant Changes since 2010

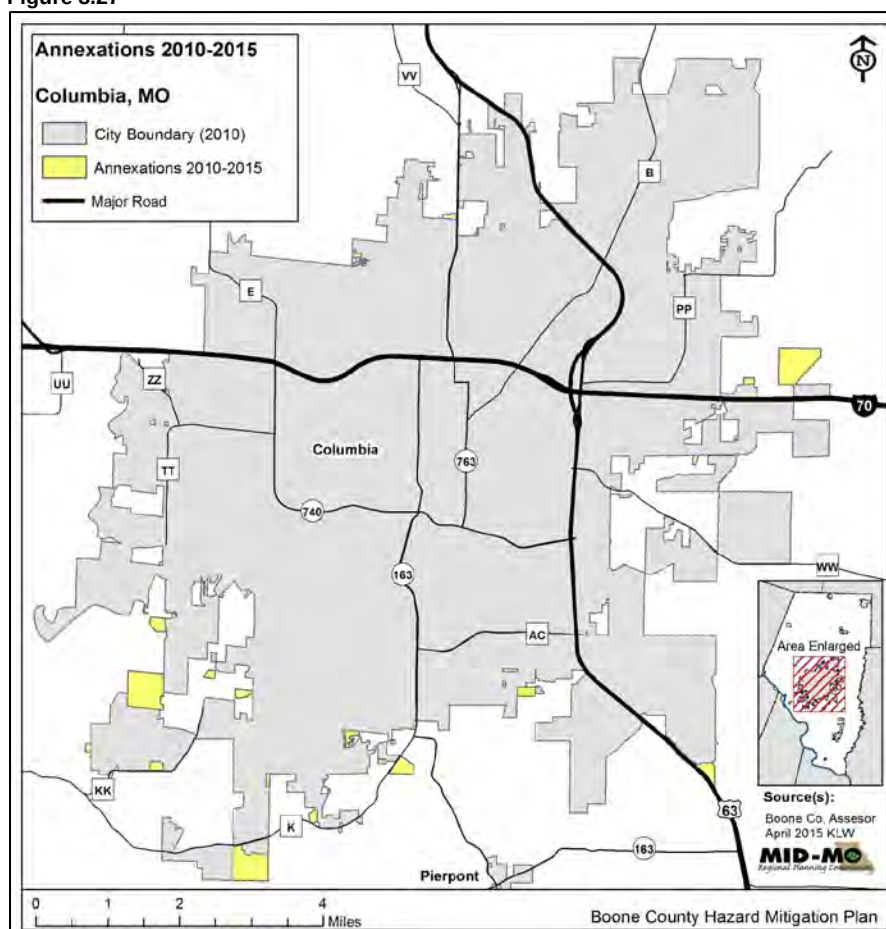
In the five years since the Boone County Hazard Mitigation Plan was last updated and adopted by the City of Columbia, ongoing mitigation activities have occurred. This includes burying electric lines and flood buyouts when possible.

A notable change in this time period is that the E-911 Columbia/Boone County Office of Emergency Management has separated from the City of Columbia's organizational structure and is now funded through a dedicated countywide three-eighths-cent sales tax passed in April of 2013.

The most notable hazard event in the five years since plan adoption was a severe windstorm in July of 2014 which resulted in power loss of up to nearly a week and tree and property damage in the western portion of the City. Other hazard events experienced by the City were limited to seasonal hazard events such as minor flooding and heavy snowfalls.

The City of Columbia has annexed numerous areas since 2010 (Figure 3.27).

Figure 3.27



Future Development Plans

The City of Columbia anticipates population growth will continue between 1.1 and 1.5% annually, according to the City's adopted comprehensive plan *Columbia Imagined*, with a projected population between 120,677 and 125,919 in 2020. This represents a growth of 5,000-10,000 people over the five year hazard mitigation plan horizon. Growth is anticipated to primarily occur within the Urban Services Area (USA) boundary identified in *Columbia Imagined*, as this area has sewer and often other utility infrastructure capacity. Most development is anticipated to occur in the southwest and northeast areas of Columbia, with areas on the southeast anticipated to also have some growth based upon recent platting activity. Large annexations and subdivision activity around the relatively new Battle High School and Elementary School in the northeast will provide many acres of new development and growth. Infill development in the City's core will also absorb some of the anticipated population growth.

The City's Capital Improvement Program (CIP) describes planned capital improvements by type (streets and sidewalks, parks, public safety, airport, utilities, etc.). Notable future civic developments likely to occur in the next five years include a new electric substation on the south side of town, the Henderson/Midway Sewer Branch extension to the west and outside of the City limits, a new taxiway at the airport, and a new police precinct/municipal service center (location to be determined).

HALLSVILLE

Figure 3.28 Hallsville Profile	
City classification	4th class
Population (2015 info from City)	1,537
Total housing units (2015 info from city)	643
Median household income (ACS)	\$52,500 (+/- \$6,492)
Median owner-occupied housing value (ACS)	\$129,700 (+/- \$6,526)
Water service	City of Hallsville; Water District 4
Electric service	Boone Electric Coop; Ameren Missouri
Sewer service	City of Hallsville
Fire service	Boone Co. Fire Protection District
Ambulance service	Boone Hospital Center
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No
Master plan	Yes
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes
Stormwater regulations	No
Floodplain regulations	Yes
NFIP member	Yes
Website	hallsvillemissouri.wordpress.com
Sources: City staff; ACS (American Community Survey 2009-2013)	

The Mayor and the Board of Aldermen are the policy making bodies in the city government. Hallsville also has the following offices and staff positions:

- City Administrator
- Chief of Police
- City Clerk
- Planning & Zoning Commission

Figure 3.29

Hallsville - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	470	\$9,855,808	\$51,872,674
Commercial	41	\$2,323,152	\$7,259,850
Agricultural	na	\$46,869	\$390,575
Real Property Total		\$12,225,829	\$59,523,099
Personal Property		\$3,277,545	\$9,813,009
Railroads and Utilities		\$668,954	\$2,090,481
Total		\$16,172,328	\$71,426,589
Source: Boone County Assessor's Office			
City Owned Property			
	Count	Value	
Buildings	6	\$1,217,828	(replacement)
Vehicles	5	\$73,135	(insured)
Source: City of Hallsville Insurance Statement			

Relevant Changes since 2010

The City of Hallsville experienced strong growth between 2000 and 2010. It continues to grow but it is pursuing a policy of continued slow growth with careful planning; this is especially important for the city as it is within commuting distance of Columbia where many jobs are located.

Part of the approach to controlled growth is the infilling of empty lots; there have not been any annexations in recent years. In addition the city specifies minimum lot sizes and setbacks.

Future Development Plans

A 60-acre subdivision is being planned for the northwest corner of the city. This area is zoned R-1 (single family). The development will include green space and a buffer space next to a nearby tributary; lot sizes will be 3-4 acres.

HARRISBURG

Figure 3.30 Harrisburg Profile	
City classification	Village
Population (2010)	266
Total housing units (2010)	121
Median household income (ACS)	\$40,625 (+/- \$9,489)
Median owner-occupied housing value (ACS)	\$122,900 (+/- \$20,150)
Water service	Village of Harrisburg; Consolidated PWD No. 1
Electric service	Boone Electric Coop
Sewer service	Village of Harrisburg
Fire service	Boone Co. Fire Protection District
Ambulance service	Boone Co. Fire Protection District
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No
Master plan	No
Building regulations	Yes
Zoning regulations	No
Subdivision regulations	No
Stormwater regulations	No
Floodplain regulations	Yes
NFIP member	Yes
Website	No
Sources: Village of Harrisburg; US Census (2010); ACS (American Community Survey 2009-2013)	

The Board of Trustees is the policy making body in Harrisburg. The village also has the following staff position:

- City Clerk

Figure 3.31			
Harrisburg - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	78	\$1,647,865	\$8,672,974
Commercial	7	\$186,412	\$582,538
Agricultural	na	\$8,537	\$71,142
Real Property Total		\$1,842,814	\$9,326,653
Personal Property		\$602,835	\$1,804,895
Railroads and Utilities		\$55,162	\$172,381
Total		\$2,500,811	\$11,303,929
Source: Boone County Assessor's Office			
City Owned Property			
Count		Replacement Value	
Buildings	2	\$86,100	
Vehicles	0	na	
Source: Village of Harrisburg Insurance Statement			

Historic Properties

The National Register of Historic Properties lists the following property in Harrisburg:

- Harrisburg School--Ancient Landmark Masonic Lodge Number 356 A.F. & A.M.

Relevant Changes since 2010

The Village of Harrisburg joined the NFIP in 2012. The Village also went through a strategic planning process during which it examined its infrastructure and what would be needed for growth.

The Village is interested in preserving its historic structures while in the process of growth. With this in mind, the Village acquired the old hardware store. It is currently in legal discussions regarding the title transfer of Harrisburg School ("The Old School House") and its grounds from the Harrisburg R-VIII School District to the Village.

Future Development Plans

The Village is discussing the sale of extra acreage at the water treatment plant and the possible sale or development of seven acres next to the cemetery.

HARTSBURG

Figure 3.32 Hartsburg Profile	
City classification	Village
Population (2010)	103
Total housing units (2010)	59
Median household income	Meaningful data is not available
Median owner-occupied housing value	Meaningful data is not available
Water service	Consolidated PWD No. 1
Electric service	Ameren Missouri
Sewer service	City of Hartsburg
Fire service	So. Boone Co. Fire Protection District
Ambulance service	University Hospital
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No - but does not seem to be needed - no paid city staff; no budget; there is a backup in place as a check writer
Master plan	No
Building regulations	Yes
Zoning regulations	Yes (follow Boone County's)
Subdivision regulations	No
Stormwater regulations	Yes (follow Boone County's)
Floodplain regulations	Yes
NFIP member	Yes
Website	No
Sources: City staff; US Census (2010)	

The Mayor and the City Council are the policy making bodies in the village government.

Figure 3.33

Hartsburg - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	42	\$411,885	\$2,167,816
Commercial	6	\$195,392	\$610,600
Agricultural	na	\$3,433	\$28,608
Real Property Total		\$610,710	\$2,807,024
Personal Property		\$212,576	\$636,455
Railroads and Utilities		\$101,153	\$316,103
Total		\$924,439	\$3,759,582
Source: Boone County Assessor's Office			
City Owned Property			
	Count	Replacement Value	
Buildings	1	\$60,000	
Vehicles	1	na	
Source: City of Hartsburg Insurance Statement			

Historic Properties

The National Register of Historic Properties lists the following properties in Hartsburg:

- Bond's Chapel Methodist Episcopal Church
- Samuel E. Hackman Building

Future Development Plans

The City of Hartsburg plans to extend its sewer line to the north; funding for the project still needs to be found.

HUNTSDALE

Figure 3.34 Huntsdale Profile	
City classification	Village
Population (2010)	31
Total housing units (2010)	15
Median household income	Meaningful data is not available due to limitations of ACS
Median owner-occupied housing value	Meaningful data is not available due to limitations of ACS
Water service	Consolidated PWD No. 1
Electric service	Boone Electric Coop
Sewer service	Septic systems
Fire service	Boone Co. Fire Protection District
Ambulance service	University Hospital
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	Not needed due to size and nature of village operations
Master plan	No
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Not applicable
Stormwater regulations	No, but great attention paid to storm water ditches and drainage
NFIP member	Application submitted May 2015
Floodplain regulations	Yes
Website	http://members.tranquility.net/~cdph/index.html
Sources: City staff; US Census (2010)	

The Mayor and the Town Council are the policy making bodies of the government. Town council members attend training sponsored by the MML and any community training provided by OEM, Fire District, & Red Cross. Huntsdale also employs a City Clerk.

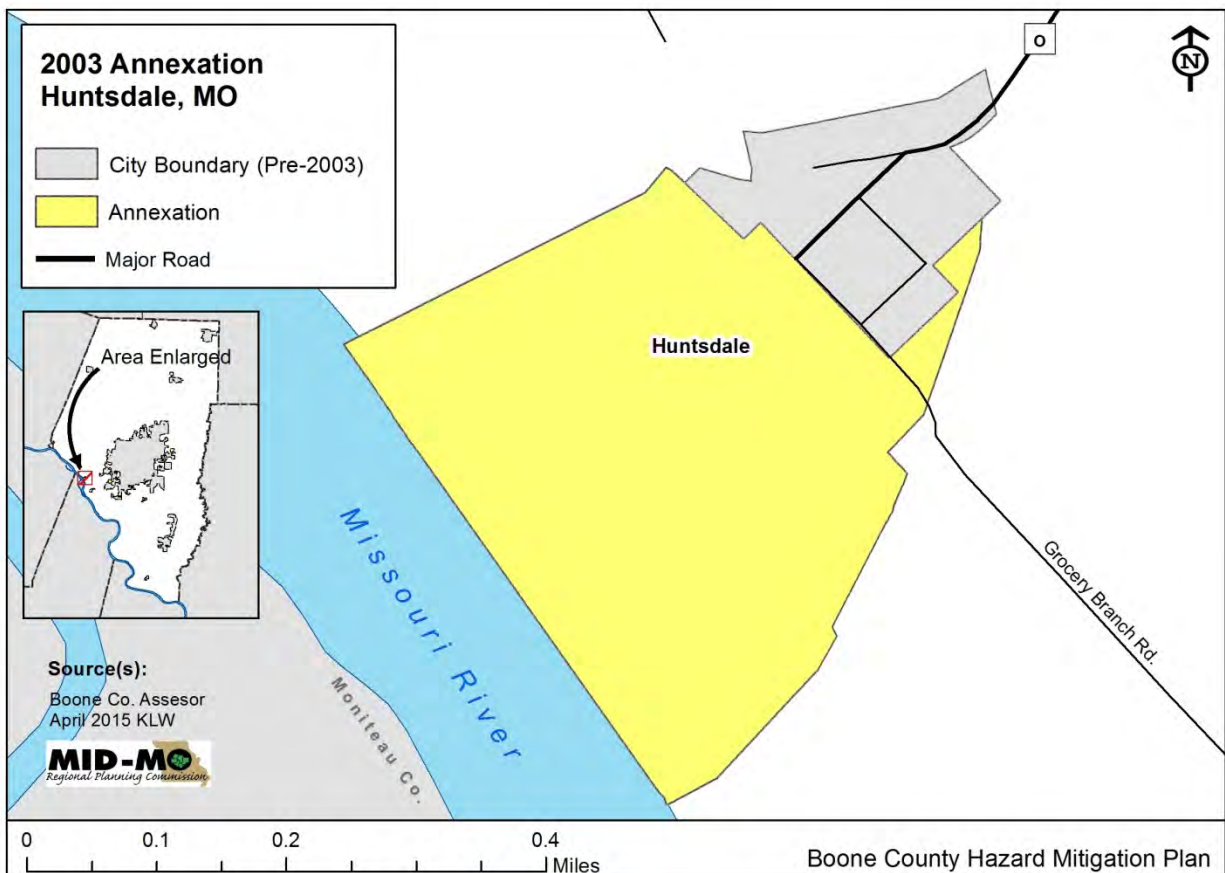
Building counts and assessed values are not available for the Village of Huntsdale; they are included in the Boone County tax levy and separate information for the village is not broken out. The Village of Huntsdale itself does not own any buildings or vehicles.

Relevant Changes since 2010

Huntsdale hired an engineering firm to redesign the streets and storm water ditches throughout the village. The project was begun in 2007 and construction was completed in 2012.

In 2010, the Village was notified by the County that paperwork for a large annexation completed in 2003 (Figure 3.35) could not be found. The paperwork for the previously annexed area was resubmitted. The piece of land in question includes Katfish Katy's, a local shop which serves visitors on the Katy Trail State Park biking trail and provides a campground by the river; the tract is entirely within the Missouri River floodplain.

Figure 3.35



Future Development Plans

There are no development plans at this time.

ROCHEPORT

Figure 3.36 Rocheport Profile	
City classification	4th class
Population (2010)	239
Total housing units (2010)	128
Median household income	Meaningful data is not available
Median owner-occupied housing value	\$128,100 (+/- \$18,957)
Water service	Consolidated PWD No. 1
Electric service	Boone Electric Coop
Sewer service	BCRSD
Fire service	Boone Co. Fire Protection District
Ambulance service	University Hospital
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	No, but there is a backup location for City Hall across town and the city does not conduct much of its own business anymore; a COOP doesn't seem necessary to size and nature of operations
Master plan	No, but City Council is discussing possibility of developing
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes - PUD (Planned Unit Development) in Planning & Zoning Ordinance
Stormwater regulations	No
Floodplain regulations	Yes
NFIP member	Yes
Website	www.rocheport.com (tourism website)
Sources: City staff; US Census (2010)	

The Mayor and the City Council are the policy making bodies in the city government. The City employs a City Clerk.

Figure 3.37

Rocheport - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	103	\$1,666,711	\$8,772,163
Commercial	29	\$698,794	\$2,183,731
Agricultural	na	\$2,301	\$19,175
Real Property Total		\$2,367,806	\$10,975,069
Personal Property		\$483,516	\$1,447,653
Railroads and Utilities		\$25,179	\$78,684
Total		\$2,876,501	\$12,501,406
Source: Boone County Assessor's Office			
City Owned Property			
Count		Replacement Value	
Buildings	3	\$178,500	
Vehicles (1) and equipment		\$100,000	
Source: City of Rocheport Insurance Statement			

Historic Properties

The National Register of Historic Properties lists the following properties in Rocheport:

- Rocheport Historic District
- Moses U. Payne House

Relevant Changes since 2010

The City of Rocheport included the following mitigation action in the 2010 plan: "Evaluate and implement effective strategies to mitigate flooding at the wastewater treatment plant in Rocheport." The City of Rocheport no longer owns or operates the wastewater treatment plant; it is now owned and operated by the Boone County Regional Sewer District.

Future Development Plans

There has been discussion at the City Council regarding developing a Master Plan for the City of Rocheport, but the city has no future development plans at this time.

STURGEON

Figure 3.38 Sturgeon Profile	
City classification	4 th class
Population (2010)	872
Total housing units (2010)	401
Median household income (ACS)	\$39,050 (+/- \$7,553)
Median owner-occupied housing value (ACS)	\$77,500 (+/- \$10,418)
Water service	City of Sturgeon
Electric service	Boone Electric Coop; Ameren Missouri
Sewer service	City of Sturgeon
Fire service	Boone Co. Fire Protection District
Ambulance service	Boone Hospital Center
Emergency Operations Plan	Yes
Continuity of Operations Plan (COOP)	In progress
Master plan	No
Building regulations	Yes
Zoning regulations	Yes
Subdivision regulations	Yes
Stormwater regulations	No
Floodplain regulations	Yes
NFIP member	Yes
Website	www.sturgeon-mo.org
Sources: City staff; US Census (2010); ACS (American Community Survey 2009-2013)	

The Mayor and the Board of Aldermen are the policy making bodies in the city government. The City employs a City Clerk and Police Chief.

Figure 3.39

Sturgeon - Property and Valuation			
Buildings		Value	
Type and Number		Assessed	Market
Residential	309	\$3,917,724	\$20,619,600
Commercial	33	\$869,716	\$2,717,863
Agricultural	na	\$10,813	\$90,108
Real Property Total		\$4,798,253	\$23,427,571
Personal Property		\$1,502,012	\$4,497,042
Railroads and Utilities		\$853,784	\$2,668,075
Total		\$7,154,049	\$30,592,688
Source: Boone County Assessor's Office			
City Owned Property			
Count		Replacement Value	
Buildings	8	\$1,307,721	
Vehicles	4	\$72,000	
Source: City of Sturgeon Insurance Statement			

Relevant Changes since 2010

In 2010, after the Hazard Mitigation Plan was finalized, the City passed Ordinance #724 re: burning in the city.

In 2015, the City annexed a parcel of land across from the high school in preparation for the location of a Dollar General Store in Sturgeon.

Future Development Plans

Sturgeon is in the process of changing the wastewater system to a no discharge/land application system. A holding basin is being built for treated wastewater from the lagoons; the treated wastewater will be applied to farmland located east of the city.

3.3 SCHOOL DISTRICTS AND HIGHER EDUCATION

School Districts

CENTRALIA R-VI SCHOOL DISTRICT

Figure 3.40			
Centralia R-VI School District			
School Name	Grades	Certified Staff	Enrollment 2013-14
Chance Elementary	PK-2	58	660
Centralia Intermediate	3-5		
Chester Boren Middle	6-8	32	327
Centralia High	9-12	39	435
	Total	129	1,422
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2014			
Property Valuation			
	Count	Replacement Value (including contents)	
Buildings	17	\$43,395,372	
Vehicles	27	na	
Source: School District Insurance Statement			

Relevant Changes since 2010

District personnel have been visiting other school districts to learn more about tornado safe rooms and possible funding avenues. The possibility of building a Fine Arts monolithic dome which would double as a safe room is being explored.

The District partnered with the City of Centralia in February 2013 to add a School Resource Officer who will be instrumental in all areas of school safety and disaster preparedness.

Future Development Plans

District personnel continue to ponder a Fine Arts Center which would double as a tornado safe room.

COLUMBIA PUBLIC SCHOOLS

Figure 3.41 Columbia Public Schools - Overview			
	Schools	Certified Staff	Enrollment 2013-14
Elementary Schools	25	744	8,918
Middle Schools	6	373	3,834
High Schools	5	607	5,120
Total	36	1,724	17,872
Sources: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2014; School District			
Property Valuation			
	Count	Replacement Value (including contents)	Insured Value
Buildings	38	Not available	
Vehicles	Not available		Not available
Sources: School District Insurance Statement			

Relevant Changes since 2010 and Future Development Plans

Columbia Public Schools is experiencing high levels of increasing enrollment and growth. (The City of Columbia had a 28% increase in growth between 2000 and 2010.) Enrollment in the district was 15,942 in 2000-01; this had increased to 17,872 by 2013-14 and is projected at 18,377 for the 2019-20 school year.

In order to meet the demands of this growth, the overall development plan is to have a building under construction in the district every year for the next 15 years. A new high school, Battle High, was opened in 2013. At the present time, there are three new schools under construction: Battle Elementary which is scheduled to open in August 2015; Beulah Ralph Elementary which is scheduled to open in August 2016; a new Early Childhood Building is being constructed at Lange Middle School.

The 2014-15 school year marked the largest all-time enrollments in the first, second, fourth and fifth grade classes. The opening of two new elementary schools will help with this growth; a new middle school will probably be constructed next.

A long-term goal of the district has been to eliminate trailer classrooms which pose an obvious heightened risk for hazards such as tornadoes, damaging winds, and earthquakes. Progress has been made on that goal; the 220 trailers being used in the district in 2010-11 had been reduced to about 150 by the 2014-15 school year.

There is a great need for satisfactory tornado sheltering at the district's schools. This is a huge and expensive task, especially given the tight economic times and the size of the district.

Figure 3.42			
Columbia Public Schools - Schools and Administrative Buildings			
School Name	Grades	School Name	Grades
Alpha Hart Lewis Elementary	PK-05	Parkade Elementary	PK-05
Battle Elementary*	PK-05	Rainforest Parkway Early Childhood Center	
Beulah Ralph Elementary*	PK-05	Robert E. Lee Elementary	PK-05
Blue Ridge Elementary	PK-05	Rock Bridge Elementary	PK-05
Cedar Ridge Elementary	PK-05	Russell Boulevard Elementary	PK-05
Derby Ridge Elementary	PK-05	Shepard Boulevard Elementary	PK-05
Fairview Elementary	PK-05	Thomas Benton Elementary	PK-05
Field Elementary/EEE	PK-05	Two Mile Prairie Elementary	K-05
John Ridgeway Elementary	K-05	Ulysses S. Grant Elementary	PK-05
Mary Paxton Keeley Elementary	PK-05	Waco Rd. Early Childhood Development	PK
Midway Heights Elementary	PK-05	West Boulevard Elementary	PK-05
Mill Creek Elementary	PK-05	Early Childhood Building (unnamed)*	
New Haven Elementary	PK-05		
Ann Hawkins Gentry Middle	6-8	Oakland Middle	6-8
Jefferson Middle	6-8	Smithton Middle	6-8
John B. Lange Middle	6-8	West Middle	6-8
David H. Hickman High	9-12	Muriel W. Battle High	9-12
Frederick Douglass High	9-12	Rock Bridge Sr. High	9-12
Columbia Area Career Center	10-12		
Aslin Administration Building		Facilities and Construction Services Building	
* Under construction			
Source: School District			

HALLSVILLE R-IV SCHOOL DISTRICT

Figure 3.43 Hallsville R-IV School District			
School Name	Grades	Certified Staff	Enrollment 2013-14
Hallsville Primary	PK-1	62	650
Hallsville Intermediate	2-5		
Hallsville Middle	6-8	31	331
Hallsville High	9-12	36	382
	Total	129	1,363
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2014			
Property Valuation			
	Count	Replacement Value (including contents)	Insured Value
Buildings	5	Not available	
Vehicles	27		Not available
Source: School District staff			

The School District received the Fleet Excellence Award for its performance on bus safety inspections in 2014; the bus inspections achieved a 95% approval rate. The award is presented by the Missouri Highway Patrol. 2014 was the 11th year out of 12 that the district received the award.

Relevant Changes since 2010

Some additions to the high school (a science wing and a health and fitness classroom/weight room) are currently nearing completion.

Future Development Plans

There are no known future development plans at this time.

HARRISBURG R-VIII SCHOOL DISTRICT

Figure 3.44 Harrisburg R-VIII School District			
School Name	Grades	Certified Staff	Enrollment 2013-14
Harrisburg Elementary	K-5	28	269
Harrisburg Middle	6-8	17	120
Harrisburg High	9-12	22	166
	Total	67	555
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2014			
Property Valuation			
	Count	Replacement Value (including contents)	Insured Value
Buildings	15	\$22,129,873	
Vehicles	15		\$47,487
Sources: School District Insurance Statement			

Relevant Changes since 2010

The following additions and enhancements to the school district infrastructure has taken place:

- addition of office complex on the elementary school
- addition of football grandstand
- playground and parking lot enhancements
- new HVAC systems in middle school

Future Development Plans

Currently there are not any specific future development plans. Long-term facilities plan goals include the addition of a middle school building, addition of a softball field in the high school sports complex and the acquisition of land for future growth.

SOUTHERN BOONE COUNTY R-I SCHOOL DISTRICT

Figure 3.45 Southern Boone Co. R-I School District			
School Name	Grades	Certified Staff	Enrollment 2013-14
Southern Boone Primary	PK-2	63	746
Southern Boone Elementary	3-5		
Southern Boone Middle	6-8	31	355
Southern Boone High	9-12	52	480
	Total	146	1,581
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2014			
Property Valuation			
	Count	Replacement Value (including contents)	Insured Value
Buildings	5	\$51,000,000	
Vehicles	32		
Sources: School District Insurance Statement			

Relevant Changes since 2010

The district demolished the original school building, built 1903. It was connected to the Middle School building that houses the 6th grade.

Future Development Plans

The district is considering a bond issue for April 2016 to potentially add on to the Primary building (6 to 8 classrooms and possibly a new gym), potentially add onto the high school gym for a weight room and locker room, and potentially install artificial turf to the track and football field.

STURGEON R-V SCHOOL DISTRICT

Figure 3.46			
Sturgeon R-V School District			
School Name	Grades	Certified Staff	Enrollment 2013-14
Sturgeon Elementary	K-4	21	206
Sturgeon Middle	5-8	16	128
Sturgeon High	9-12	19	148
	Total	56	482
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2014			
Property Valuation			
	Count	Replacement Value (including contents)	
Buildings	2	\$15,895,192	
Vehicles	8		
Sources: School District Insurance Statement			

Future Development Plans

Sturgeon R-V School District is currently constructing the following new facilities:

- Two classrooms at the High School
- An outdoor track at the High School
- A canopy at the High School

Higher Education

COLUMBIA COLLEGE

Figure 3.47 Columbia College (planning area only)			
		Property Valuation	
	Count	Replacement Value (including contents)	Insured Value
Student Population (planning area only)	1597		
Faculty	157		
Staff	483		
Buildings	27	\$270,000,000	
Vehicles	22		\$5,500,000
Sources: College staff, Insurance Statement			

Relevant Changes at Columbia College since 2010

Columbia College has invested in the following new construction and improvements in the past five years:

- Browder Science Center (new building construction)
- Athletic Soccer Field and Facility (new building construction and new artificial turf)
- New cooling tower and wells
- Parking lot build and upgrade (8th St. and Wilkes Blvd.)

Future Development Plans

There are plans to redevelop the central part of campus.

STEPHENS COLLEGE

Figure 3.48		
Stephens College		
	Count	Property Valuation
Student Population	775 on-campus	
	385 commuting	
Faculty and Staff	318	
Total Buildings	14	Not available
Residential dorms	5	
Office & Operations facilities	4	
Learning Center	4 and the library	
Plant Facilities	1	
Source: Stephens College		

Relevant Changes since 2010

Stephens College sold off property, including two buildings, in 2013. The college received a \$15 million donation by an anonymous donor in 2014. The money is to be used to support Stephen's mission and invest in its future as the college deems fit; the donation was the largest in the college's history.

Future Development Plans

There are currently no future development plans which would impact hazard mitigation considerations on the campus.

UNIVERSITY OF MISSOURI

Figure 3.49		
University of Missouri - Columbia		
	Count	
Student Population	35,441	
Faculty	2,600	
Staff	5,500	
	Count	Total Property Valuation (estimate)
Buildings	357	\$3,209,097,047
Vehicles	967	
Sources: University staff		

MU owns its own power generation capability and potable water treatment system; the entire MU campus is a botanical garden.

The University has both a Continuity of Operations Plan for infrastructure and a Business Continuity Plan in place.

Relevant Changes since 2010

The University of Missouri has made several significant changes since 2010. It has built numerous new buildings and facilities for faculty, students and staff, as well as sporting facilities open to the public. This expansion has created \$1.14 billion in economic impact from planning, design and construction.

The average rate of growth of student, faculty and staff positions over the past 5 years averages 2.5% per year. MU is self-insured for general liability, loss, health insurance and workers compensation.

The university has also hired a professional emergency manager, revised a campus-wide emergency management plan and individual building emergency plans, and developed a complete suite of alert and warning capabilities.

Future Development Plans

The University has an updated master plan for all facilities and infrastructure in direct collaboration with the City of Columbia. This includes major renovations to historic buildings, refurbishing outdated infrastructure and building new state of the art facilities. Information about the most the recent MU Campus Master Plan can be found at:
<http://www.cf.missouri.edu/masterplan/>.

Additional activities include working on the NWS Storm Ready designation and continued work on improving mass alert and warning systems to be compliant with Clery Act and accreditation requirements of the state and federal government.

3.4 OTHER SPECIAL DISTRICTS AND ORGANIZATIONS

There are numerous special districts in the planning area which are vital to the health and safety of the population. In addition to providing basic services, personnel of the Special Districts possess a wealth of knowledge and experience valuable for hazard mitigation planning.

ROAD AND BRIDGE DISTRICTS

Centralia Special Road District

- Organized through Chapter 233 of the Missouri Statutes
- Composed of three commissioners elected to serve three-year terms
- Responsible for maintaining the roads and bridges of the Centralia Township and an additional 15 square miles in the area

The three commissioners of the District can identify projects that may be particularly helpful to protecting the road infrastructure of northeastern Boone County.

NON-GOVERNMENTAL AND VOLUNTEER ORGANIZATIONS

Organizations and Volunteers Active in Disasters (OVAD)

OVAD provides for the effective use of volunteers in enhancing the ability to mitigate, prepare, respond, and recover from disasters throughout Boone County. OVAD activity is coordinated through the Boone County office of the State of Missouri Division of Family Services, in conjunction with the overall plan from the Office of Emergency Management.

Organizations in Boone County such as the American Red Cross, Columbia Office of Volunteer Services, Salvation Army, Columbia/Boone County Health Department, church agencies, and other non-profits are active in supporting the work of OVAD.

3.5 POLICY, PLANNING, AND PROGRAM CAPABILITIES

This section presents a general overview of capabilities found within the planning area. It begins with a discussion of the legal authority invested in the local governments by the State of Missouri. This is followed by an overview of policy, planning, and program capabilities within the planning area which can contribute to hazard mitigation efforts and the important roles of the special districts, non-governmental/volunteer organizations, and community/regional partnerships. The section ends with an assessment of the political willpower present in the planning area for taking action on hazard mitigation

LEGAL AUTHORITY

Boone County has at its disposal a variety of powers given to it by the State of Missouri relevant to mitigation activities. A brief review of these powers is listed below.

Land Use and Building Codes

The State of Missouri has given local governments the right to create and enforce planning and zoning regulations around construction and development including areas within designated floodplains and subdivisions.

In Boone County, zoning ordinances define how and where residential and commercial developments can be built. They prescribe the following:

- Where communication facilities can be built
- Where developments can be built
- What the density of a development should be

Subdivision regulations provide specific guidelines that new developments must meet in order to be in compliance with safety and management decisions.

Information on which incorporated communities have zoning and/or building codes is included in Figure 3.50. Boone County, Ashland, Centralia, and Columbia all have building and zoning information available on their websites.

Acquisition

Local governments may find the most effective method for completely “hazard-proofing” a particular piece of property or area is to acquire the property (either in fee or a lesser interest, such as an easement); this removes the property from the private market and eliminates or reduces the possibility of inappropriate development. Missouri legislation empowers cities, towns, and counties to acquire property for public purpose by gift, grant, devise, bequest, exchange, purchase, lease or eminent domain.

Taxation

The power to levy taxes and special assessments is an important tool delegated to local governments by Missouri law. The power of taxation extends beyond the collection of revenue, and impacts the pattern of development in the community.

Local units of government also have the authority to levy special assessments on property owners for all or part of the costs of acquiring, constructing, reconstructing, or improving protective structures within a designated area. This can serve to increase the cost of building in such areas, thereby discouraging development. Special assessments seem to offer little in terms of control over land use in developing areas. They can, however, be used to finance the provision of necessary services within municipal or county boundaries. In addition, they are useful in distributing to the new property owners the costs of the infrastructure required by new development. The major constraint in using special assessments is political.

Spending

Local governments have the power to make expenditures in the public interest. A community can control its growth to some extent by tentatively committing itself to a timetable for the provision of capital to extend services, especially when the provision of on-site sewage disposal and water supply to the surrounding area is unusually expensive. A local community can also regulate the extension of and access to services. This tactic can help guide development away from hazard prone areas.

Police Powers

The police are responsible for protecting the overall public; local governments can add requirements pertinent to hazard mitigation.

COMMUNITY AND REGIONAL PARTNERSHIPS

The Boone County government has working relationships with the towns and cities located within the county as well as with neighboring counties. This is particularly evident in mutual aid agreements that exist between fire and law enforcement jurisdictions.

Boone County jurisdictions have partnered successfully through and with the Mid-MO RPC on regional transportation planning and multiple local grant applications. In addition, local governments have representation on Mid-MO RPC transportation and economic development advisory committees.

POLITICAL WILLPOWER

Boone County citizens have seen the effects of natural hazards in the floods of 1993 and 1995 and the Southridge tornado of 1998. People are well aware of the impacts these events had on lives and property in the county. Due to this awareness, it is expected that the current and future political climates are favorable for supporting and advancing mitigation strategies in Boone County.

PLANS AND REGULATIONS

A summary of the plans and regulations in the County and incorporated communities of the planning area is shown in Figure 3.50.

Figure 3.50

Plans and Regulations Boone County and Incorporated Communities										
✓ = Plan or regulations in place * = in progress ** = follows County	Boone County	Ashland	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon
Emergency Operations Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Continuity of Operations Plan (COOP)	-	-	-	*	-	-	-	-	-	-
Master Plan	✓	✓	✓	✓	✓	-	-	-	-	-
Building regulations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Zoning regulations	✓	✓	✓	✓	✓	-	**	-	-	-
Subdivision regulations	✓	✓	✓	✓	✓	-	-	-	-	-
Stormwater regulations	✓	✓	-	✓	-	-	**	-	-	-
Stormwater Plan	✓	-	-	✓	-	-	-	-	-	-
Floodplain regulations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
National Flood Insurance Program (NFIP) participation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) was established by an act of Congress in 1968. Jurisdictions which participate in the program are required to adopt and enforce floodplain regulations. Property owners in participating jurisdictions are able to purchase federal flood insurance.

Boone County and all of the municipal participating jurisdictions in the Boone County Hazard Mitigation Plan are members of the NFIP (Figure 3.51).

Figure 3.51		
Boone County Jurisdictions - NFIP Status		
Jurisdiction	Entry into Program	Date of Current FIRM
Boone County	06/15/83	3/17/11
Ashland	08/24/84	3/17/2011 (M)
Centralia	04/15/77	3/17/11
Columbia	08/28/71	3/17/11
Hallsville	01/01/06	3/17/2011 (M)*
Harrisburg	06/08/12	3/17/2011 (M)
Hartsburg	08/16/82	3/17/11
Huntsdale	06/11/15	3/17/11
Rocheport	08/02/82	3/17/11
Sturgeon	05/01/87	3/17/2011 (M)
(M) = No Elevation Determined - All Zone A, C and X		
* The City of Hallsville is NSFHA - all Zone C and X.		
Source: http://www.fema.gov/fema/csb.shtm		

Section 4: Risk Assessment

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

Requirement §201.6(c)(2)(ii): *[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2009 must also address NFIP insured structures that have been repetitively damaged by floods.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

Risk assessment is a process of estimating the potential for injury, death, property damage, or economic loss which may result from a hazard. A risk assessment is only as valuable as the thoroughness and accuracy of the information on which it is based. As will be seen, there is a great variation between hazards in the amount and reliability of the data available for analysis.

Identification of Hazards

The following natural hazards have been identified as posing potential risk in Boone County:

- Flood (includes riverine flooding, flash flooding, and storm water flooding)
- Levee Failure
- Dam Failure
- Earthquake
- Land Subsidence/Sinkhole
- Severe Thunderstorms (includes Damaging Winds, Hail, and Lightning)
- Tornado
- Severe Winter Weather (Snow, Ice, and Extreme Cold)
- Drought
- Extreme Heat
- Wildfire

The Missouri State Hazard Mitigation Plan (2013) indicates that expansive soils, landslides, and rockfalls are recognized as hazards in Missouri but occur infrequently and with minimal impact. For this reason, those hazards were not profiled in the state plan nor will they be profiled in the Boone County Plan.

There are certain other natural hazards which FEMA requires to be addressed in Hazard Mitigation Plans if they are applicable to the planning area. Avalanches and volcanoes have not been included in this plan as they do not pose a threat due to Boone County's topography and geology. Coastal erosion, coastal storms, hurricanes, and tsunamis do not pose a threat to the county due to its inland location.

In addition to natural hazards, the following technological/human hazards have been identified as posing potential risk in Boone County and are profiled in this plan in Section 5:

- Public Health Emergency
- Hazardous Materials Release
- Transportation Incident
- Nuclear Incident
- Utility Service Disruption
- Telecommunications Disruption
- Cyber Attack
- Unwanted Intruder/Active Shooter
- Terrorism
- Civil Disorder
- Mass Casualty/Fatality Event

Risk Assessments for Identified Hazards

A Risk Assessment has been conducted for each hazard identified as affecting the planning area. The remainder of this section includes these risk assessments which are organized according to the following outline:

DESCRIPTION OF HAZARD

Location

Extent - The extent of the hazard refers to the strength or magnitude of that hazard which can be expected in the planning area; extent is an attribute of the hazard alone and does not include its effect on humans or the built environment.

Previous Occurrences

Probability of Future Events (Natural Hazards) - The probability of future events is, for the most part, based on historical data while also taking into account the expected impact of climate change. It is assigned based on the following scale which was slightly modified from that found in the *Missouri State Hazard Mitigation Plan (2013)*:

- Low – The hazard has little or no chance of happening (less than 1 percent chance of occurrence in any given year)
- Moderate – The hazard has a reasonable probability of occurring (between 1 and 10 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).

In the case of earthquakes, projections made by the USGS have also been taken into account in assessing the probability.

Probability of Future Events (Technological/Human-made Hazards) – There is a lack of historical data for most of the technological/human-made hazards profiled; in addition, some of them are evolving on a monthly basis as political and cultural events play a large role in some of the hazards.

For at least one technological/human-made hazard for which historical is available (hazardous materials release), the probability calculated using the same scale as used for natural hazards was considered ridiculous by those working closely with this hazard. (The calculated probability would have been high.) Representatives of the LEPC indicated that seeing a “high” probability associated with this hazard would make them question the validity of the entire hazard mitigation plan.

So, for these reasons, the probability of technological/human-made hazards was evaluated and assessed by those working most closely with these hazards in some emergency management or preparedness capacity.

IDENTIFICATION OF COMMUNITY ASSETS potentially affected by or helping to mitigate the effects of the hazard in each participating jurisdiction; this is covered in Section 2 of the plan.

ANALYSIS OF RISK presented by the hazard, including a **measure of severity** for each participating jurisdiction. The **measure of severity** is an estimate of the deaths, injuries, or damage (property or environmental) that could result from the hazard. It is also broadly based on the scale found in the Missouri State Hazard Mitigation Plan (2013):

Low – Few or minor damage or injuries are likely.

Moderate – Personal injuries and/or damage to property or the environment are expected.

High – Major injuries and/or death and/or major damage will likely occur.

SUMMARY OF VULNERABILITY

A jurisdiction's vulnerability to a hazard is connected to the extent of that hazard, the probability of future events, the estimated measure of severity, and mitigation measures already in place for that hazard.

In many cases, the potential severity of the hazard event contributes the greatest weight to the vulnerability rating. In some cases, however, a low severity event with high frequency can cause economic strain which translates into a higher vulnerability.

Existing Mitigation/Operating Assumptions: Both the measure of severity and overall vulnerability are greatly impacted by the mitigation already in place in the planning area; this existing mitigation is taken as an operating assumption when evaluating the vulnerability to a particular hazard. The following mitigation activities are applicable to many or all hazards:

- Building codes are in place in Boone County and the following incorporated communities: Ashland, Centralia, Columbia, Hallsville, Harrisburg, Hartsburg, Pierpont, Rocheport, and Sturgeon.
- Resources for the public on retrofitting and protecting buildings are available through the Office of Emergency Management.
- Critical infrastructure in the county is accessible and provided with backup power.
- Cooperative agreements are in place between utility providers in the county.
- Agreements are in place with local shelters in the county.
- General evacuation procedures are included in the Office of Emergency Management's (OEM) Emergency Operation Plan.
- Evacuation routes are in place in all school districts in the county.

- Buses in all school districts have two-way radios on board.
- A public education hazard awareness program is in place through the OEM.
- Hazard information is provided to customers of local hotels through an agreement between the OEM and the Missouri Hotel & Lodging Association.

Other current mitigation activities are aimed at mitigating the effects of a specific hazard and are described under the specific hazard profile.

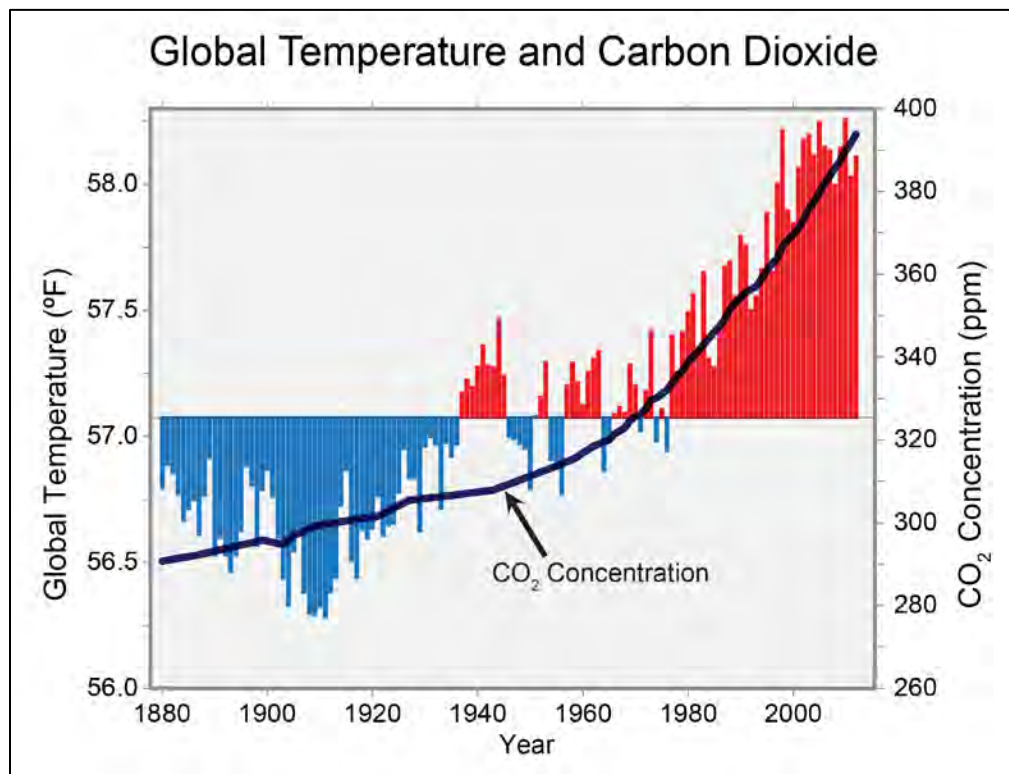
THE EFFECTS OF CLIMATE CHANGE ON HAZARDS

While climate change remains a contentious political issue in the United States, the scientific data is overwhelmingly clear – the climate is changing. The Boone County Hazard Mitigation Planning Committee deemed it important to include a consideration of the effect of climate change on the hazards profiled. This is not required for the county level plans but, as of March 2016, will be required for state hazard mitigation plans.

The information for this section is taken primarily from *The National Climate Assessment 2014*. The 2014 assessment was put together by a team of 300 experts under the guidance of a 60-member Federal Advisory Committee. The assessment was reviewed by the public and other experts in the field, including the federal agencies and a panel from the National Academy of Sciences. The full report can be accessed at: GlobalChange.gov. A number of charts from *The National Climate Assessment 2014* have been included to indicate just some of the scientific data supporting the conclusion that the climate is changing.

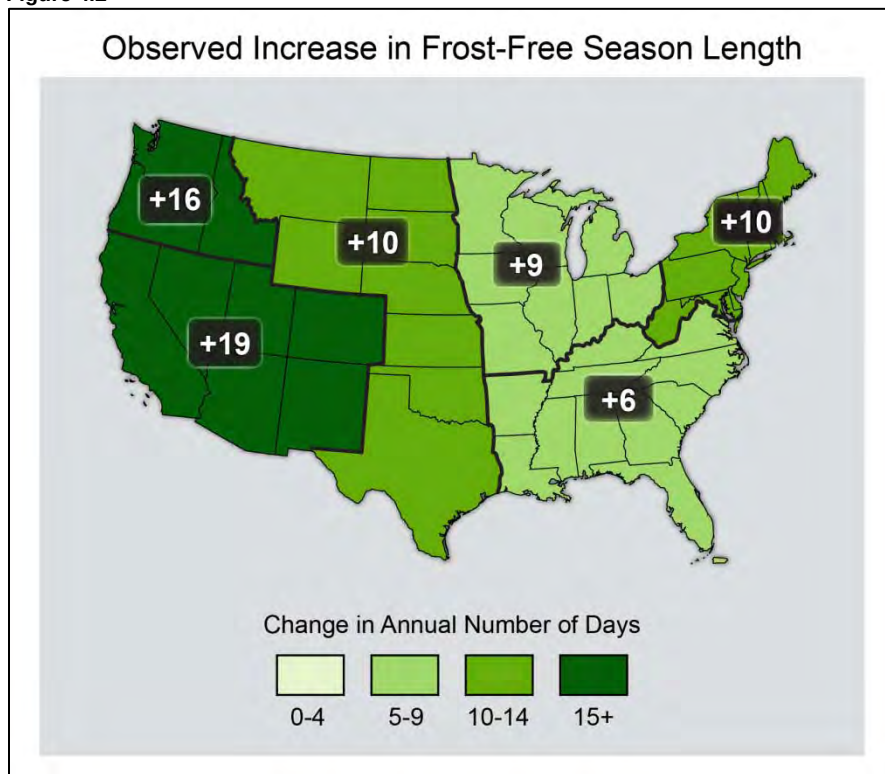
Global temperatures show a sharp increase which correlates with the increasing CO₂ concentration in the atmosphere (Figure 4.1).

Figure 4.1



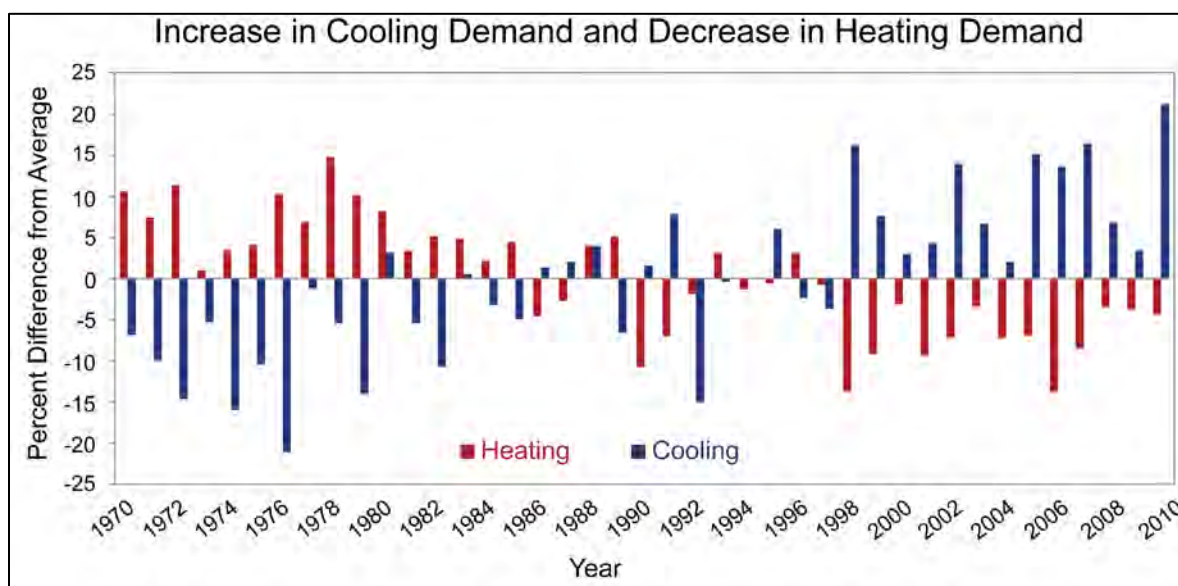
There has been a significant increase in frost-free days across the continental U.S. in the past two decades when compared with the average for the period 1901-1961 (Figure 4.2).

Figure 4.2



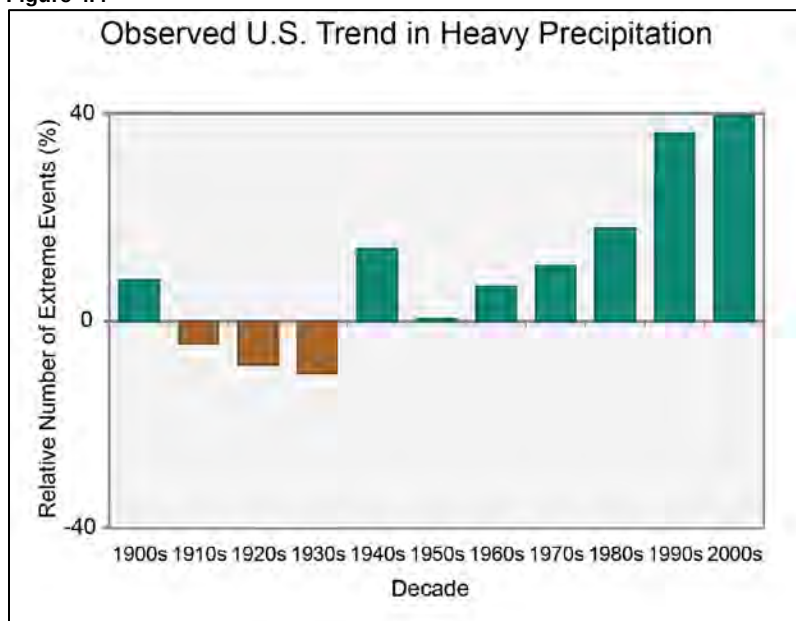
Likewise, there has been a trend of increased cooling demand in the past two decades (Figure 4.3).

Figure 4.3



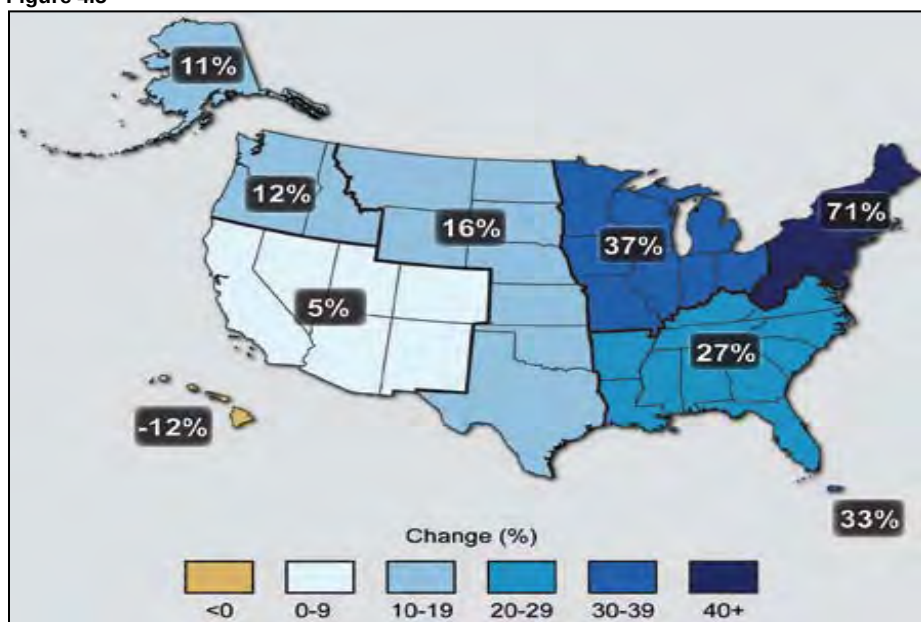
There is a strong upward trend in heavy precipitation for the U.S. as a whole, beginning in the 1940s (Figure 4.4). (The horizontal line at zero represents the average precipitation for the period 1901-1960.)

Figure 4.4



However, this heavier precipitation is affecting different regions of the country to varying degrees; the Northeast and the Midwest are experiencing the largest increase in sudden torrential downpours (Figure 4.5).

Figure 4.5



The National Climate Assessment, 2014, states that the current data indicates observed increases in the following: winter storms, extreme heat, heavy downpours, and the intensity, frequency, and duration of hurricanes. All of these have potential effects on hazards profiled for Boone County and its jurisdictions:

- Boone County has been included in five Presidential Disaster Declarations for severe winter weather since 2002; only one year in that period (2001) has not had a recorded severe winter weather event. It would be expected that severe winter weather events will continue to be of greater importance in the planning area.
- Extreme heat is already the number one weather-related killer in the United States. The increase in extreme heat makes it even more urgent that all jurisdictions ensure their citizens, especially the most vulnerable, are both aware of the dangers of extreme heat and have cooling resources/locations available.
- Heavy downpours are a causative factor for flash flooding and small stream flooding. It would be expected that flash flooding might become a larger problem in areas which already have problems with it, like the City of Columbia and parts of unincorporated Boone County, and might become a problem in some areas previously unaffected.
- The increase in hurricane intensity can affect the planning area both directly and indirectly. The remnants of Hurricane Ike spread over the Midwest (and the planning area) in September 2008. Flooding from the extremely heavy rains caused flash flooding and the closing of 28 roads in Boone County; a woman in Columbia lost her life when she was swept away by floodwaters while trying to rescue a man from a flooded stream. In June 2015, the planning area received heavy rains from the remnants of Hurricane Bill; numerous roads were closed because of flooding and the Missouri River, already moderately high, rose even further.

Indirectly, the high cost of huge disasters, such as those caused by hurricanes, further strains the FEMA budget; pre-disaster mitigation project funding has become increasingly difficult to obtain. This has an indirect, but very real and problematic, impact on the planning area.

This list of the probable effects of climate change on the hazards profiled is conservative by design and not intended to be exhaustive. There are some natural hazards for which the effects of climate change are still unclear. *The National Climate Assessment 2014* indicates that the trends for tornadoes, hail, and damaging thunderstorm winds are still uncertain at this point.

NATURAL HAZARDS AFFECTING THE PLANNING AREA

A summary of the Probability and Severity ratings for natural hazards in each of the participating jurisdictions is shown in Figure 4.6.

Figure 4.6

Natural Hazard Probability and Severity Ratings by Participating Jurisdiction																				
		Boone Co. (uninc.)	Ashtand	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon	Centralia R-VI	Columbia Public	Hallsville R-IV	Harrisburg R-VIII	Southern Boone	Sturgeon R-V	Columbia College	Stephens College	University of MO
Flood	P	H	L	L	H	L	L	M	M	M	L	L	L	L	L	L	L	L	L	L
	S	M	L	L	M	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L
Levee Failure	P	M	na	na	M	na	na	M	M	na	na	na	na	na	na	na	na	na	na	na
	S	M	na	na	L	na	na	M	M	na	na	na	na	na	na	na	na	na	na	na
Dam Failure	P	M	na	L	M	L	na	L	na	na	na	na	na	na	na	na	na	na	na	na
	S	M	na	L	M	M	na	M	na	na	na	na	na	na	na	na	na	na	na	na
Earthquake	P	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	S	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Land Subsidence/ Sinkhole	P	H	L	L	H	na	na	L	na	L	na	na	na	na	na	na	na	na	na	na
	S	L-H	L-H	L-H	L-H	na	na	L-H	na	L-H	na	na	na	na	na	na	na	na	na	na
Thunderstorm	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H
Tornado	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Severe Winter Weather	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H
Drought	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Extreme Heat	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Wildfire	P	H	L	L	M	L	M	M	L	M	L	L	L	L	L	L	L	L	L	L
	S	M	L	L	M	L	M	M	L	M	L	L	L	L	L	L	L	L	L	L

Key: H = High, M = Moderate, L = Low, ? = unknown, na = not applicable

4.1 FLOOD

DESCRIPTION OF HAZARD

Boone County and its jurisdictions are at great risk for flooding because the southern border of the County is situated on the bank of the Missouri River, the longest river in the United States. The Missouri River drains approximately one-sixth of the area of the continental United States, according to the USGS. It drains over half the state of Missouri as it flows eastward to join the Mississippi River at St. Louis. Since Boone County is located less than 200 miles upstream from the mouth of this 2,540 mile river, it is obvious that flooding is a potential concern for the county. There are also numerous creeks throughout the county with year-round water flows draining into the Missouri River.

The areas adjacent to rivers and stream banks that serve to carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat areas adjoining rivers and streams. 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 upon historical records.

In addition to the threat of **riverine flooding**, when a river or creek overflows its normal boundaries, the planning area is also susceptible to **flash flooding**. NOAA defines a flash flood as “an event that occurs within 6 hours following the end of the causative event (such as rains, ice jams, or dam breaks)....” Flash floods develop quickly and are responsible for more flood related deaths than any other type of flooding. The textual descriptions for flash flooding events in the NOAA database indicate that flash flooding in the planning area is usually triggered by 2-5 inches of rainfall within a “short period”.

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

FEMA defines sheet flooding as “a type of flood hazard with flooding depths of 1 to 3 feet that occurs in areas of sloping land.”

Local **storm water flooding** can result when tremendous flow of water occurs due to large rain events. Local flooding can create public safety issues due to flooded roadways and drainage structures.

Most flooding in Boone County occurs in late spring and summer but floods can occur in any season.

Location

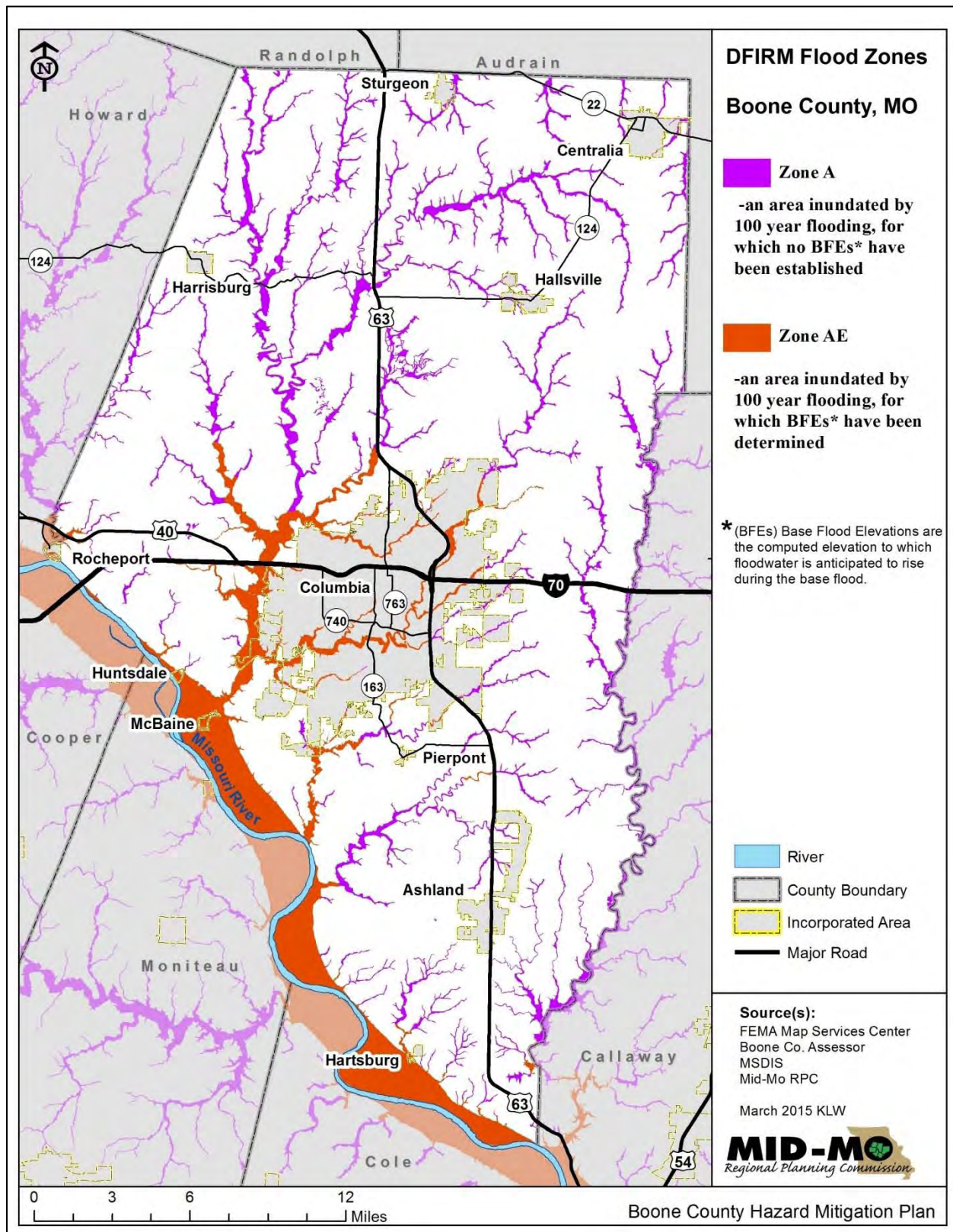
The entire planning area is at risk from some type of flooding.

Hartsburg, Huntsdale, McBaine, Rocheport, and the unincorporated areas near the Missouri River are at higher risk of riverine flooding than the rest of the county. In addition, there are numerous creeks or branches throughout the planning area subject to small stream flooding. The City of Columbia can experience flooding from the backup of tributary branch of the Missouri River when river levels are high.

Varying levels of flood risk are designated by flood zones mapped on Flood Insurance Rate Maps (FIRMs).

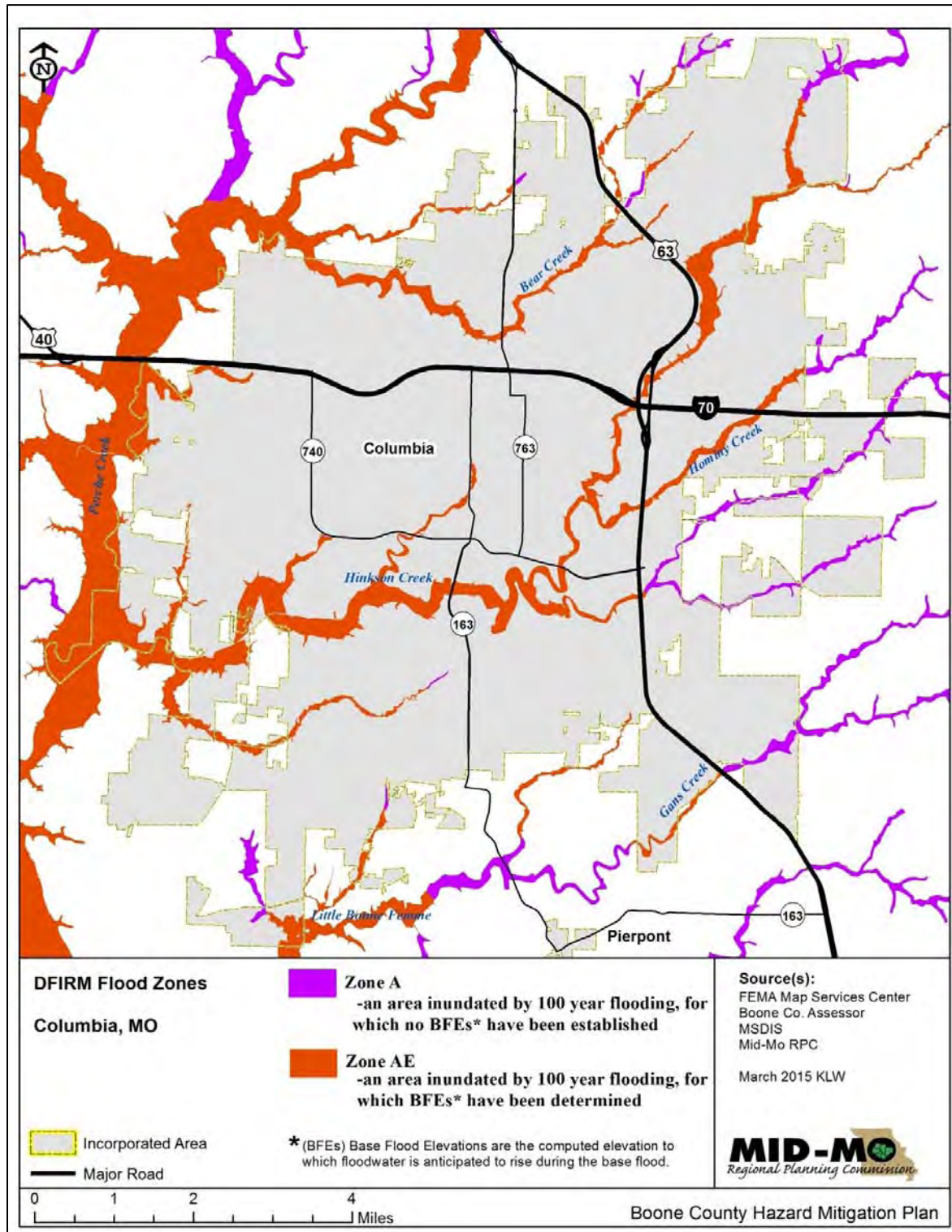
The current FIRMs for Boone County have an effective date of 3/17/2011. Overview maps showing the floodplains for the entire planning area (Figure 4.7) and for the City of Columbia (Figure 4.8) included in the following pages. For the smaller jurisdictions with significant flooding risk, the National Flood Hazard Layers from the online system and the FIRMettes are included (Figures 4.9-4.11).

Figure 4.7



Columbia

Figure 4.8



Hartsburg

Figure 4.9 A

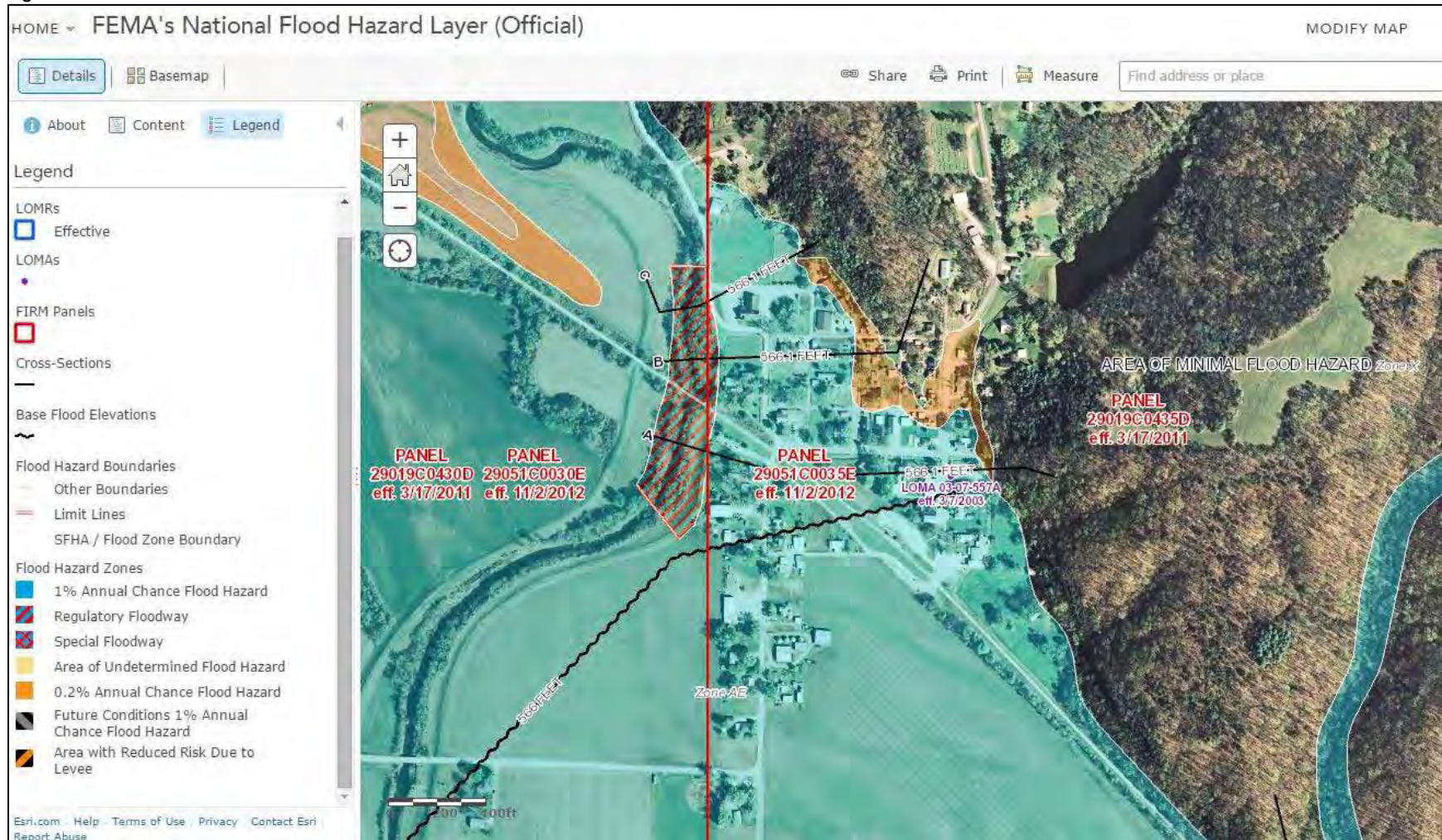


Figure 4.9 B

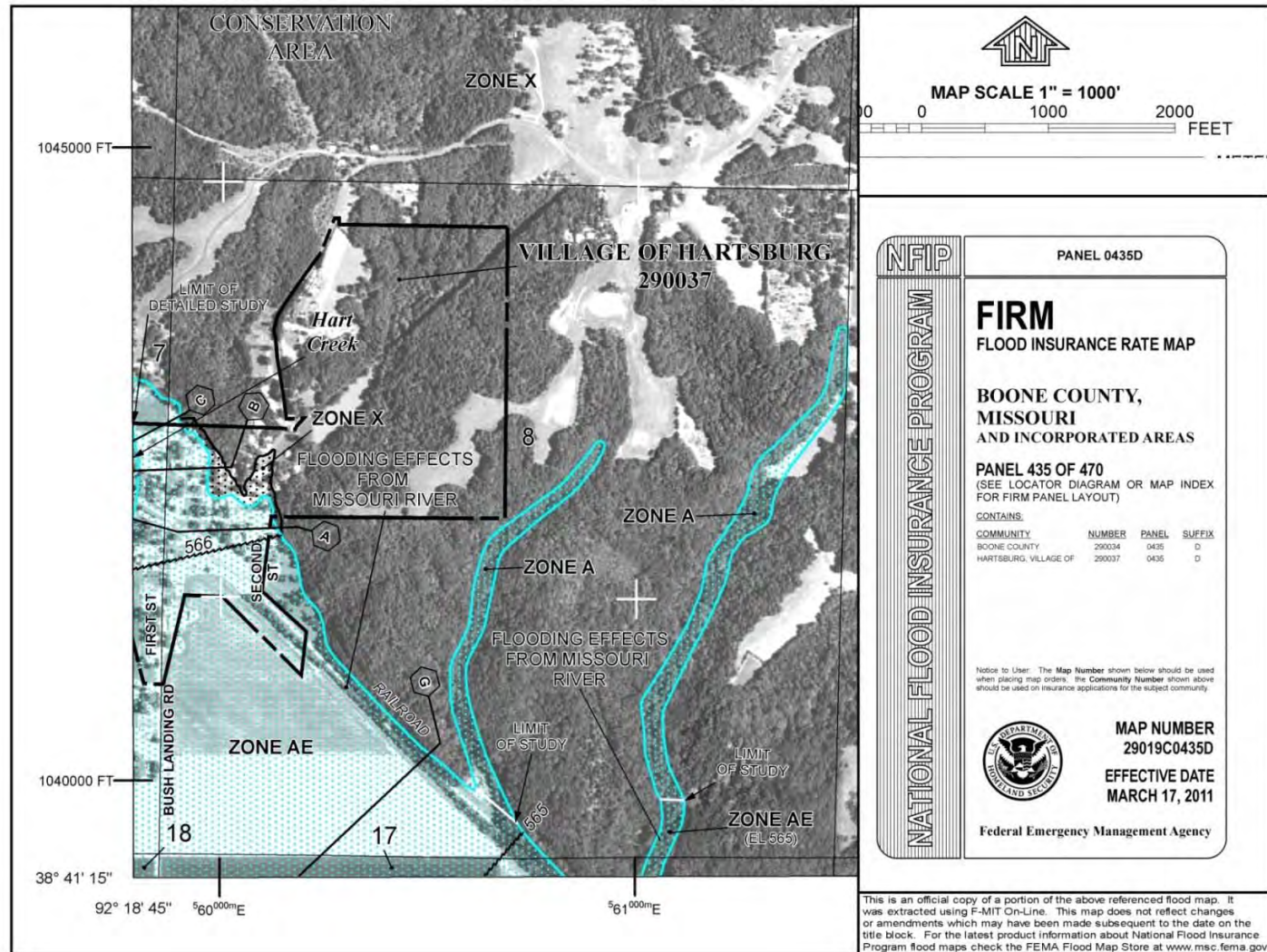
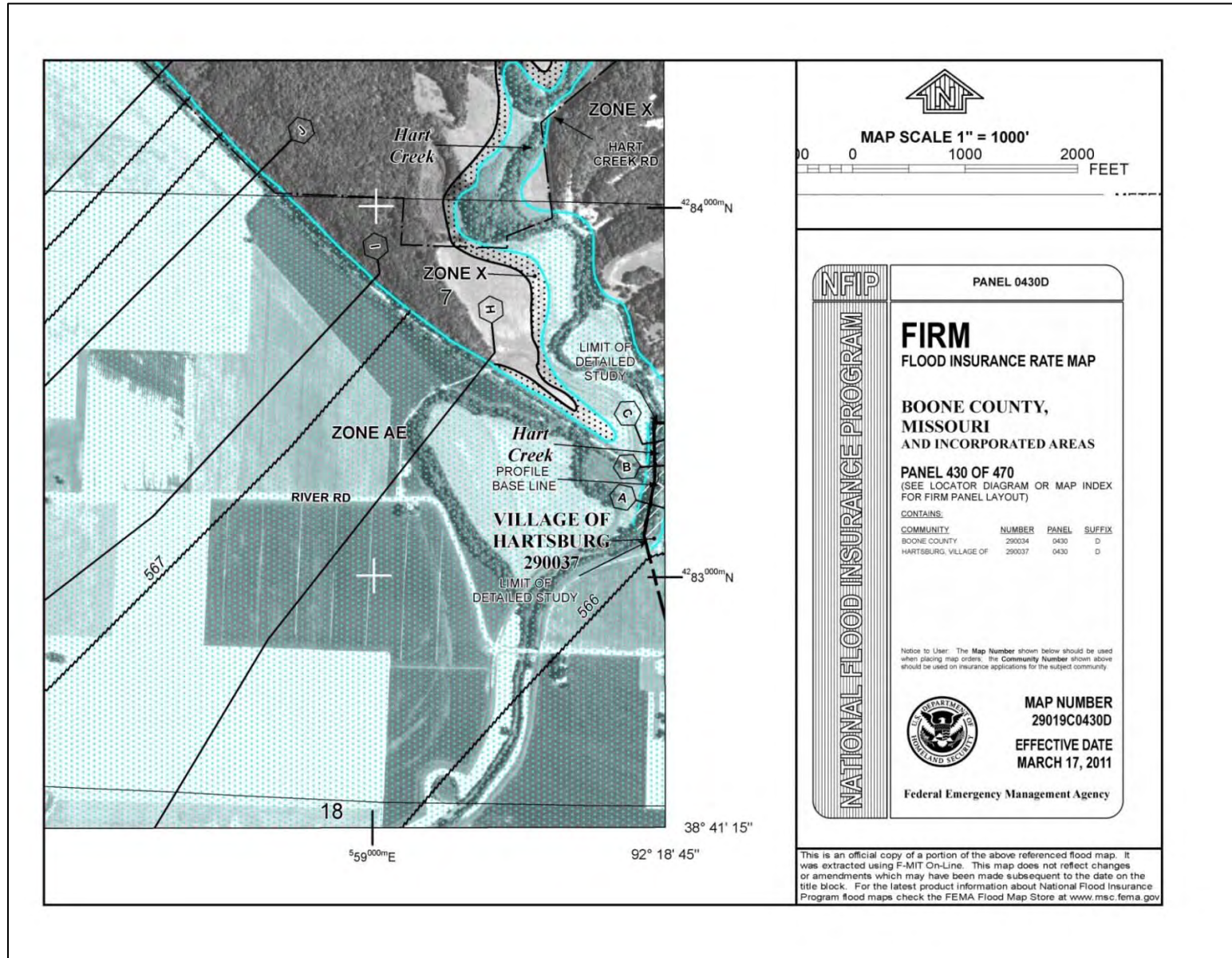


Figure 4.9 C



Huntsdale

Figure 4.10 A

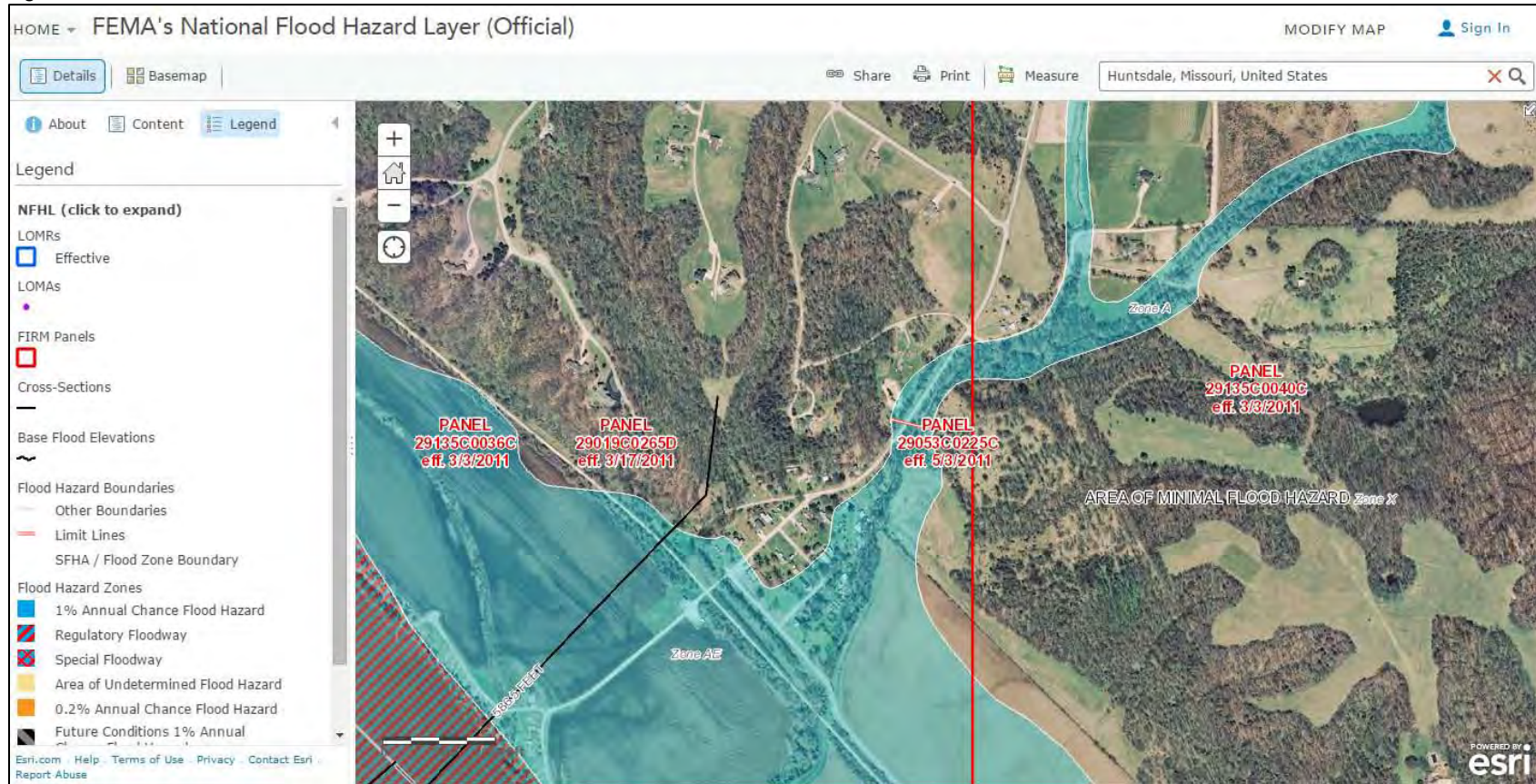
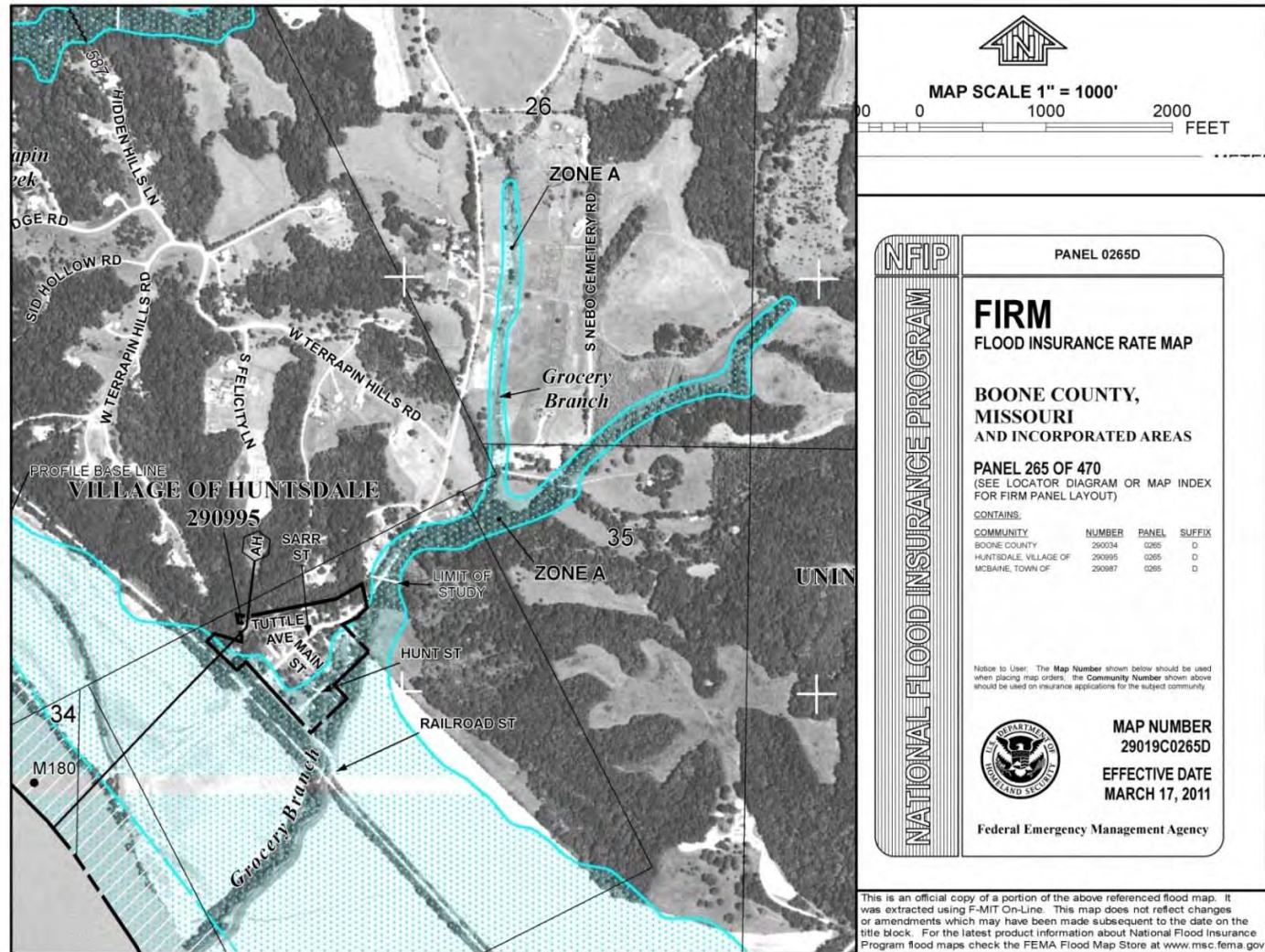


Figure 4.10B



Rocheport

Figure 4.11A

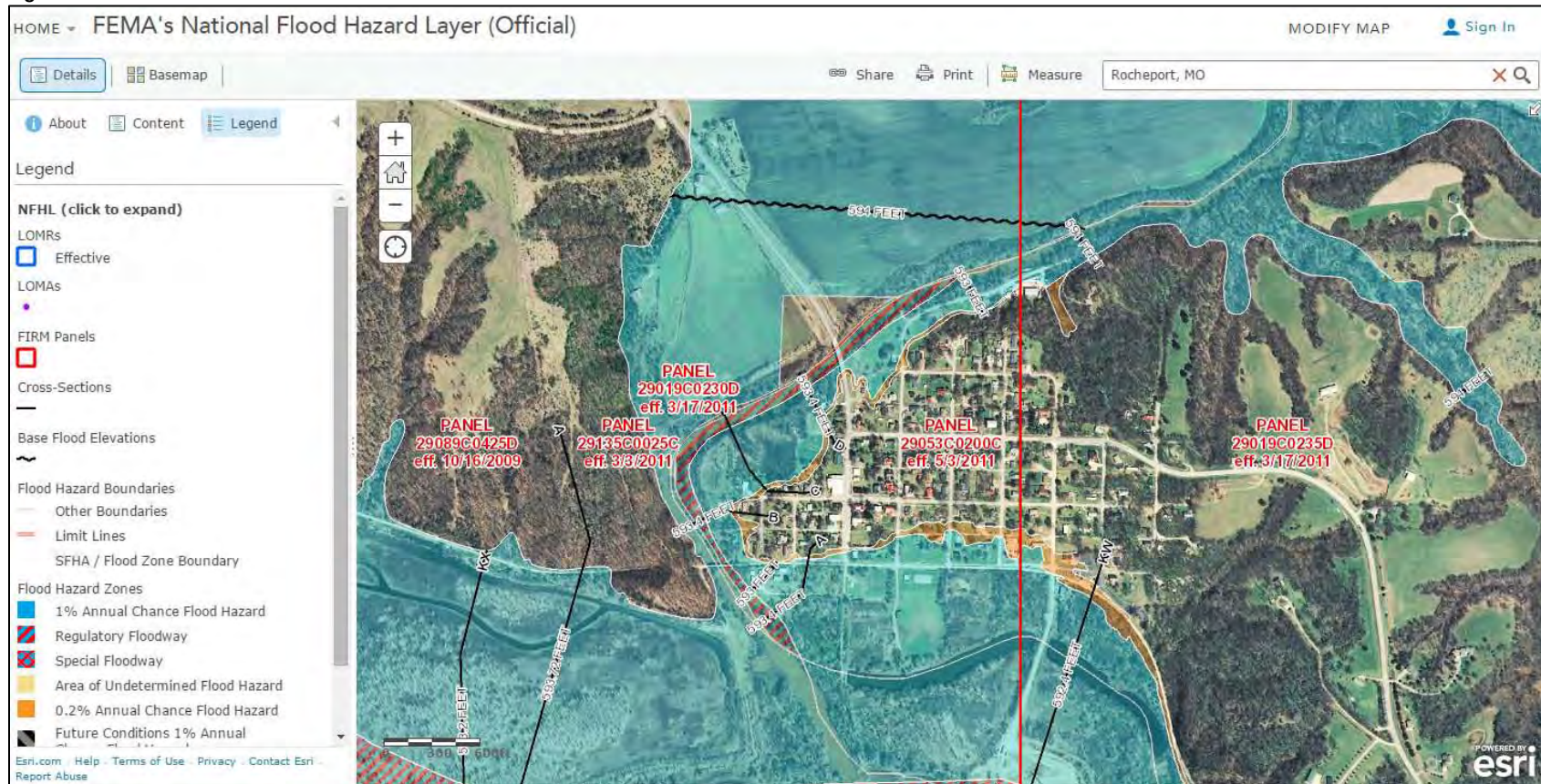
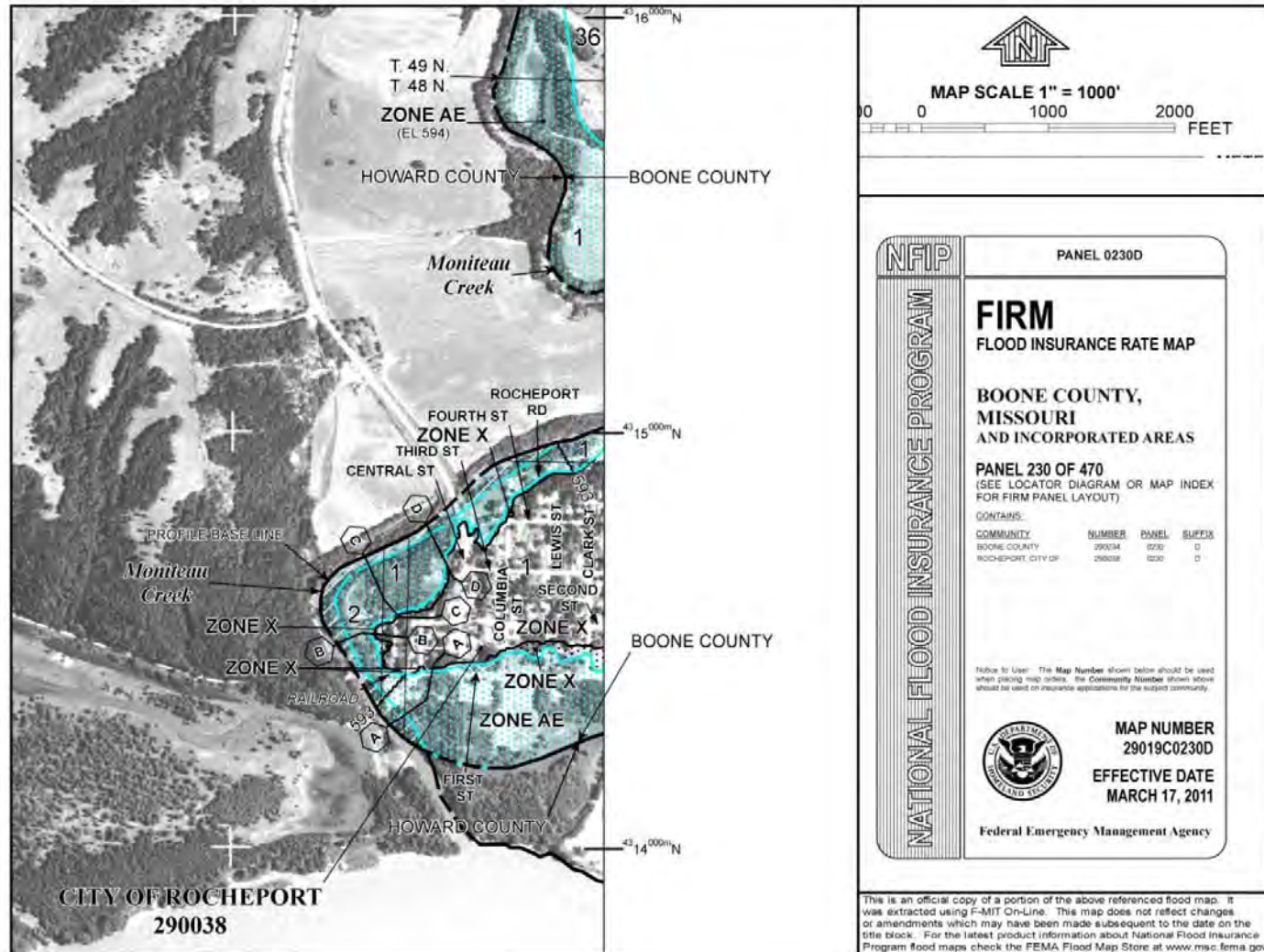


Figure 4.11B



Figure 4.11C



Road closures due to high water or flash flooding are common throughout the planning area. An indication of the extent of flash flooding and road closures may be gained from data for a 13-month period (Figures 4.12 A, B). There were 129 locations with at least one closure during that period. This averages to almost 10 closure locations per month.

Figure 4.12A

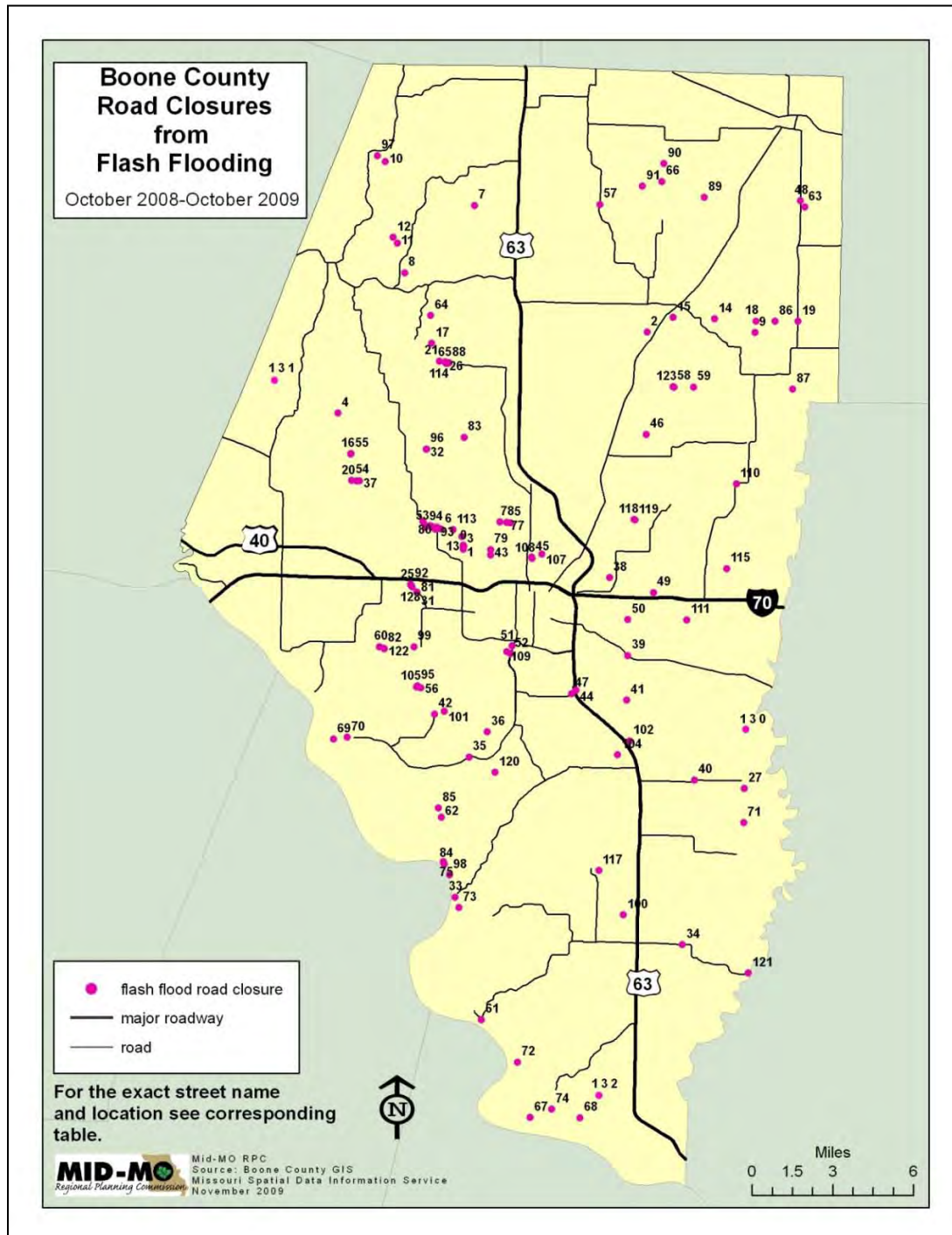


Figure 4.12B**Road Closures Due to Flash Flooding Events****October 2008-October 2009****(see corresponding map)**

#	Road Name	#	Road Name
0	Black Foot Rd	44	4100 BLK Lenoir RD
1	Blackfoot Rd @ City/County Line	45	Northland @ Blue Ridge
2	Frink Rd at Kemper Rd	46	Orear Rd @ Hill View
3	2850 Blk of Blackfoot Rd	47	Nifong @ Ponderosa
4	Wilhite Rd East of Evert School Rd	48	19000 BLK Rt Z
5	Brown School Rd E East of Providence Rd	49	6700 BLK St Charles
6	Wilcox at Twin Bridges	50	5500 BLK Richland Rd
7	Williams Rd near the low water crossing	51	Research Park @ outer rd (Providence)
8	Lockwood Ln East of Hgwy NN	52	Providence @ Mic Deaver
9	Davenport Rd 1 mi North of Doris Blvd	53	Rt E @ Twin bridges
10	Perche Church Rd 1/4 mile south of RT F	54	Locust Grove @ Hatton Chappel
11	Stidham Rd, closed from the bridge to Hwy NN	55	Locust Grove @ Bell
12	Richardson Dr @ Stidham Rd	56	3800 Blk Scott Blvd
13	Blackfoot Rd at the Columbia City Limits	57	Route V @ Thomas Hill
14	Owen School Rd @ Level Rd	58	Mount Zion @ Hecht
15	Rt B @ Kemper Rd	59	Mount Zion @ hague
16	Bell Rd @ Locust Grove Church Rd	60	Gillespie Bridge near Coats Ln
17	Red Rock Rd, Lewis Ln and Silver Fork Creek	61	River Rd at Wilton
18	Owen School @ Davenport Rd	62	Woodie Proctor Rd at Smith Hatchery RD
19	Owen School Rd @ Rt Z	63	Grassland School Rd near Rt Z
20	Hatton Chapel Rd, east of Locust Grove Church Rd	64	Willis West of Rt YY
21	Stone Dr @ Silver Fork Hill Creek	65	Stone Dr/Dripping Springs Rd
22	Driskel at RT E	66	20000 Block Farwest School Rd N
23	Wilcox at RT E	67	Hartsburg Bottom Rd at Hart Creek
24	Route E at the Twin Bridges	68	Hartsburg Bottom Rd, Claysville to Soft Pit Hill
25	Strawn at Hominy Creek	69	Burr Oak Rd @ McBaine
26	Stone Dr at the low water crossing	70	Route K @ McBaine
27	IT Testing	71	Boone county IT testing
28	Driskell Rd closed at Route E	72	River Rd, between Hartsburg and Wilson
29	Route E @ Twin Bridges	73	Rippeto Rd, Harold Cunningham to Easley River Rd
30	Wilcox Rd @ Route E	74	Bush Landing Rd, Hartsburg to Grimes Rd
31	Strawn Rd near I70 Dr. Southwest	75	Smith Hatchery Rd at Coopers Landing
32	Akeman Bridge Rd @ low water crossing	76	Wilcox Rd near Route E

Figure 4.12B (cont.)**Road Closures Due to Flash Flooding Events****October 2009-October 2010****(see corresponding map)**

#	Road Name	#	Road Name
33	Easley River Rd near Coopers Landing	77	Brown School east of Clearview
34	Route Y, west of Rangeline Rd	78	Brown School west of Clearview
35	Route K @ Southwest Way (Gateway S. Subd)	79	Creasy Springs at Bear Creek Trail
36	Old Plank Rd just south of Forum	80	Route E @ Wilcox
37	6800 BLK Hatton Chappel	81	500 BLK STRAWN
38	Orchard Ln @ McKee	82	Gillespie Bridge Rd @ Coats Ln
39	Broadway @ Old Hawthorne	83	4500 Block Akeman Bridge Rd
40	Rangeline RD @ Highway AB	84	Easley River Rd
41	Rolling Hills @ Sugar Grove	85	Smith Hatchery RD
42	RT KK @ Apple Wood Creek Rd	86	Owens School Rd
43	3200 BLK Creasy Springs	87	Marshall Ln, just east of Nienaber Ln
88	Stone Dr closed at low water crossing	109	Research Park Behind Stoney Creek Inn
89	Adams Rd near Lost Woods Ln	110	Rt Z @ Maupin Rd
90	Farwest School Rd from Lost Woods to Hgwy CC	111	Richland Rd @ Trade Winds PKWY
91	Barnes Rd North of Dunbar Rd	112	Blackfoot @ Oneal Rd
92	Strawn near I70 Dr SW	113	Oneal @ Blackfoot
93	Wilcox Rd, between Rt E and Oneal Rd	114	Stone Dr West of Dripping Springs RD
94	Driskel Rd, between Rt E and Moreau Rd	115	9200 Block of St Charles Rd E
95	Brushwood Lake Rd, between Scott Blvd and bridge	116	Route E @ Twin Bridges
96	3900 Block Akeman Bridge Rd	117	Minor Hill Rd just East of RT DD
97	Porter Rd South of RT F	118	Hinkson Creek Rd @ Wyatt Ln
98	Easley River Rd near Rippeto Rd	119	Hinkson Creek Rd near Wyatt Ln
99	Gillespie Bridge near Scott BLVD	120	Hill Creek Rd at Little Bonne Femme Creek
100	Crump Ln S. South of Martin Ln	121	RT Y @ Boone/Callaway Co Line
101	Highway KK near Old Mill Creek	122	Gillespie Bridge Rd near Coats Ln
102	Bass Ln near Rolling Hill RD	123	Mt Zion Church Rd at Hague Rd
103	Black Foot at the City Limits	124	Wilcox Rd East of RT E
104	Boone Femme Church Rd at Low Water Crossing	125	Blackfoot Rd at city limits
105	Brushwood Lake West of Scott	126	Driskel Rd @ Route E
106	2800 Block Stone Dr W	127	Wilcox Rd @ Route E
107	Blue Ridge Rd and Parker	128	Strawn Rd, south of I-70 Dr. Southwest
108	Northland @ Blueridge	129	Rte E at Twin Bridges
Source: Boone County GIS Department			

Extent

There are characteristic differences between riverine flooding and small stream/flash flooding in the planning area; these differences involve both the speed of onset and duration of flooding events.

Riverine flooding –

- Speed on Onset - Riverine flooding is a hazard which allows for mitigation, preparation, and potential evacuation because of the relatively long speed of onset.
- Duration - An examination of the NOAA data for riverine flooding 1996-2014 indicates an average duration of Missouri River flooding of over 13 days per event (Figure 4.13).

Small Stream and Flash Flooding –

- Speed on Onset - In contrast to riverine flooding, small stream flooding and flash flooding occur very quickly with heavy rains.
- Duration - Small stream flooding in the planning area usually takes place within the span of one day, according to the NOAA data (Figure 4.13). Information from Boone County Public Works indicates that many flash flooding events which cause road closures are confined to a few hours, although the water takes longer to recede in some locations.

Figure 4.13			
Boone County Historic Data River and Small Stream Flood January 1 1996 - July 31, 2014			
Location	Date	Type of Flood	Duration (days)
Southern Boone	1996: 5/1/96 - 5/31/96	Missouri River	31
Southern Boone	1998: 10/6/1998	Missouri River	1
Southern Boone	2001: 6/4/01 - 6/13/01	Missouri River	10
Southern Boone	2002: 5/8/02 - 5/20/02	Missouri River	13
Southern Boone	2007: 5/8/2007	Missouri River	1
Southern Boone	2010: 6/9/10 - 7/?/10	Missouri River	23+
	Average duration of Missouri River flood (days)		13+
Central Boone	1997: 9/8/1997	Urban/Small Stream	1
Columbia	1998: 8/27/1998	Urban/Small Stream	1
Countywide	2001: 1/28/01 - 1/29/01	Urban/Small Stream	2
Countywide	2001: 6/6/2001	Urban/Small Stream	1
Countywide	2008: 9/13/2008	Urban/Small Stream	1
Source: http://www.ncdc.noaa.gov/stormevents ; available data as of 10/31/14			

Previous Occurrences

The floods of 1993 and 1995 were the worst repetitive flood events in Missouri history, according to the *Missouri State Hazard Mitigation Plan (2013)*. There were five presidential disaster declarations for flooding during this period; Boone County was included in Disaster Declaration #995 (July 9, 1993) and Disaster Declaration #1054 (June 2, 1995).

All levees in Boone County failed during the Flood of 1993, according to the U.S. Army Corps of Engineers. More information about this is included under Levee Failure (Section 4.2).

The towns of Hartsburg, Huntsdale, McBaine, Rocheport and the unincorporated areas near the Missouri River experienced elevated loss statistics during the Missouri River floods of 1993 and 1995 as compared with damages in the remainder of the county.

Data from NOAA indicates 11 river or small stream floods in Boone County since the Missouri River flood of 1995 (Figure 4.13). Six of these events were floods of the Missouri River. There have been 51 reported flash flood events in this same time period (Figure 4.14).

Figure 4.14

Boone County Historic Data Flash Flood January 1 1996 - July 31, 2014			
Location	Date	Location	Date
Eastern Boone	06/22/97	Northern Boone	04/10/08
Northern Boone	06/29/98	Central to Northern Boone	06/13/08
Central Boone	07/04/98	Central to Southern Boone	07/22/08
Countywide	10/05/98	Northern Boone	07/25/08
Northern Boone	06/12/99	Hallsville	07/27/08
Southern Boone	05/27/00	Countywide	09/12/08
Central and Northern Boone	08/07/00	Countywide	09/13/08
Columbia	05/17/01	Countywide	03/24/09
SW Columbia and North of McBaine	07/19/01	Northern Boone	04/29/09
Countywide	05/07/02	Northern Boone	05/15/09
Countywide	05/09/02	Southern Boone	07/04/09
Countywide	05/12/02	Countywide	10/08/09
Southern Boone	08/18/02	Countywide	10/22/2009
Columbia	08/20/02	Columbia	4/23/2010
Northern Boone	06/12/03	Countywide	4/24/2010
Northern Boone	06/25/03	Columbia area	5/12/2010
Countywide	03/26/04	Columbia/Centralia	5/13/2010
Countywide	08/26/04	Countywide	7/7/2010
Countywide	01/12/05	Centralia	7/29/2010
Columbia	05/11/05	Columbia	8/20/2010
Columbia	08/26/05	Columbia area	5/25/2011
Columbia	09/19/05	Countywide	4/29/2012
Central Boone	06/11/06	Midway/Columbia area	5/26/2013
Centralia	05/06/07	Easley	5/31/2013
Columbia	05/06/07	Southern Boone	4/3/2014
Centralia	03/17/08		
Source: http://www.ncdc.noaa.gov/stormevents ; available data as of 10/31/14			

There was one death from an urban/small stream flood in during this period. On Sept. 13, 2008, a 20-year old woman attempted to help a man who had been swept off Clark Lane into Hominy Creek on the east side of Columbia. She was swept away by the floodwaters to her death. The flooding in this period originated from the remnants of Hurricane Ike which swept across the Midwest causing widespread and extensive flooding.

Probability of Future Events

Figure 4.15 Probability of Future Flooding Events			
EF-Scale	# of years with flood event (1996-2014)	Probability	Probability Rating
Missouri River flood	6	32%	High
Urban/small stream flood	4	21%	High
Flash flood	18	95%	High

While the probability of flooding of the Missouri River is high, the towns by the river (Hartsburg, Huntsdale and Rocheport) are all protected to varying degrees by levees. The Katy Trail State Park functions as a levee for all three jurisdictions; Hartsburg and Huntsdale are also protected by agricultural levees. For this reason, they are only at a moderate probability of flooding in these three towns.

Boone County is vulnerable to both Missouri River floods and flash flooding; the City of Columbia is vulnerable to flash flooding and flooding from the backup of branches feeding into the Missouri River during times of river flooding.

Probability: High – Boone County (unincorp.), Columbia
Moderate – Hartsburg, Huntsdale, Rocheport
Low - all other participating jurisdictions

ANALYSIS OF RISK

Severity: High – Hartsburg, Huntsdale, Rocheport
Moderate – Boone County (unincorporated), Columbia
Low - all other participating jurisdictions

The City of Rocheport relies on the County in times of major flooding to provide sandbags or concrete barriers which are placed on the north side of the Katy Trail to protect the city. This has been effective but is an expensive venture for the County. There are also four houses on the south (river) side of the Katy Trail which could sustain damage in times of flooding and would not be assisted by the sandbagging; the city has targeted three of these houses for potential flood buyouts; one house has been elevated. The city park on the south side of town will flood with lower river levels but this is not a major concern for the city. The Boone County Regional Sewer District now owns and operates the wastewater treatment facility serving the city; it is located in the floodplain.

While Huntsdale is located near the river and has a significant area in the floodplain, the main part of the town is almost totally surrounded by levees. There is a campground along the river

outside of the levee protection area, but it is not used in the event of potential flooding. The town sandbags a small area along the Grocery Branch on the southeast edge of town but has not experienced severely problematic flooding since the 1993 floods.

Hartsburg also has levee protection from both the agricultural Hartsburg Levees and a section of the Katy Trail which runs through the village. This section was elevated to 32 feet following the 1993 flood and provides extra protection for about half of the village, including the business section. In times of flood threat, Hartsburg sandbags on this part of the Katy Trail but more than half of the town residences (11 houses) are on the river side of the trail and protected only by one of the agricultural levees. If flooding overtops the agricultural levees, the consequences for these 11 houses would be severe. There have been a number of times in the past 15 years when the village sandbagged on the trail but no levees were overtopped in that period.

Flash flooding is of particular concern in the City of Columbia; recent flood buyouts in the city have been outside of the floodplain in Zone X where the properties were repeatedly affected by flash flooding. Columbia still has a significant number of NFIP repetitive loss properties. Data on NFIP repetitive loss properties in the planning area gives further insight into the extent and location of some of the flooding problems (Figure 4.16).

National Flood Insurance Program Repetitive Loss Properties

Requirement §201.6(c)(2)(ii):	<i>[The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.</i>

The NFIP defines a **Repetitive Loss Property** as “any insurable building for which two or more claims of more than \$1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978.” A repetitive loss property may or may not currently be insured by the NFIP.

A Severe Repetitive Loss (SRL) property is defined as a **residential property** that is covered under an NFIP flood insurance policy and:

- (a) Has at least four NFIP claim payments (including building and contents) over \$5,000 each, and the cumulative amount of such claims payments exceeds \$20,000; or
- (b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

Figure 4.16

NFIP Repetitive Loss Properties – Boone County
(current as of 2/2/2015)

Jurisdiction	# of Properties	Residential	Commercial	# of Losses	Total Cost	Average Cost Per Loss
Columbia	8	7	1	41	\$1,724,825	\$42,069
Hartsburg	4	3	1	8	\$121,572	\$15,197
Sturgeon	1	1	0	2	\$2,576	\$1,288
Total	13			51	\$1,848,974	\$36,254

Source: State Emergency Management Agency

Potential Impact – Life

All types of flooding present a threat to human life. Small stream/urban stream flooding and flash flooding are particularly hazardous due to their quick onset. It is an ongoing struggle to educate the public concerning the very real hazard presented by flooded low water crossings and other flash flooding situations.

In addition to the risk of drowning, exposure to flood waters can result in infection or injury from sewage, agricultural runoff, and industrial chemicals. Flooded buildings present health risks from mold, chemicals and electrical hazards.

Flooding also poses a threat to the livelihood of those farming in low lands; this is especially a problem near the Missouri River. When the river level is high for an extended period, water will seep up through the soil and cause additional flooding to that already caused by heavy rains. Standing water in fields may prevent planting at the optimal time for a successful harvest or damage/destroy crops during the growing season.

Potential Impact on Existing Structures

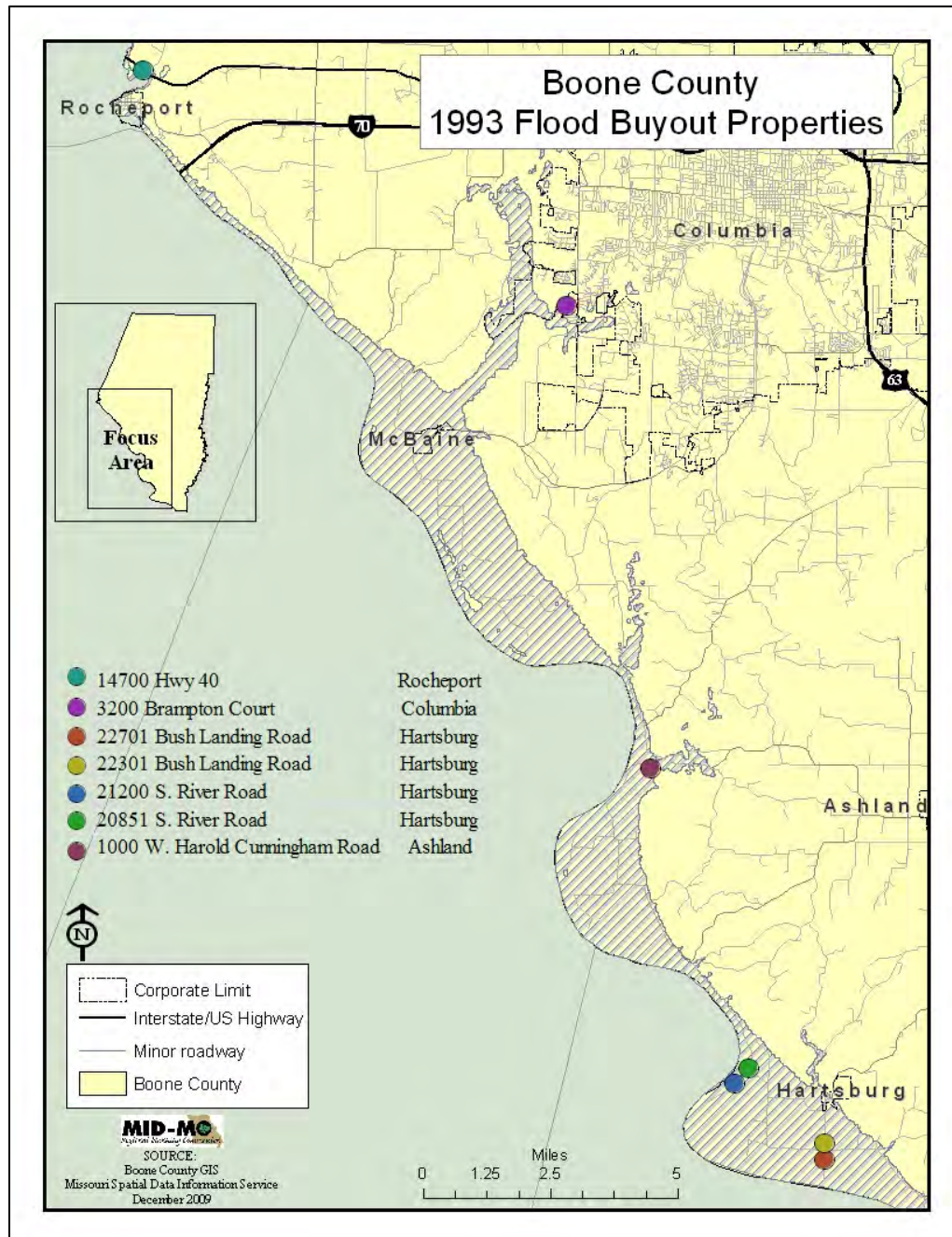
Structures and infrastructure near the Missouri River are potentially vulnerable to damage from riverine flooding; many of these structures are protected by levees and sandbagging at times of high river levels but there is the potential for floodwaters to top the levees or for levee failure (Section 4.2).

Flash flooding events present a risk of damage to roadways, drainage systems, and culverts. In addition, there are homes at risk of flash flooding, especially in the City of Columbia.

Existing Mitigation Activities

The Missouri River floods of 1993 and 1995 were devastating events for many parts of the Midwest United States. Changes in river management, including major wetland restoration projects along the river's long course, the buildup of some levee sections in parts of the planning area, and the buyout of properties in the river floodplain (Figure 4.17) have all helped to mitigate risk associated with riverine flooding in the planning area.

Figure 4.17



National Flood Insurance Program (NFIP)

The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968. The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community as a financial protection against flood losses. This insurance is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods.

Participation in the National Flood Insurance Program is a critical aspect of hazard mitigation planning for it provides communities with direct resources that can be used for controlling the potentially devastating impacts of floods. Furthermore, participation in the program helps communities more easily recover from flood impacts.

Boone County and all the eligible participating jurisdictions in the hazard mitigation plan participate in the NFIP (Figure 4.18).

Figure 4.18		
Boone County Jurisdictions - NFIP Status		
Jurisdiction	Entry into Program	Date of Current FIRM
Boone County	06/15/83	3/17/11
Ashland	08/24/84	3/17/2011 (M)
Centralia	04/15/77	3/17/11
Columbia	08/28/71	3/17/11
Hallsville	01/01/06	3/17/2011 (M)*
Harrisburg	06/08/12	3/17/2011 (M)
Hartsburg	08/16/82	3/17/11
Huntsdale	06/11/15	3/17/11
Rocheport	08/02/82	3/17/11
Sturgeon	05/01/87	3/17/2011 (M)
(M) = No Elevation Determined - All Zone A, C and X		
* The City of Hallsville is NSFHA - all Zone C and X.		
Source: http://www.fema.gov/fema/csb.shtm		

A comparison of NFIP insurance policies in effect in the planning area in 2009 and 2014 indicates an overall increase in participation in the NFIP (Figure 4.19). The number of policies increased by almost 48% and the amount insured increased by almost 69%.

Figure 4.19						
NFIP Policies in Boone County						
Community	Policies In-Force		Insurance In-Force Whole		Written Premium In-Force	
	7/31/2009	8/31/2014	7/31/2009	8/31/2014	7/31/2009	8/31/2014
Boone County	63	86	\$10,121,600	\$17,261,200	29,808	55,510
Ashland	0	0	na	na	na	na
Centralia	0	2	na	\$238,000	na	485
Columbia	76	133	\$18,405,800	\$32,670,500	52,474	98,420
Hallsville	1	1	\$28,000	\$350,000	119	458
Hartsburg	25	23	\$2,861,000	\$2,363,600	15,435	16,983
Rocheport	3	3	\$237,200	\$235,500	1,326	1,973
Sturgeon	1	2	\$46,900	\$326,900	370	925
Source: http://bsa.nfipstat.fema.gov/reports/reports.html						

Risk MAP

Both Boone County and the City of Columbia have been actively participating in FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program. Most of Boone County is located in the Lower Missouri-Moreau Watershed; this watershed is in the Data Development phase of Risk MAP process. The northeastern part of Boone County is located in the South Forth Salt watershed which is in the Discovery and Topo Data phase of the Risk MAP process (see Figure 4.19a).

As of September 2015, an update of the 2011 Boone County FIRM is in process; this update is using LIDAR data provided by Boone County. The updated map has not yet been published; once published, there will be a review/appeal period. The final updated FIRM is expected to be ready for release sometime in the spring of 2016; the jurisdictions in Boone County will then have a 6 month period in which to adopt the map.

Any further developments in the Risk MAP process will be covered during the monitoring of the plan before the next full update.

Figure 4.19a



County

A Stream Buffer Ordinance, Order 205-2009, was passed by the Boone County Commission in April 2009 with an implementation date of June 1, 2009, and a review after one year of implementation. One of the ordinances many focuses is reduction of flash flooding. The ordinance governs the unincorporated areas of the county.

A Joint Storm Water Task Force, formed by the Boone County Commission and the City of Columbia, met from 2002 to 2008 and drafted a Storm Water Ordinance for the County. The ordinance is currently under review and pending adoption.

Columbia

The City of Columbia Water Treatment Plant is located in the Missouri River floodplain. After the floods of 1993 and 1995, the following mitigation was put in place to protect the water supply: the well platforms were raised seven feet; secondary power and waterlines were run from the well field to the water treatment plant and a concrete flood protection wall was constructed around the plant.

Lagoons for the city's wastewater treatment system are also located in the floodplain and surrounded by a berm for flood protection.

The Public Works Department staff reviews all subdivision plans to ensure structures are not built in the floodway and are 2 feet above the 100 year flood elevation when placed in the flood fringe.

The City of Columbia has a Stormwater Master Plan. It has a Stormwater Management Program located within the Department of Public Works.

Columbia's "Stormwater Management & Water Quality Manual" was updated in February 2009. The manual includes the following specifications for road classifications and their respective levels of safety against flooding (Figure 4.20).

Figure 4.20		
Design Capacity for Streets		
Street Classification	Minimum Design Storm Capacity	Design Storm Return Interval
Arterial	1%	100 year
Collector and Local Non-Residential	4%	25 year
Residential	10%	10 year
Source: Stormwater Management & Water Quality Manual, Columbia, MO, 2009		

Other

The National Weather Service issues flooding hazard alerts according to three response levels (Figure 4.21). These alerts are broadcast through local media.

Figure 4.21

Flood Response Levels	
Level	Description
Flood Watch	Flash flooding or flooding is possible within a designated area
Flood Warning	Flash flooding or flooding has been reported or is imminent
Flood Advisory	Flooding of small streams, streets, and low lying areas, such as railroad underpasses and some urban drains is occurring

Potential Impact - Future Development

There is a high level of awareness in the planning area regarding the dangers and potential of flooding. Participation in the NFIP by Boone County and all the major communities means that floodplain ordinances are in place regulating development in the floodplain. In addition, Boone County and the City of Columbia have storm water management plans and requirements in place.

However, development is vigorous in the planning area, especially in and around the City of Columbia. The city is already vulnerable to flash flooding and an increase in impervious surface means an increase in runoff. It is important that development projects are closely monitored to ensure compliance with all storm water requirements and regulations in order to minimize increases to flash flooding from development. This is increasingly crucial as it is now known that climate change is causing an increase in the type of heavy downpours which trigger flash flooding.

SUMMARY OF VULNERABILITY

The entire planning area is at risk from some type of flooding. The most common types of flooding in the area are flash and sheet flooding associated with heavy downpours. This is of particular concern in the unincorporated parts of Boone County, where roads can become impassable, and in the City of Columbia, where flash flooding affects a number of NFIP repetitive loss properties. Climate change is causing an increase in heavy downpours and this will, in turn, most likely increase the frequency and/or severity of flash flooding.

Flooding of the Missouri River is a potential problem for the areas near the river: the unincorporated areas of Boone County, the jurisdictions of Hartsburg, Huntsdale, and Rocheport and also the City of Columbia, which has significant infrastructure situated in the river bottoms.

Some county roads near the river become impassable during times of high water levels. The incorporated areas of Hartsburg and Huntsdale are protected both by agricultural levees and the Katy Trail, which acts as a levee, but the levees and trail require sandbagging at times of high river levels. Most of Rocheport is also protected by the Katy Trail; the trail is also sandbagged at this location at times of potential flooding. The levees, along with the sandbagging efforts, have

kept these towns safe from flooding for the past few decades; however, there is always the possibility that the levees could be overtopped, or fail, with very high river levels.

The City of Columbia's infrastructure near the river is protected by berms and the McBaine Levee; again, there is always the potential for the levee to be overtopped or fail. Columbia can also experience flooding from the backup of a major tributary branch when the Missouri River is high.

All major jurisdictions of the planning area are members of the NFIP and have floodplain regulations in place. In addition, Boone County and the City of Columbia have put extensive time, energy, and resources into developing storm water plans and regulations. Both Boone County and the City of Columbia are participating in meetings for FEMA's Risk MAP program. These factors, plus a high awareness of the threat of potential flooding, all act to help mitigate the vulnerability to this hazard.

4.2 LEVEE FAILURE

DESCRIPTION OF HAZARD

A levee is defined by the National Flood Insurance Program as “a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.”

Federally authorized levees are typically designed and built by the US Army Corps of Engineers in cooperation with a local sponsor then turned over to a local sponsor to operate and maintain.

Non-federal levees are designed, built, and managed by a non-federal entity.

There is no single agency with responsibility for levee oversight. The Corps of Engineers has specific and limited responsibilities for approximately 2,000 levees nationwide through their Levee Program.

The responsibilities of local levee owners or sponsors are broad and may include levee safety; land use planning and development; building codes; and operations, maintenance, repair, rehabilitation, and replacement of the levee. The certification of levees for FEMA’s National Flood Insurance Program is also the responsibility of the local levee owners or sponsors.

Federally authorized and some non-federal levees may be eligible for Corps of Engineers rehabilitation assistance funding.

This assessment discusses the major levees in the planning area; these levees are owned and operated by levee districts. There are also several privately owned levees which are maintained by their owners; official data on the locations of these private levees is not available.

The USACE notes that there is a “large universe of private and other non Corps levees that have not been inventoried or inspected/assessed. We don’t know the size of this universe, where the levees are located, their condition, or the consequences of failure, loss of life being of paramount concern.”

Location

Boone County, the Villages of Hartsburg and Huntsdale, and the City of Columbia are all vulnerable to levee failure.

The major levees in the planning area, the McBaine and Hartsburg Levees, are located along the southwestern border of Boone County on the left descending bank of the Missouri River between river miles 180 and 150 (Figures 4.22-4.23). They protect agricultural land, the communities of McBaine, Huntsdale, and Hartsburg, and critical infrastructure of the City of Columbia from Missouri River flooding.

Figure 4.22

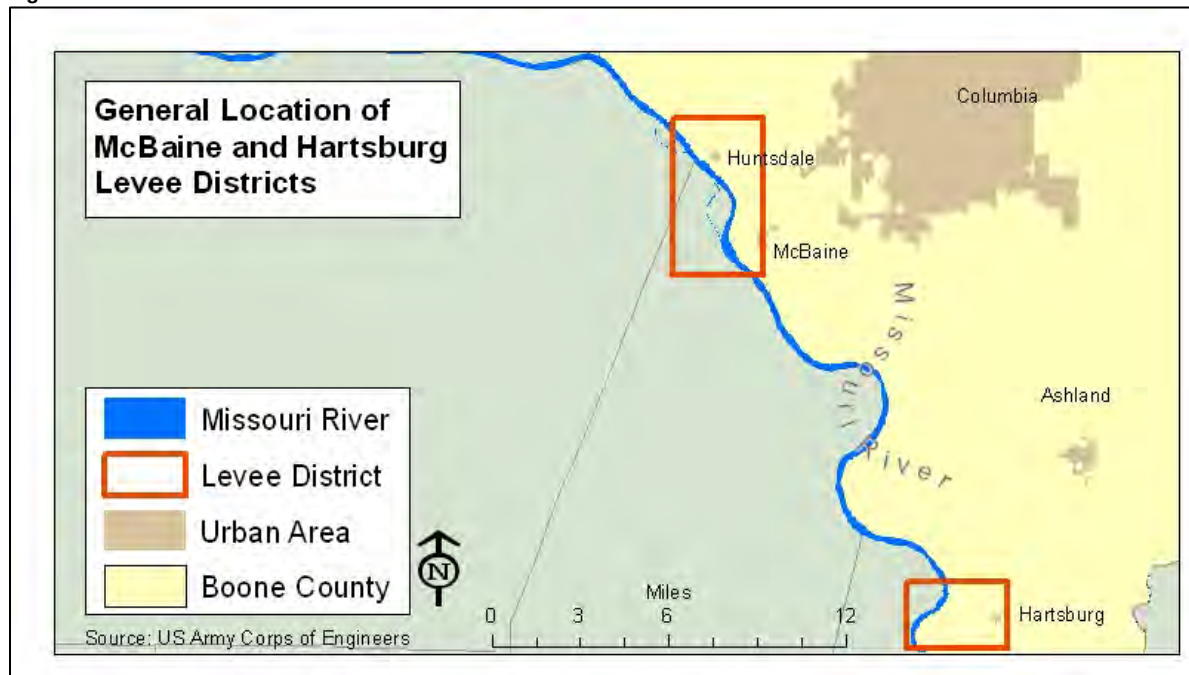


Figure 4.23

Major Levees in Planning Area			
Levee Name	MO River Mile Location (left descending bank)	Segment Length (miles)	Leveed Area Acreage
McBaine Levee	179.6 to 175.0	10.59	2492.94
Hartsburg Levee District Section 1	160.5 to 155.3	7.32	2,071.05
Hartsburg Levee District Section 2	155.2 to 153.6	5.60	1,341.90
Hartsburg Levee District Section 3	153.6 to 150.8	6.53	739.14
Sources: USACE National Levee Database: USACE Levee Inspection Reports			

The McBaine and Hartsburg levees together protect over 6,000 acres of land; they are earthen levees which were locally constructed and are locally operated and maintained. The levees were built as agricultural levees to withstand 50 year floods; none are NFIP certified. The sponsoring levee districts are separate taxing entities organized by the Boone County Circuit Court.

The levees are part of the Army Corps of Engineers Rehabilitation Program and were last inspected in 2014 (McBaine Levee) and 2012 (Hartsburg Levees). According to the USACE, “The rating is based on the levee inspection checklist, which includes 125 specific items dealing with operation and maintenance of levee embankments, floodwalls, interior drainage, pump stations, and channels.” The McBaine Levee received an “acceptable” rating during the most recent inspection and the Hartsburg Levees received “minimally acceptable” ratings. This is based on a 3 tier scale ranging from acceptable to unacceptable.

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

As part of the USACE Levee Program, the levee districts are eligible for Corps of Engineers levee rehabilitation assistance should their levees receive damage during a flood event. The levee must maintain a *minimally acceptable* standard to remain eligible for the assistance.

More detailed views of the major levees are shown in Figures 4.24 and 4.25.

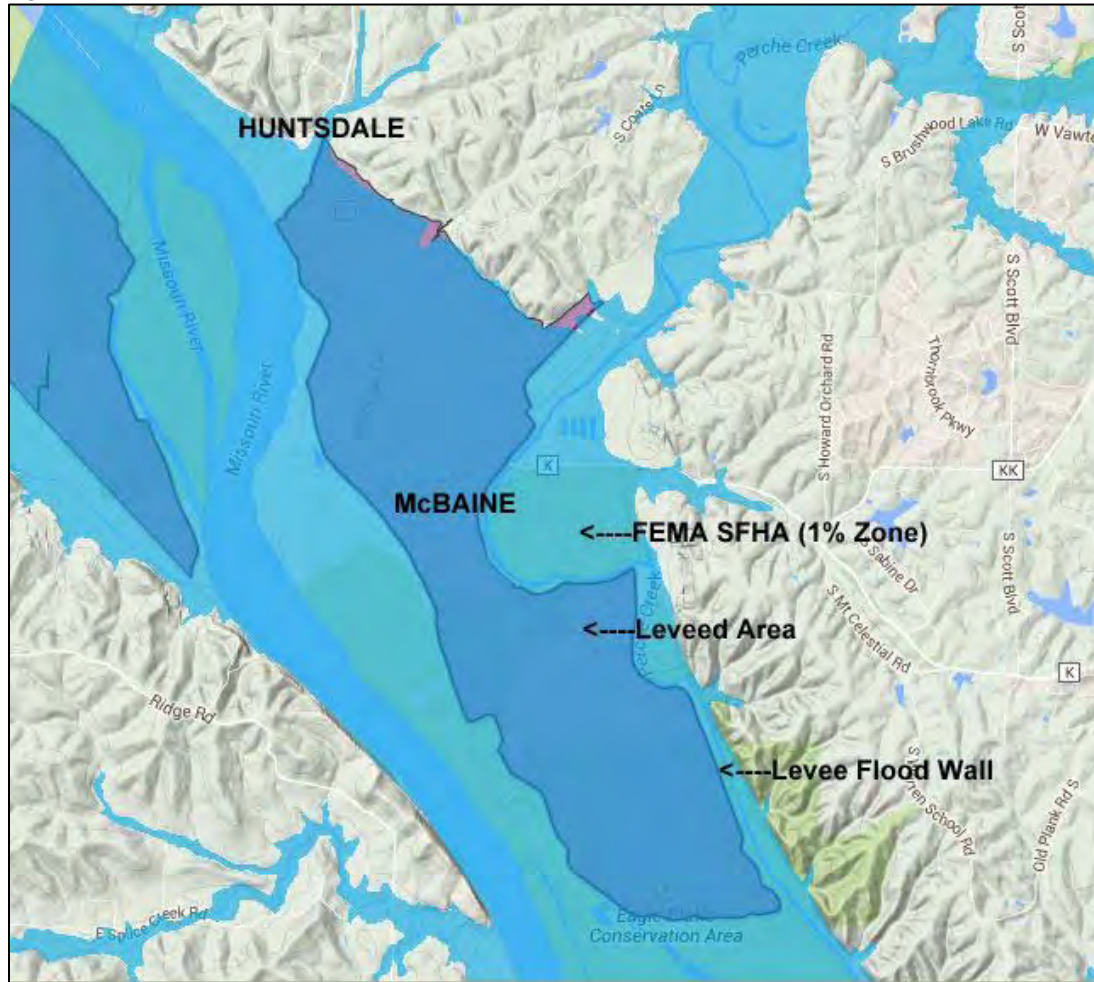
MCBAINE LEVEE

Figure 4.24A



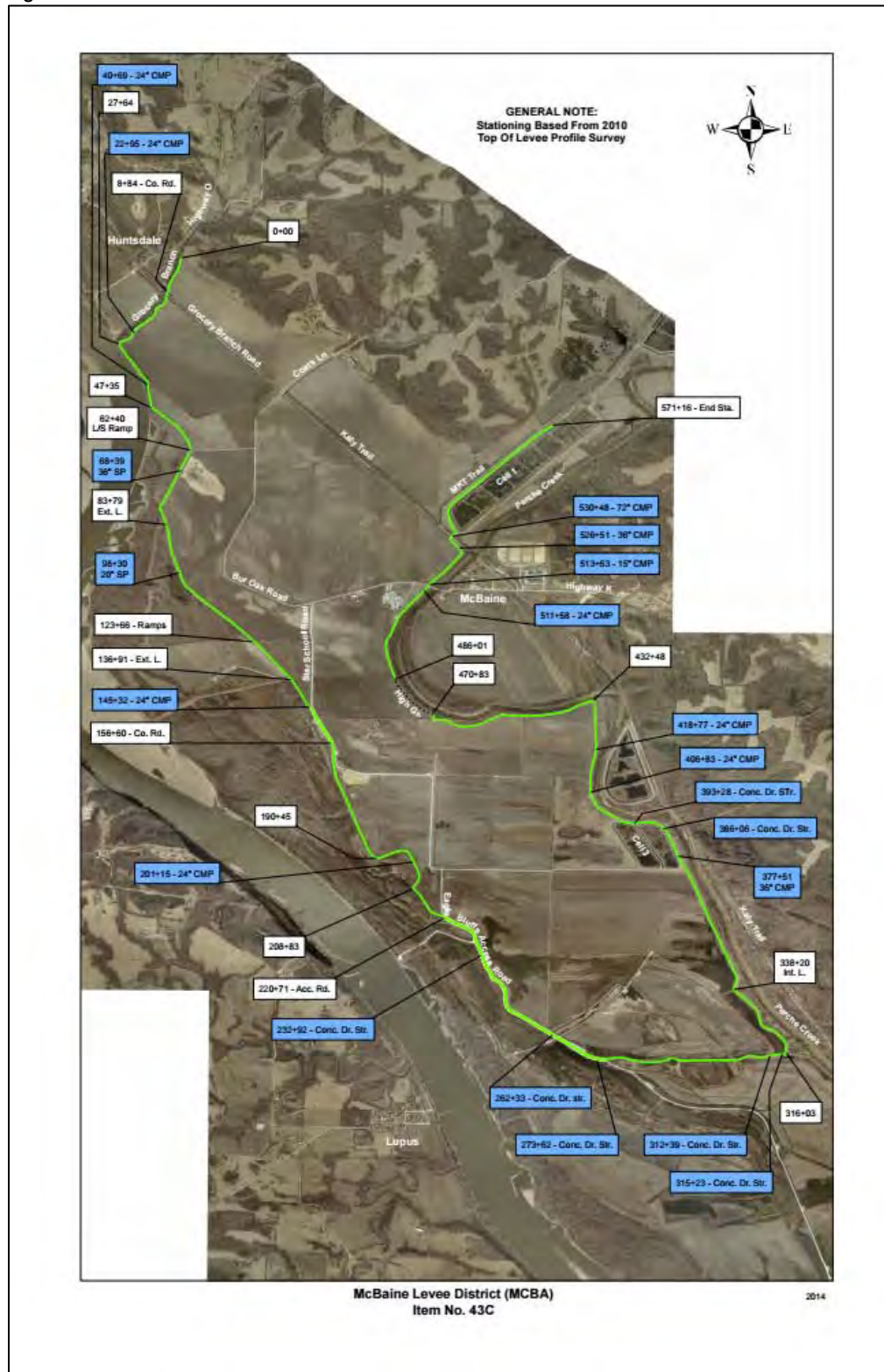
Source: McBaine Levee District President, John Sam Williamson and Joe Gibbs PE

Figure 4.24B



Source: USACE National Levee Database

Figure 4.24C



Source: USACE

HARTSBURG LEVEES

Figure 4.25A

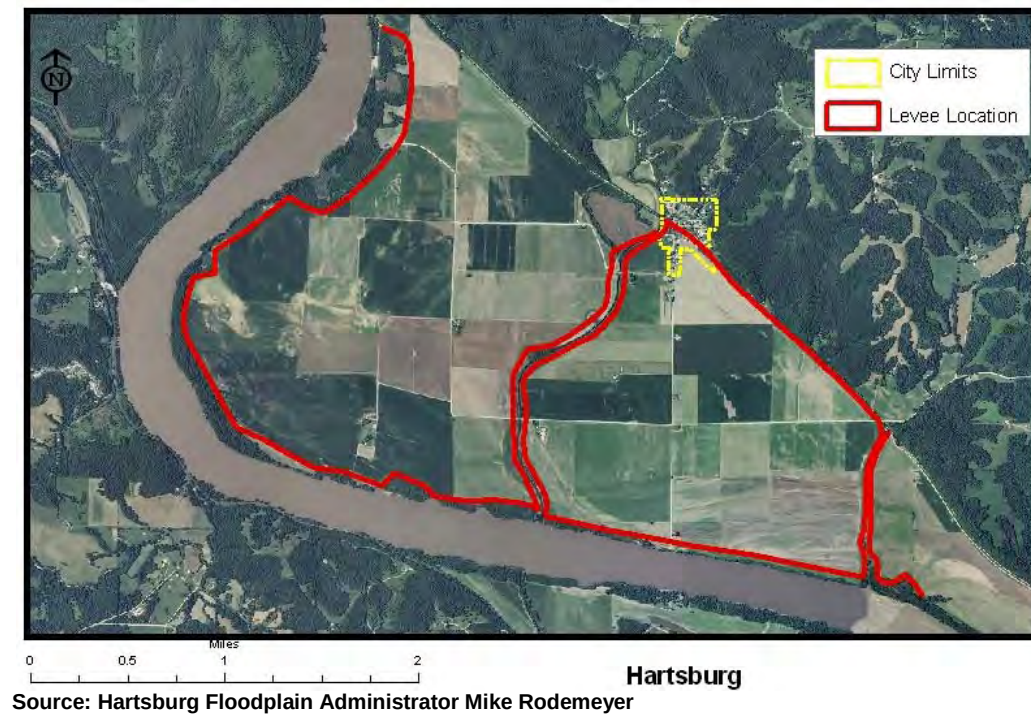


Figure 4.25B

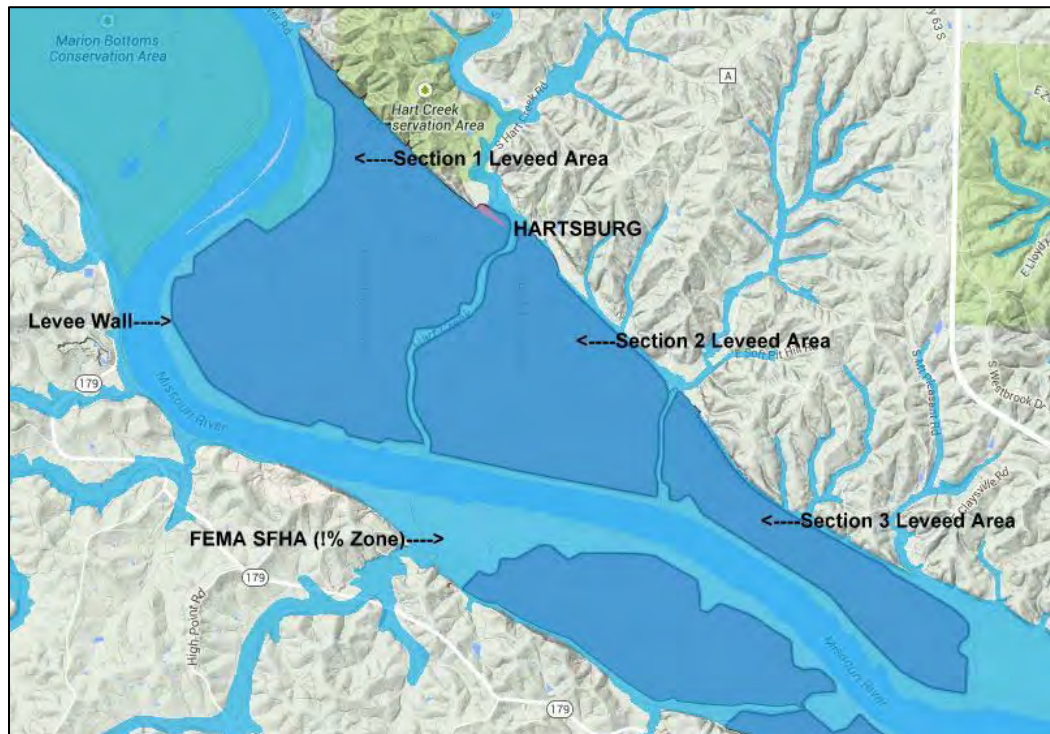
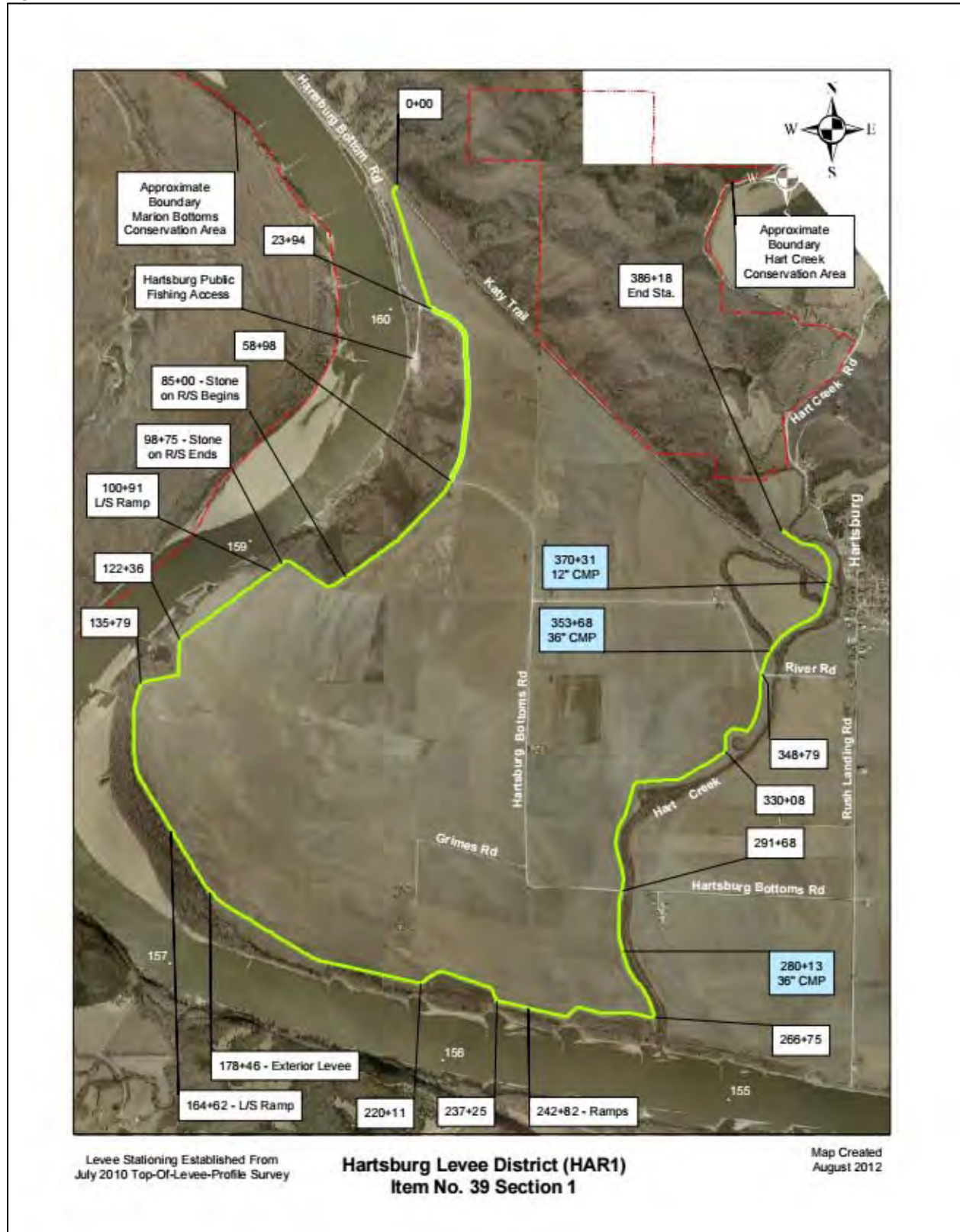


Figure 4.25C



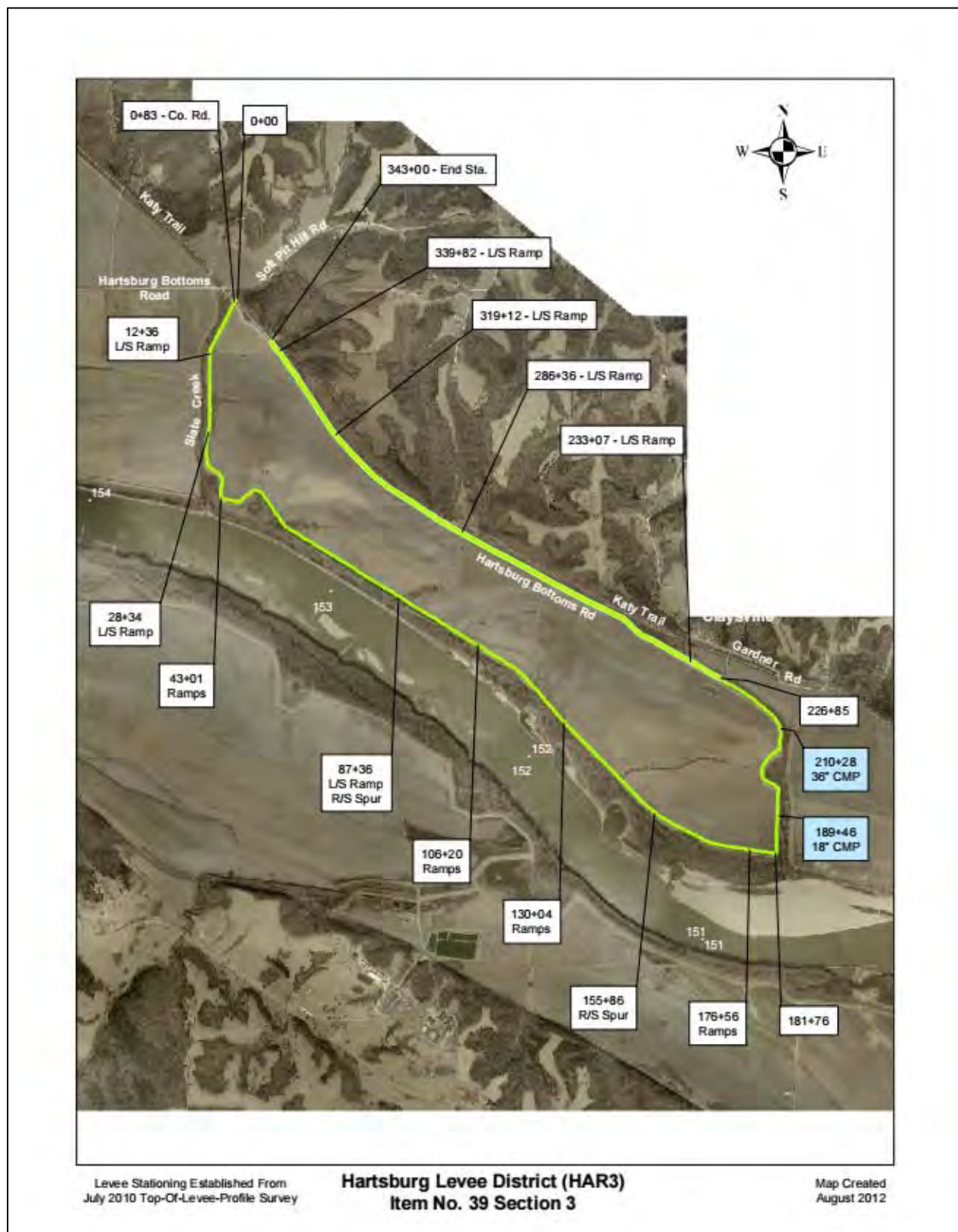
Source: USACE

Figure 4.25D



Source: USACE

Figure 4.25E



Source: USACE

In addition to receiving protection from the Hartsburg Levees, the Village of Hartsburg receives add levee protection from a section of the Katy Trail State Park (owned and maintained by the MO Department of Natural Resources) which runs through the town. This section was elevated to 32 feet following the 1993 flood and provides extra protection for about half of the village, including the business district. The Katy Trail also provides added levee protection for the Village of Huntsdale and the City of Rocheport.

Extent

Levee failure, according to FEMA, can occur by the following means:

- **Overtopping** - When a large flood occurs, water can flow over a levee. The stress exerted by the flowing water can cause rapid erosion.
- **Piping** - Levees are often built over old stream beds. Flood waters will follow these sub grade channels causing a levee to erode internally thereby allowing flood waters to rupture the levee structure.
- **Seepage and Saturation** - If flood waters sit up against a levee for a long period, the levee may become saturated and eventually collapse.
- **Erosion** - Most levees are constructed of sand or soil which erodes easily under high-velocity flood waters.
- **Structural Failures** - Lack of regular maintenance is a key reason levees fail at gates, walls, or closure sites.

Regular maintenance and inspection of the levees is critical. For the major levees in the planning area, the potential of major failure is connected to flooding of the Missouri River, a hazard with a longer speed of onset than many other hazards. This longer speed of onset allows time to mitigate and prepare for potential failure as flooding threatens.

Previous Occurrences

During the 1993 Flood, according to the US Army Corps of Engineers, all levees in Boone County failed and resulted in the inundation of land and structures being protected by those levees. The water treatment plant for the City of Columbia was located in the path of the flood water but, due to intensive efforts by several parties, there were no effects on the structure.

According to the Boone County Health Department, no Boone County public water or city water supplies in the county suffered contamination. Some private wells were sampled and found to contain higher bacteria levels after the flood. These wells were treated with chlorine and the issue was resolved.

Probability of Future Events

Probability: Moderate – Boone County, Columbia, Hartsburg, Huntsdale
Not applicable – All other participating jurisdictions

ANALYSIS OF RISK

Severity: Moderate – Boone County, Hartsburg, Huntsdale
Low – Columbia

The severity rating for Columbia has been assessed as low because there is additional protection in place for the critical infrastructure protected by the McBaine Levee.

Impact – Life

Levee failure presents a flooding threat to life. The longer period of onset associated with failure of levees along the Missouri River would minimize the threat of actual drowning; however, drowning could still occur. The greater threat from levee failure would be exposure to flood waters with possible resulting infection or injury from sewage, agricultural runoff, and industrial chemicals. Flooded buildings present health risks from mold, chemicals and electrical hazards.

Impact - Existing Structures

Information on the agricultural land and built environment protected by the major levees in the planning area is available in data from the most recent USACE Levee Inspection Reports (Figures 4.26-4.27).

Figure 4.26

McBaine Levee District Levee Embankment Data	
Levee Designed Gage Function Reading/Station: 33.7' Boonville Gage Level Of Protection Provided: Exceeds a 10-year flood event Average Height Of Levee: Ranges from 4' to 14' Average Crown Width: Ranges from 10' to 24' Average Side Slope: L/S & R/S 1 on 3 to 1 on 4 Annual Maintenance Costs: \$7,500	
Protected Features	
Total Acres Protected: 2,614 Total Agricultural Production Acres Protected: 2,351 Towns: 1 Businesses: 4 Residences: 0 House Trailers: 2 Roads: Approximately 3 miles of County asphalt surfaced roads; approximately 3 miles of County gravel surfaced roads; approximately 2 miles of service roads within MO Dept. of Conservation Eagle Bluffs Conservation Area; 3 miles of unimproved farm to market roads Utilities: City of Columbia municipal electric, potable water, wastewater lines; City of Columbia potable water wells; private and domestic water wells; City of Columbia and State of MO wetland wastewater management units, pipelines and pump station; and public electric, phone, fiber optic, natural gas and refined petroleum fuel lines Barns: 0 Machine Sheds: 4 Outbuildings: 0 Irrigation Systems: 3 Grain Bins: 0 Domestic Potable Water Wells: 4	
Source: USACE Inspection Report 3/21/14	

Figure 4.27A

**Hartsburg Levee District - Section 1
Levee Embankment Data**

Levee Designed Gage Function Reading/Station: 32.0' Jefferson City Gage

Level Of Protection Provided: Exceeds a 10-Year Flood Event

Average Height Of Levee: 6' To 14' above landside natural ground surface

Average Crown Width: 10' To 22'

Average Side Slope: 1 on 3 to 1 on 4 both slopes

Annual Maintenance Costs: \$2,000

Protected Features

Total Acres Protected: 1,800

Total Agricultural Production Acres Protected: 1,800

Towns: 0

Businesses: 1

Residences: 3

Roads: Approximately 6 miles of gravel surfaced County roads and approximately 6 miles of unimproved farm to market roads

Utilities: Approximately 8 miles of utility lines

Barns: 9

Machine Sheds: 3

Outbuildings: 0

Irrigation Systems: 10

Grain Bins: 10

Other Facilities: Approximately 2 miles of Katy Trail State Park

Source: USACE Inspection Report 8/27/12

Figure 4.27B

**Hartsburg Levee District - Section 2
Levee Embankment Data**

Levee Designed Gage Function Reading/Station: 32.0' Jefferson City Gage

Level Of Protection Provided: Exceeds a 10-year flood event

Average Height Of Levee: 3' to 12' above landside natural ground surface

Average Crown Width: 5' To 12'

Average Side Slope: L/S 1 on 3 to 1 on 4, R/S 1 on 3

Annual Maintenance Costs: \$2,000

Protected Features

Total Acres Protected: 1,000

Total Agricultural Production Acres Protected: 950

Towns: Sections of the City of Hartsburg, Missouri

Businesses: 12

Residences: 35

Roads: Approximately 4.00 miles of gravel surfaced County Roads, approximately 2 miles of asphalt surfaced Township Roads and approximately 4 miles of non-surfaced farm roads

Utilities: Approximately 10 miles of utility lines

Barns: 2

Machine Sheds: 10

Outbuildings: 12

Irrigation Systems: 2

Grain Bins: 7

Other Facilities: Lions Park and ball field, 2 City parks, approximately 2 miles of Katy Trail State Park along with Department of Natural Resources parking lot with restrooms, U.S. Post Office, 2 churches, 12 senior housing units (HUD), American Legion Post, town sewer system and public water supply district

Source: USACE Inspection Report 8/27/12

Figure 4.27C

**Hartsburg Levee District - Section 3
Levee Embankment Data**

Levee Designed Gage Function Reading/Station: 32.0' Jefferson City Gage

Level Of Protection Provided: Exceeds a 10-year flood event

Average Height Of Levee: 4' to 14' above landside natural ground surface

Average Crown Width: 8' To 18'

Average Side Slope: 1 on 3 to 1 on 4 both slopes

Annual Maintenance Costs: \$2,000

Protected Features

Total Acres Protected: 700

Total Agricultural Production Acres Protected: 700

Towns: 0

Businesses: 0

Residences: 0

Roads: Approximately 3.00 miles of gravel surfaced County Roads and approximately 2.00 miles of unimproved farm to market roads.

Utilities: 0

Barns: 0

Machine Sheds: 1

Outbuildings: 0

Irrigation Systems: 3

Grain Bins: 0

Other Facilities: Approximately 2.5 miles of Katy Trail State Park

Source: USACE Inspection Report 8/27/12

Impact - Future Development

Almost all of the land protected by the major levees in the planning area is within the Missouri River floodplain and any development would be subject to the floodplain regulations of either Boone County or the Village of Hartsburg and Huntsdale. It is highly unlikely that development, other than necessary infrastructure, will take place in these areas

Existing Mitigation Activities

The McBaine and Hartsburg Levees are maintained by the levee districts. They receive regular inspections as part of the USACE Rehabilitation and Inspection Program.

SUMMARY OF VULNERABILITY

Boone County, the Villages of Hartsburg and Huntsdale, and the City of Columbia are all vulnerable to levee failure.

The Villages of Huntsdale and Hartsburg are both protected from Missouri River flooding by major agricultural levees (the McBaine Levee and Hartsburg Levees, respectively). These levees also protect some county roads and agricultural lands; in addition, the McBaine Levee protects some of Columbia's critical infrastructure and significant public utilities located in the floodplain.

These levees failed during the 1993 Missouri River flood. Changes in management of the Missouri River, including major wetland restoration projects along the river's long course, have helped to control flood levels on the lower Missouri since that time. In addition, some properties in the floodplain were abandoned, moved, or bought out following that flood; this reduced the number of structures vulnerable to flooding/levee failure. Regular maintenance and inspection of the levees has helped to ensure their integrity to withstand the pressures of rising river levels.

The risk of flooding from levee failure remains, however. The warning time afforded by a hazard such as levee failure, which has a long period of onset, will allow for preparations and evacuations to take place, should the need arise.

4.3 DAM FAILURE

DESCRIPTION OF HAZARD

A dam is defined by the National Dam Safety Act as an artificial barrier which impounds or diverts water and is:

1. more than 6 feet high and stores 50 acre feet or more or
2. 25 feet or more high and stores more than 15 acre feet.

Based on this definition, there are over 80,000 dams in the United States. Over 95% are non-federal, with most being owned by state governments, municipalities, watershed districts, industries, lake associations, land developers, and private citizens.

Dam owners have primary responsibility for the safe design, operation and maintenance of their dams. They also have responsibility for providing early warning of problems at the dam, for developing an effective emergency action plan, and for coordinating that plan with local officials. The State has ultimate responsibility for public safety, and many states regulate construction, modification, maintenance, and operation of dams, and also ensure a dam safety program.

Dam construction varies widely throughout the state. A majority of dams are of earthen construction. Missouri's mining industry has produced numerous tailing dams for the surface disposal of mine waste. These dams are made from mining material deposited in slurry form in an impoundment. Other types of earthen dams are reinforced with a core of concrete and/or asphalt. The largest dams in the state are built of reinforced concrete, and are used for hydroelectric power.

Failure - Dams can fail for many reasons. The most common are:

Piping: internal erosion caused by embankment leakage, foundation leakage and deterioration of pertinent structures appended to the dam.

Erosion: inadequate spillway capacity causing overtopping of the dam, flow erosion, and inadequate slope protection.

Structural Failure: caused by an earthquake, slope instability or faulty construction.

These three types of failures are often interrelated. For example, erosion, either on the surface or internal, may weaken the dam or lead to structural failure. Similarly a structural failure may shorten the seepage path and lead to a piping failure.

Dam Hazard Classification - Dams in Missouri have been classified according to both a federal and state system with regards to potential hazard posed.

The **federal classification system** is based upon the probable loss of human life and the impact on economic, environmental and lifeline interests from dam failure. It should be noted that there is always the possibility of loss of human life when a dam fails; this classification system does not account for the possibility of people occasionally passing through an inundation area which is usually unoccupied (e.g. occasional recreational users, daytime user of downstream lands, etc.)

The **state classification system** is based upon the type and number of structures downstream from a dam. An inventory of all the dams of the state was done in the late 1970s and early 1980s, according to Glenn Lloyd, Civil Engineer and Dam Safety Inspector with the Dam Safety Program of the MO Department of Natural Resources (DNR). All of the known dams were classified by the state at that time.

A summary of the federal and state classification systems, how the two systems relate to each other, and inspection requirements for regulated dams is shown in Figure 4.28.

Figure 4.28				
Dam Hazard Classification Systems				
Federal		State		
Classification	Criterion	Classification	Downstream Environment	Inspection Requirement (Regulated Dams)
High hazard	Probable loss of human life	Class 1	10 or more permanent dwellings; or any public building	Every 2 years
		Class 2	1-9 permanent dwellings; or 1 or more campgrounds with permanent water, sewer and electrical services; or one or more industrial buildings	Every 3 years
Significant hazard	No probable loss of human life but potential economic loss, environmental damage, disruption of lifeline facilities or other impact of concern	Class 3	Everything else	Every 5 years
Low hazard	No probable loss of human life; low economic and/or environmental loss; loss principally limited to owner's property			
Sources: Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams, April 2004, http://www.fema.gov/library/viewRecord.do?id=1830 ; http://www.sos.mo.gov/adrules/csr/current/10csr/10c22-2.pdf ; Glenn Lloyd, Civil Engineer/Dam Safety Inspector, MO DNR, Water Resources Center, Dam Safety Program				

Dam Regulation in Missouri

Pursuant to Chapter 236 of the Revised Statutes of Missouri, a dam must be 35 feet or higher to be state regulated; regulation makes a dam subject to permit and inspection requirements. For regulated dams, the state classification system dictates the required inspection cycle. According to the Association of State Dam Safety Officials, 5206 dams in Missouri have been classified and only 653 are regulated by the state.

The inspection cycle for regulated dams allows for a regulated dam's classification to be updated when appropriate. Classification is a dynamic system; development can easily change the situation downstream. A regulated dam in Missouri would have its classification appraised at least once every 5 years.

The DNR National Dam Inventory database lists 127 dams in Boone County; one of these (Moon Valley Lake Dam) is no longer in existence due to failure. The database reflects only the known dams; a dam less than 35 feet in height which was built since the inventory was taken some 30 years ago may not appear in the database. One additional dam (McNew Lake Dam) was brought to the attention of the hazard planning committee; it is located outside of Hartsburg.

Of the known dams, only seventeen are regulated by the state (Figure 4.29).

Figure 4.29					
State Classification and Regulation of Dams in the planning area					
	State Hazard Classification				
	1	2	3	NA	Total
Regulated	4	10	3	0	17
Non-regulated	18	15	76	1	110
Total dams	22	25	79	1	127

One must use caution in assuming the classifications of non-regulated dams are currently accurate. It is very probable that, for most of the non-regulated dams, the classification does not take into account almost 30 years of development and change in Boone County.

Location

The locations of dams in the planning area are shown in the following series of maps and associated data charts:

- An overview of all known dams in the planning area (Figure 4.30)
- State Regulated dams (Figures 4.31A,B,C)
- Non-regulated dams (Figures 4.32A,B and Appendix B)
- Non-regulated dams in the City of Columbia (Figure 4.33)
- Dams located in or near other incorporated communities (Figure 4.34)

Figure 4.30

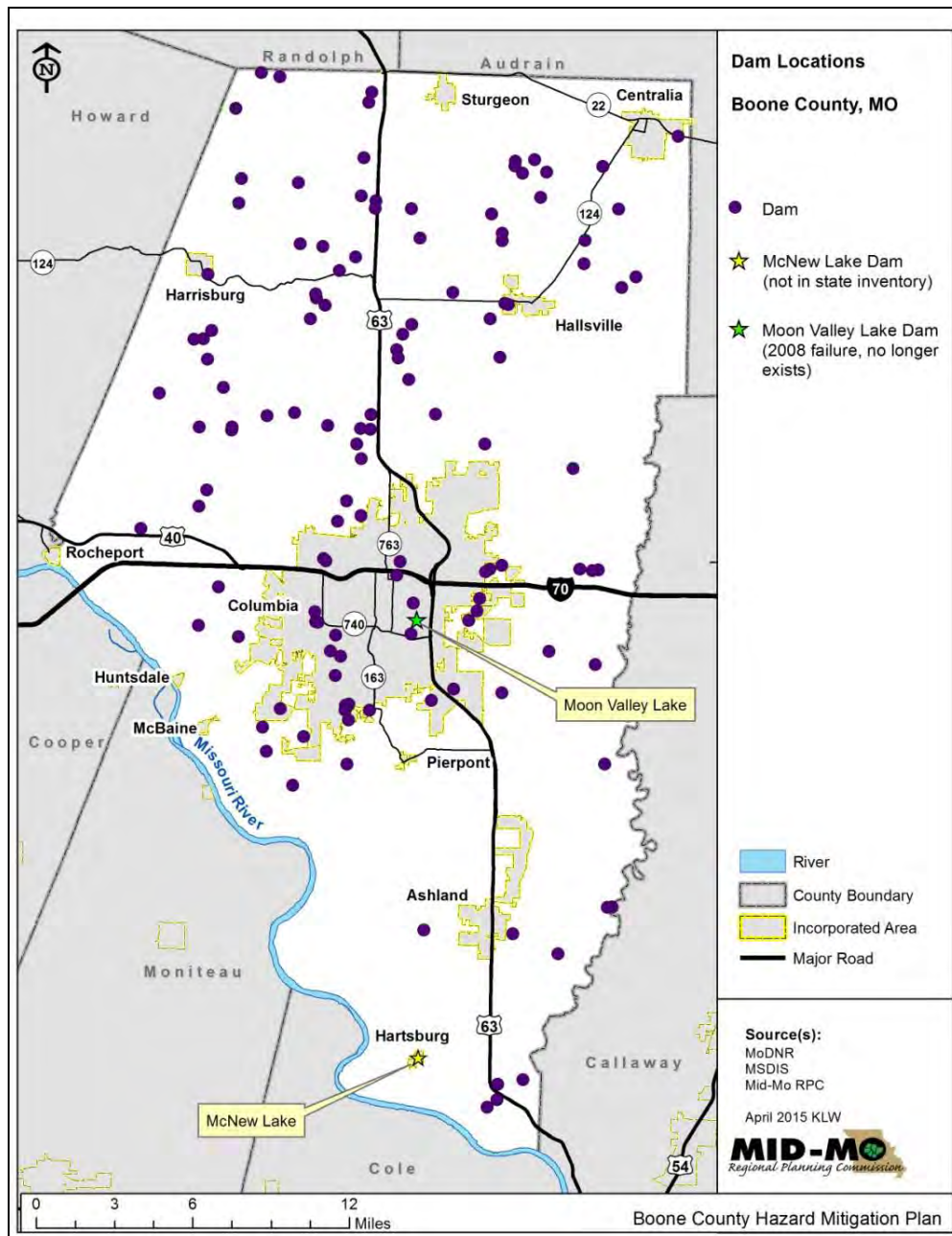


Figure 4.31A

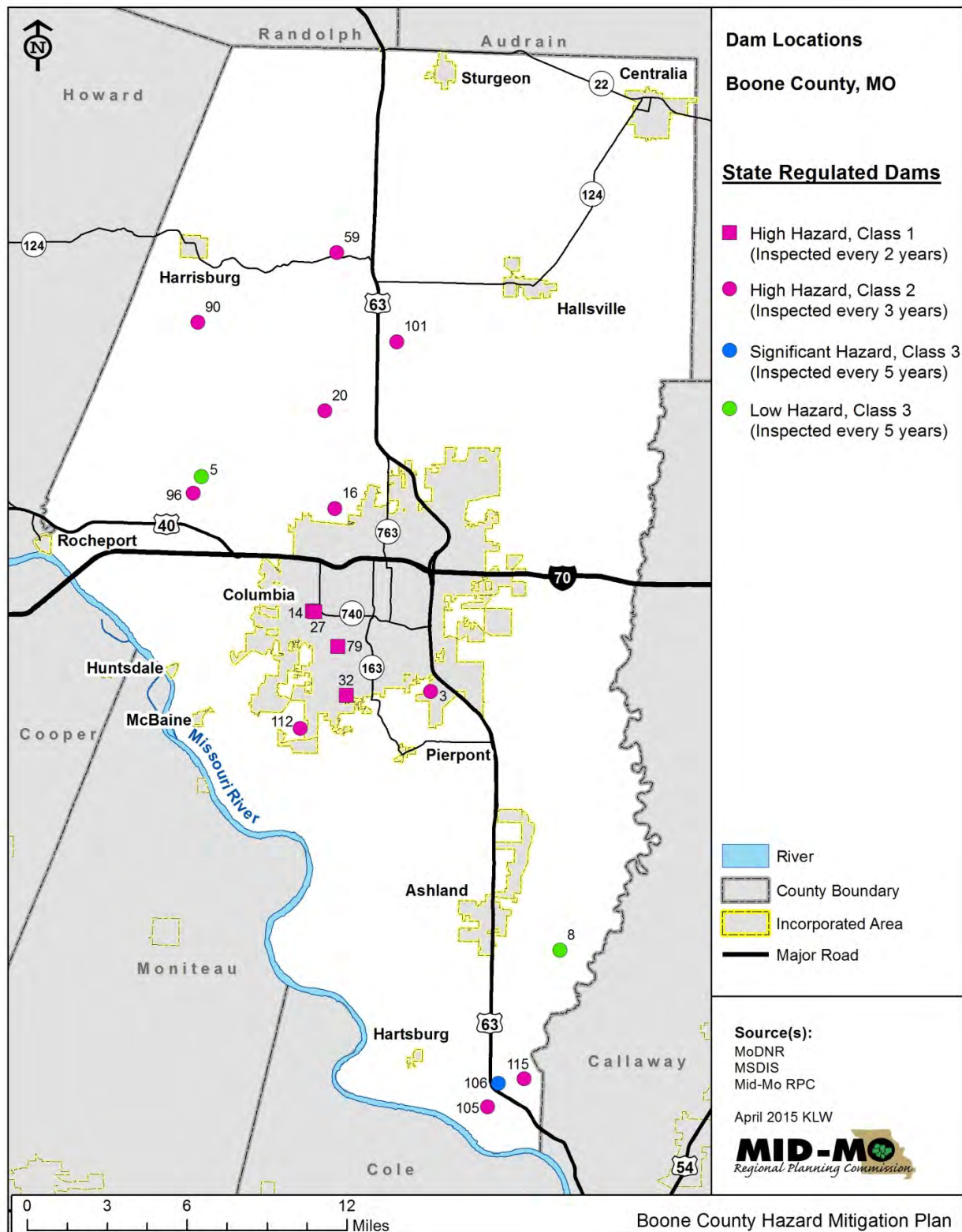


Figure 4.31B

State Regulated Dams in Planning Area											
Map ID #	Name	Federal Hazard Class	State Hazard Class	Year Built	Length (ft.)	Height (ft.)	Reservoir Area (acres)	Max. Storage (acre-feet)	Most Recent Inspection	Emergency Action Plan (EAP)	Owner Type
3	Philips Park Lake Dam	H	2	1965	985	46	33	653	6/1/2013	YES	Private
5	Callahan Creek C-1	L	3	1966	500	42	16	336	5/11/2011	NO	Local Gov.
8	Ashland Wildlife Area Dam	L	3	1937	270	44	29	429	9/10/2014	NO	State
14	Hulen Lake West Dam	H	1	1948	600	50	18	309	7/15/2014	NO	Private
16	Roemer'S Lake Dam	H	2	1963	700	37	26	347	4/30/2013	YES	Private
20	Boco Mo Dam	H	2	1974	912	39	64	759	12/2/2013	NO	Private
27	Hulen Lake East Dam	H	1	1948	420	50	7	171	7/15/2014	NO	Private
32	Cedar Lake Dam	H	1	1975	600	42	21	302	7/15/2014	YES	Private
59	Country Boy Estates Lake Dam 2	H	2	1977	510	37	8	100	12/19/2012	NO	Private
79	Woodrail Lake Dam	H	1	1968	480	54	12	324	6/10/2014	NO	Private
90	Callahan Creek A-1	H	2	1979	950	35	15	220	8/22/2012	YES	Local Gov.
96	Callahan Creek C-2	H	2	1979	450	54	5	1000	5/14/2012	YES	Local Gov.
101	Finger Lakes Dam South	H	2	0	910	44	79	585	7/15/2014	NO	State
105	Claysville Lake Dam	H	2	1979	470	42	13	273	2/26/2014	NO	Private
106	Brandel Lake Dam	S	3	1989	220	46	0	6	1/19/2012	NO	Private
112	Arrowhead Lake Dam	H	2	1995	950	37	42	382	5/21/2013	-	Private
115	Lake Champetra Dam	H	2	1970	600	60	47	1530	9/25/2013	YES	Private

Source: MO DNR - National Inventory of Dams

Figure 4.31C

State Regulated Dams in Planning Area							
Map ID #	Name	Watershed (acres)	Purpose of Reservoir				Corps ID #
			Recreation	Flood Control/storm water mgmt.	Fire protection, stock, or small farm pond	Other	
3	Philips Park Lake Dam	360	✓				MO10019
5	Callahan Creek C-1	3,600		✓			MO10021
8	Ashland Wildlife Area Dam	2,475	✓			✓	MO10036
14	Hulen Lake West Dam	160	✓				MO10726
16	Roemer'S Lake Dam	245	✓	✓			MO10731
20	Boco Mo Dam	2,000	✓				MO10893
27	Hulen Lake East Dam	51	✓				MO10975
32	Cedar Lake Dam	530	✓				MO11058
59	Country Boy Estates Lake Dam 2	60	✓				MO11579
79	Woodrail Lake Dam	240	✓				MO11603
90	Callahan Creek A-1	1,523	✓	✓			MO11646
96	Callahan Creek C-2	980		✓			MO11774
101	Finger Lakes Dam South	540	✓				MO12212
105	Claysville Lake Dam	245	✓				MO12234
106	Brandel Lake Dam	5			✓		MO12235
112	Arrowhead Lake Dam	506	✓				MO12374
115	Lake Champetra Dam	597	✓				MO30880

Source: MO DNR - National Inventory of Dams

Figure 4.32A

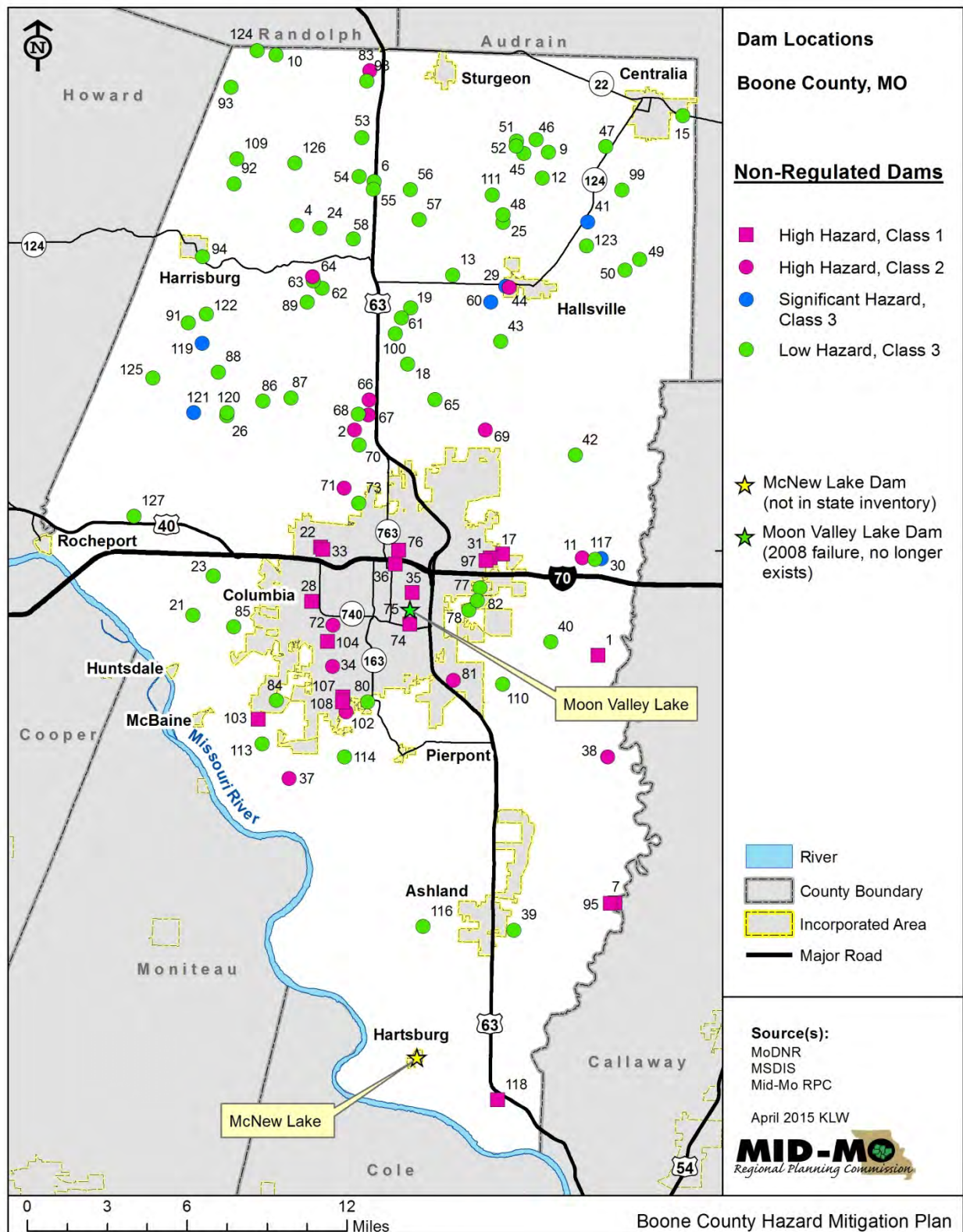


Figure 4.32B

Non-regulated Dams in Planning Area										
Map ID #	Name	Federal Hazard Class	State Hazard Class	Year Built	Length (ft.)	Height (ft.)	Reservoir Area (acres)	Max. Storage (acre-feet)	Most Recent Inspection	Owner Type
1	Lake Chateau Dam	H	1	1964	0	31	25	415	5/31/1979	Private
2	County Downes Lake Dam	H	2	1968	0	30	26	417		Private
4	Gurwit Lake Dam	L	3	1963	0	22	13	153		Private
6	Bailey Lake Dam	L	3	1967	0	15	12	96		Private
7	Windmill Dam #1	H	1	1962	0	30	23	369	5/31/1979	Private
9	Tri-City Community Lake Dam	L	3	1957	0	25	28	374		State
10	Hood Lake Dam	L	3	1968	0	25	20	268		Private
11	Turkey Farm Lake Dam	H	2	1957	0	20	13	139		State
12	Montgomery Lake Dam	L	3	1957	0	25	6	80		Private
13	Mckenzie Lake Dam	L	3	1958	0	25	8	107		Private
15	Wabash Lake Dam	L	3	1890	0	15	35	281		Private
17	Welch Lake Dam	H	1	1960	0	22	9	106	3/10/1981	Private
18	Rocky Fork Creek Dam	L	3	1965	0	15	55	441		State
19	Columbia Sportsmans Club Lake Dam	L	3	1972	0	20	23	246		Private
21	Cedar Lake Dam-Sec 23	L	3	1971	0	30	8	128		Private
22	Columbia Mun Golf Course Lower L. Dam	H	1	1953	0	15	3	24	9/13/1978	Local Gov.
23	Smarr Lake Dam	L	3	1967	0	25	2	27		Private
24	Bumgarner Lake Dam-Sec 3	L	3	1972	0	25	10	134		Private
25	Upper Lake Chapperal Dam	L	3	1972	0	25	22	294		Private
26	Little Leech Dam	L	3	1973	0	21	3	34		Private
28	Fairview Lake Dam	H	1	1948	0	34	2	36	4/13/1978	Private
29	Andy Lake Dam	S	3	1974	0	25	4	54		Private
30	Lake Lavista Dam	S	3	1973	0	25	22	294		Private
31	Hagan Lake Dam	H	1	1960	0	19	7	71	6/3/1980	Private
33	Columbia Mun. Golf Course Dam	H	1	1950	0	17	7	64	9/13/1978	Local Gov.
34	Country Club Of Mo Lake Dam	H	2	1972	0	30	8	128		Private
35	Stephens Lake Dam	H	1	1939	0	23	11	135	7/11/1980	Private
36	Moore's Lake Dam	H	1	1904	0	30	7	112	7/11/1980	Local Gov.
37	Smith Hatchery Lake Dam	H	2	1974	0	25	6	80		Private
38	Ginn Lake Dam	H	2	0	0	30	8	128		Private
39	Peterson Lake Dam	L	3	0	0	30	6	96		Private
40	Landhuis Lake Dam	L	3	0	0	25	19	254		Private
41	Musgraves Lake Dam	S	3	1974	0	23	11	135		Private
42	Cummings Lake Dam	L	3	1978	0	25	10	134		Private
43	Wasley Lake Dam	L	3	0	0	25	4	54		Private
44	Scott Lake Dam	H	2	1974	0	25	5	67		Private
45	Schnarre Lake Dam Sec 23	L	3	1975	0	25	13	174		Private

Figure 4.32B (cont.)

Non-regulated Dams in Planning Area										
Map ID #	Name	Federal Hazard Class	State Hazard Class	Year Built	Length (ft.)	Height (ft.)	Reservoir Area (acres)	Max. Storage (acre-feet)	Most Recent Inspection	Owner Type
46	Schnarre Dam Sec 24	L	3	0	0	20	11	118		Private
47	Forrest Lake Dam	L	3	1963	0	25	6	80		Private
48	Lower Lake Chapparel Dam	L	3	1976	0	27	45	660		Private
49	Bunn'S Lake Dam East	L	3	1978	0	15	14	112		Private
50	Bunn S Lake Dam West	L	3	1977	0	25	24	321		Private
51	Fountain Lake Dam	L	3	1975	0	25	8	107		Private
52	Roberts Lake Dam	L	3	1969	0	25	4	54		Private
53	North 40 Lake Dam	L	3	1936	0	25	4	54		Private
54	Angel Lake Dam	L	3	1968	0	29	8	124		Private
55	Wayland Lake Dam	L	3	0	0	25	5	67		Private
56	Pollock Lake Dam	L	3	1971	0	25	10	134		Private
57	Salmons' Lake Dam	L	3	1960	0	25	3	40		Private
58	Bumgarner Lake Dam-Sec 11	L	3	1973	0	24	10	128		Private
60	Aaron Lake Dam	S	3	1974	0	20	10	107		Private
61	Silver Creek Lake Dam	L	3	1975	0	24	20	270		Private
62	Country View Acres Lake Dam	L	3	0	0	25	6	80		Private
63	Lewis Lake Dam South	L	3	0	0	25	2	27		Private
64	Lewis Lake North Dam	H	2	1977	0	25	13	174		Private
65	Garrett Lake Dam	L	3	1968	0	25	5	67		Private
66	Walnut Crest Lake Dam	H	2	1969	0	25	3	40		Private
67	Weil Lake Dam	H	2	0	0	25	3	40		Private
68	Hopper Dam	L	3	0	0	25	3	40		Private
69	Seltsam Lake Dam	H	2	1979	0	25	3	40		Private
70	Bon-Gor Lake Dam	L	3	1950	0	20	9	96		Private
71	Rayfield Lake Dam	H	2	1964	0	25	3	40		Private
72	Mills Lake Dam	H	2	1947	0	30	3	48		Private
73	Ausburn'S Lake Dam	L	3	1965	0	19	8	81		Private
74	Lake Cyrene Dam	H	1	1930	0	25	7	94	3/11/1981	Private
75	Moon Valley Lake Dam	H	1	1964	0	18	13	125	3/11/1981	Private
76	Shady Lake Dam	H	1	1968	0	26	4	56	6/2/1980	Private
77	Liddell Dam	L	3	0	0	25	3	40		Private
78	Fletchall Lake Dam	L	3	1977	0	25	2	27		Private
80	Smith Lake Dam Sec 1	L	3	1950	0	25	3	40		Private
81	Univ Of Mo-R1 Dam	H	2	1959	0	18	12	116		State
82	Smith Lake Dam	L	3	1959	0	30	9	144		Private
83	Tincher Lake North Dam	H	2	1950	0	25	5	67		Private
84	Sapp Lake Dam	L	3	1977	0	25	6	80		Private
85	Rapp Lake Dam	L	3	1968	0	30	4	64		Private
86	Kimmy Lake Dam	L	3	1970	0	25	5	67		Private
87	Dexter Lake Dam	L	3	0	0	25	3	40		Private

Figure 4.32B (cont.)

Non-regulated Dams in Planning Area										
Map ID #	Name	Federal Hazard Class	State Hazard Class	Year Built	Length (ft.)	Height (ft.)	Reservoir Area (acres)	Max. Storage (acre-feet)	Most Recent Inspection	Owner Type
88	Callahan Creek Watershed Dam A-4	L	3	1975	0	27	11	159		Local Gov.
89	Bennett Lake Dam	L	3	1973	0	20	13	139		Private
91	Callahan Creek Watershed Dam A-6	L	3	1977	0	25	6	80		Local Gov.
92	Lohmar Lake Dam	L	3	0	0	30	8	128		Private
93	Llorens Lake Dam	L	3	1957	0	30	8	128		Private
94	Blakemore Lake Dam	L	3	1963	0	30	4	64		Private
95	Windmill Dam #2	H	1	1962	0	20	5	67	5/31/1979	Private
97	Waters Edge Estates Lake Dam	H	1	1980	0	25	17	227	7/12/1980	Private
98	Tincher Lake South Dam	L	3	1979	0	25	20	268		Private
99	Roddy Lake Dam	L	3	1967	0	25	11	147		Private
100	Finger Lakes Dam North	L	3	0	0	26	48	668		State
102	Highlands Lake Dam	H	2	1986	0	34	5	91	7/16/1986	Private
103	B & C Subdivision Dam	H	1	1989	0	34	38	691		Private
104	Limerick Lake Dam	H	1	0	0	31	2	33		Private
107	Highlands Lower Lake Dam	H	1	1989	0	30	4	64		Private
108	Highlands South Lake Dam	H	1	1989	0	30	1	16		Private
109	Windmill Lake Dam	L	3	1980	0	25	5	104		Private
110	Horner Lake Dam	L	3	1980	0	26	5	59		Private
111	Harrison Lake Dam	L	3	1985	0	24	2	85		Private
113	Woodbine Lake Dam	L	3	1965	0	25	3	40		Private
114	Hill Creek Acres Lake Dam	L	3	1969	0	32	7	120	12/22/1997	Private
116	Herny Dam	L	3	1965	0	15	8	64		Private
117	Cheng Lake Dam	L	3	1971	0	15	10	80		Private
118	Demarco Lake Dam	H	1	0	0	31	3	50	7/1/1980	Private
119	Callahan Creek A-2	S	3	1975	620	29	5	240		Local Gov.
120	Callahan Creek B-1	L	3	1967	700	26	6	188		Local Gov.
121	Callahan Creek B-3	S	3	1980	780	33	6	280		Local Gov.
122	Fields Dam	L	3	1989	336	28	1	27		Private
123	Greg Bunn Lake	L	3	1979	650	18	1	128		Private
124	Hargis Dam	L	3	1989	185	26	1	19		Private
125	Kreisel Lake Dam	L	3	1977	438	21	15	104		Private
126	Silas Mccubbin Lake Dam	L	3	1979	322	28	1	57		Private
127	Yates Dam	L	3	1990	460	23	1	64		Private
128	McNew Lake	not in state database - no information available								

Source: MO DNR - National Inventory of Dams

Additional information (the watershed area, purpose of the reservoir, and Corps ID #) on the non-regulated dams can be found in Appendix B.

Figure 4.33 (See Figure 4.32B and Appendix B for detailed information)

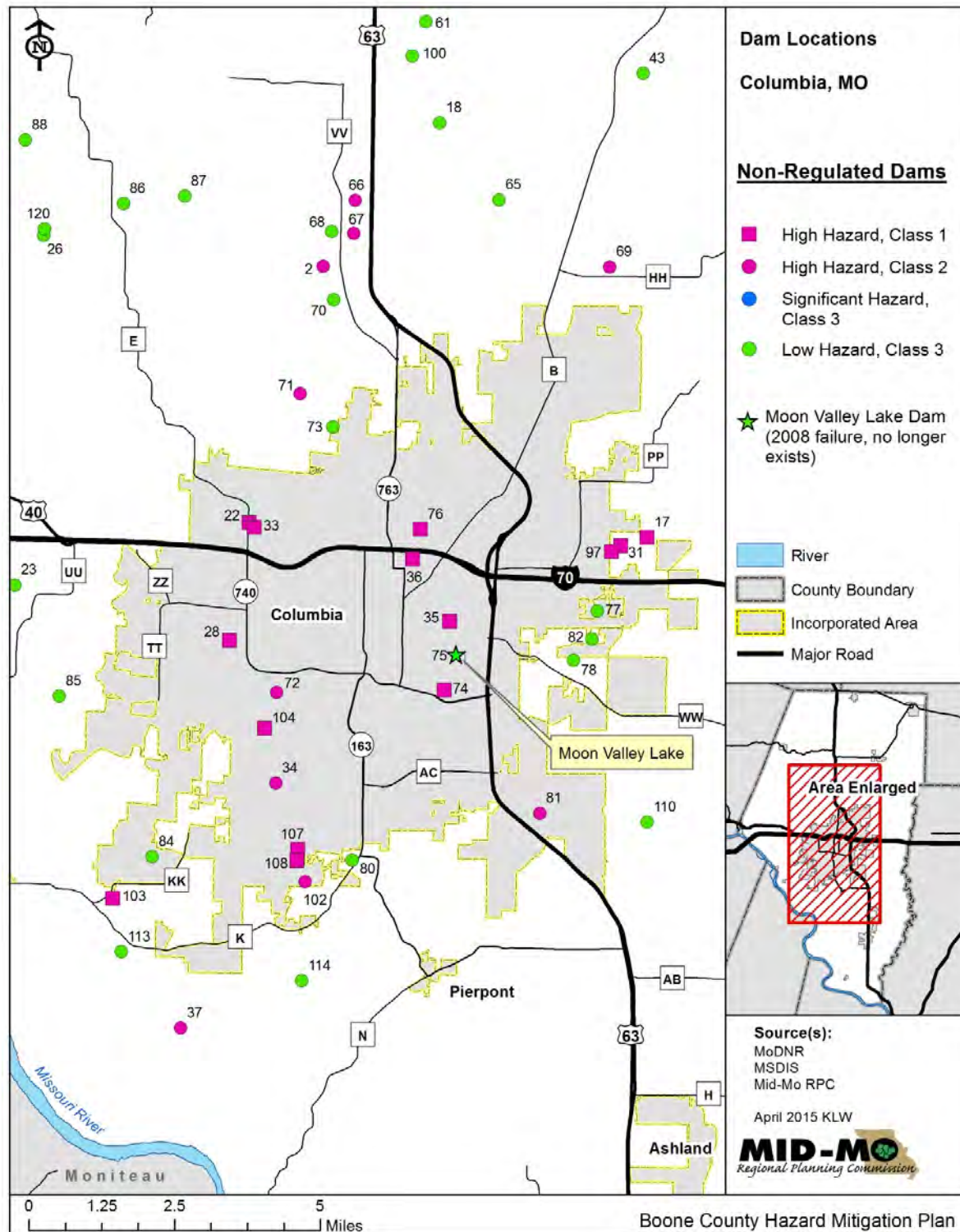


Figure 4.34

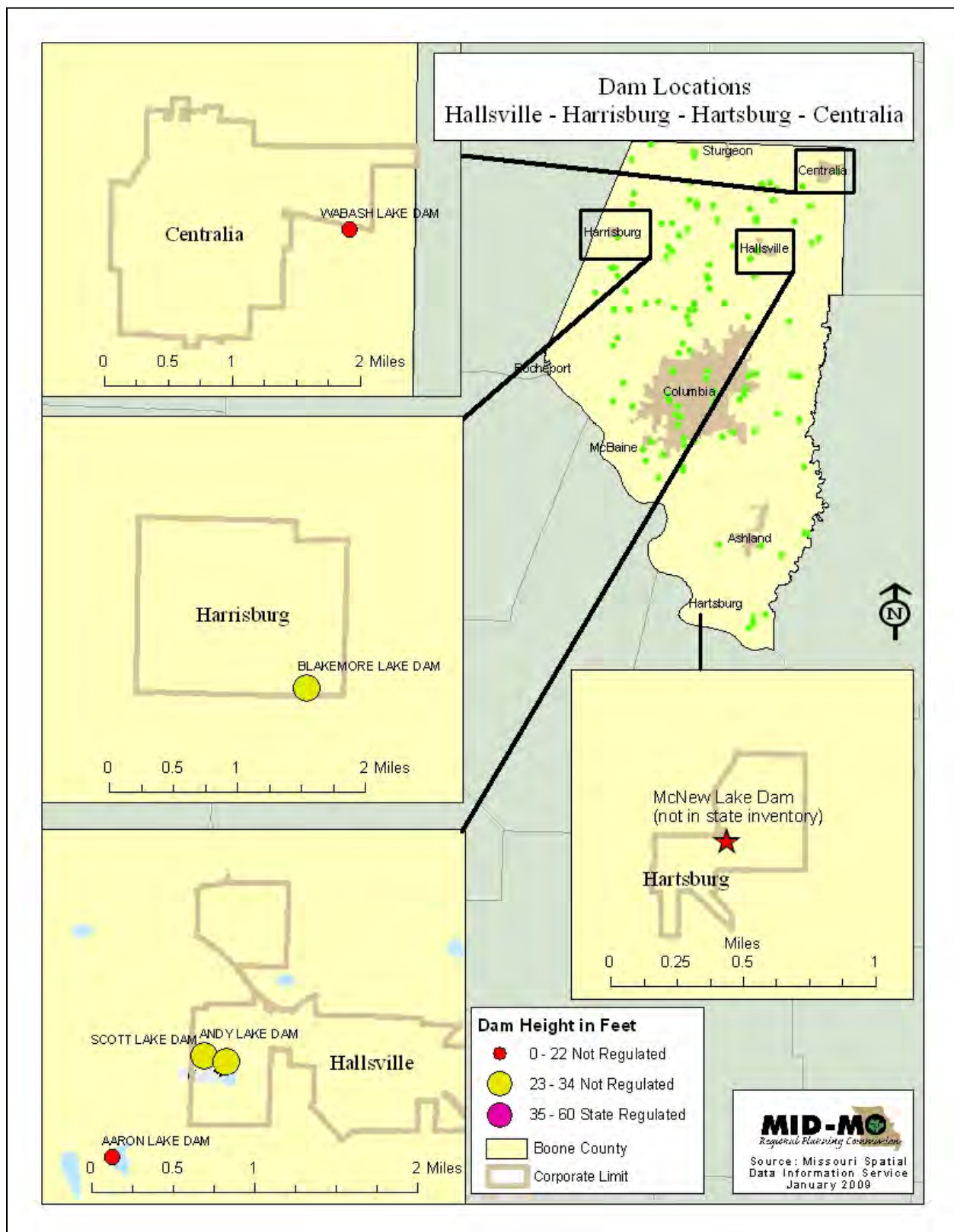


Figure 4.35



A more detailed mapping of the area of Blakemore Lake Dam on the southeastern edge of the village of Harrisburg shows that the dam is actually located outside the city limits (Figure 4.35). If a dam failure occurred, the drainage from this dam would move away from the village so the dam is not considered a threat to Harrisburg.

Extent

The speed of onset of a dam failure can vary considerable. In most cases, regular inspections, either formal or informal, will promote a longer period of onset and allow for possible mitigation. Unfortunately, the current lack of required dam inspections increases the likelihood of dam conditions being ignored by owners – a situation which promotes a quicker speed of onset and an increased threat from the hazard.

The extent of hazard which a dam failure poses is also influenced by the reservoir size.

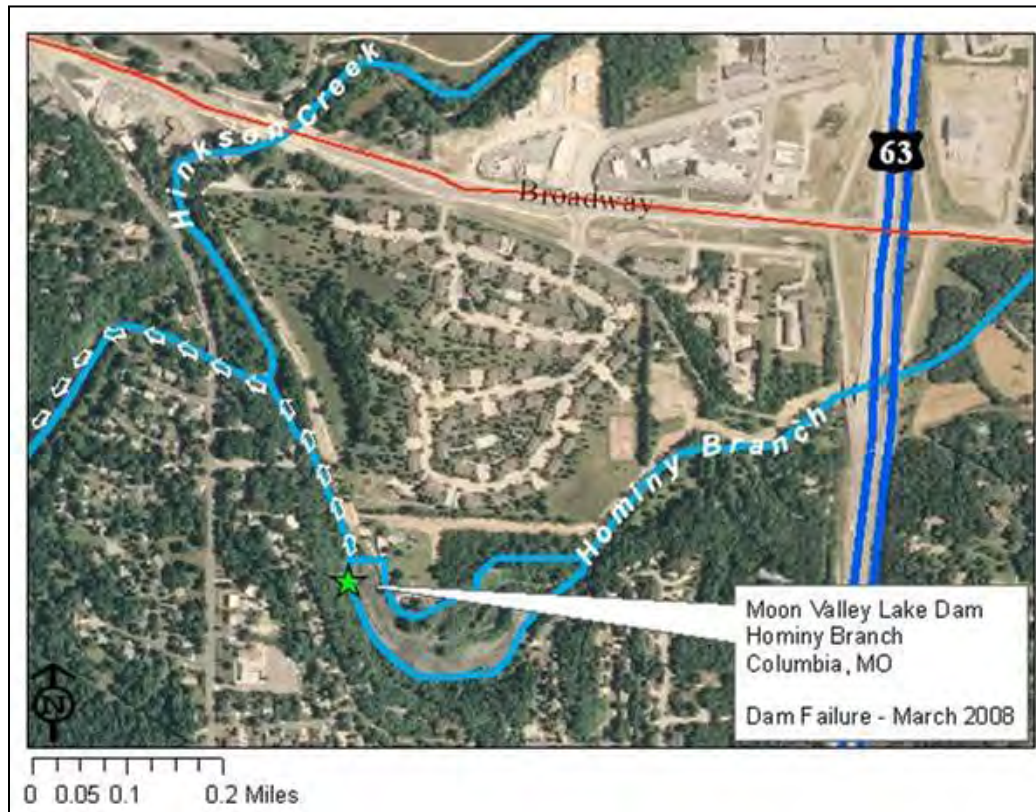
Previous Occurrences

Boone County experienced its first widely known dam failure in March 2008 when Moon Valley Lake Dam in Columbia failed (Figures 4.33 and 4.36). This 18 foot high dam had been built in 1964; it drained 2,100 acres and had a 13 acre reservoir according to the DNR database.

Moon Valley Lake Dam was classified as high hazard according to the federal classification system and Class 1 in the state classification; however, there was no loss of life with the dam failure. This may be partially attributable to the fact that Moon Valley Lake was silted in and the main release from the dam failure was silt. Silt from the lake went down the Hominy Branch into the Hinkson Creek (Figure 4.2.2.F). The added silt has caused greater flooding problems on the

Hinkson Creek since the time of the dam failure. The City of Columbia estimated the cost of removing the sediment and stabilizing about 2,000 feet of the stream bank to be in the vicinity of \$400,000.

Figure 4.36



In addition to the Moon Valley Lake Dam failure, the NOAA database reports the failure of a “small earthen dam on a neighborhood lake” in southern Boone County on August. 18, 2002. This resulted in the flooding of streets and some basements and a minor injury from an electrical shock in a flooded basement.

In late October 2009, there was a near failure of Renn’s Lake Dam in neighboring Cole County. The dam’s structure had been weakened by tree roots and heavy rainfall caused a 15-foot section of the earthen dam to erode. Emergency crews and volunteers were able to relieve the pressure on the dam and avert complete failure by pumping thousands of gallons of water out of the lake. The failure or near failure of two dams in central Missouri within two years has highlighted this potential hazard in the region.

Boone and Cole Counties are not the only counties in Missouri to experience dam failures. According to the Missouri State Hazard Mitigation Plan (2007), Missouri has the largest number of manmade dams in any state. The Stanford University’s National Performance of Dams Program documented 16 dam failures in Missouri between 1975 and 2001.

More recently, there was a huge dam failure which destroyed Johnson Shut-Ins State Park in Reynolds County. On December 14, 2005, the AmerenUE’s Taum Sauk reservoir dam at their

hydroelectric complex failed; 1.5 billion gallons of water were released into the park in 10 minutes. There was no loss of life, even though the superintendent's family was swept out of their home. However, if this failure had occurred during the summer when the popular park has many visitors, it could have resulted in a catastrophic loss of life.

All of these dam failures indicated that this is a serious problem which needs attention. Many of Missouri's smaller dams are becoming a greater hazard as they continue to age and deteriorate. While hundreds of them need to be rehabilitated, lack of available funding and often questions of ownership loom as obstacles difficult to overcome.

Probability of Future Events

Based on known historical occurrences, there have been two dam failures in the planning area since 2002, one in unincorporated Boone County and one in Columbia. This gives a probability of 7.7% ($1/13 \times 100$) for these jurisdictions where the failing dams were located. The probabilities for the other jurisdictions are either low, if they have dams, or nonexistent if they are not vulnerable to the hazard.

McNew Lake Dam, located within the Village of Hartsburg, is not currently considered to pose much of a threat for a number of reasons, according to village officials. Physically, the dam has a wide base with a low angled slope; a metal culvert, approximately 3 feet wide, allows for overflow. Driving is not allowed on top of the dam. The dam owner is responsible in maintain the dam and cooperates well with the City Council.

Probability: Moderate – Boone County (unincorporated), Columbia
 Low – Centralia, Hallsville, Hartsburg
 Not applicable – all other participating jurisdictions

ANALYSIS OF RISK

Many incorporated and unincorporated areas of Boone County are vulnerable to the effects of dam failure. A dam failure in Boone County could range from very minimal environmental damage to a significant loss of life and infrastructure. All impacts are dependent upon several variables: water, debris, people, and structures.

Fifty-two (52) dams in Boone County are considered to pose a high hazard should there be a dam break. Of these dams, forty-one (41) of them are not regulated by the state and thus not subject to inspection requirements. The Missouri State Hazard Mitigation Plan (2007) quoted Jim Alexander, chief engineer for the DNR's Dam Safety Program, who says that many of the non-regulated dams have gone without inspections for years. "There are accidents out there waiting to happen," he notes.

The Dam Inventory for the state of Missouri was compiled in the late 1970's to early 1980's. Of the High Hazard dams in Boone County, 31 are non-regulated. Only half of those 31 non-regulated dams have ever been documented as having been inspected; one was inspected in 1997 and all others were inspected between 1979 and 1986. This presents two main problems. First, it has been more than 20 years since most of the non-regulated High Hazard dams have been inspected, not counting the ones that were never inspected. Second, because these are *non-regulated* dams, the state has no jurisdiction over maintenance. These two issues lead to the overall problem of dam location and development downstream.

State regulated dams are classified by what lies downstream of the dam and what will be impacted by the failure of that dam. Non-regulated dams received their classifications nearly 30 years ago or more and development that occurs downstream is not monitored by any agency; this potentially puts the public at risk. Also, development upstream that might increase the contents held by the dam can cause failure. Because there is no entity in charge of non-regulated dams, the original classifications for these dams may not be correct. Some dams may not exist anymore while others may pose a greater downstream threat than their classifications indicate.

While evaluating the state dam inventory list and comparing it to 2009 aerial images of the planning area a few locations were found to be inconsistent with the Missouri Department of Natural Resources database.

The following dam is listed as High Hazard according to the state database, but according to 2009 aerial imagery they no longer exist or hold water: Moon Valley Lake Dam (non-regulated)

In addition to the data changes above, Stephens Lake Dam in Columbia is listed as an non-regulated High Hazard dam, but was completely drained and rebuilt in 2004; this has not been updated in the state database.

McNew Lake Dam, located within the Village of Hartsburg, does not appear in the state inventory of dams. Because of its close proximity and position uphill from several residences in the community, this dam should be viewed as "High Hazard". This dam has been included in all maps.

Hallsville has both a non-regulated high hazard dam and a non-regulated significant hazard dam within its corporate boundaries. Centralia has a non-regulated low hazard dam just at the edge of the city; it would drain towards Centralia if a failure would occur.

Note that ratings for dam failure are based on estimates of homes that lie within a half mile downstream of a high hazard dam. Due to the current lack of inundation studies, dam failure estimates are not exact and may change when proper inundation data is collected. Again, inundation information is not available to accurately quantify vulnerability.

Severity: Moderate – Boone County, Columbia, Hallsville, Hartsburg

Low – Centralia

Not applicable - all other participating jurisdictions

Potential Impact – Life

There is the very real danger of injury or loss of life with a dam failure event. This threat is recognized and built into the dam classification system.

Potential Impact - Existing Structures

The potential impact on structures downstream from a dam failure directly correlates to the amount of water and/or debris that is behind the dam. As previously discussed, it is important to take into account the age of the data that has been compiled on state regulated and non-regulated dams in the county and in the state. Because data on non-regulated dams was collected in the late 1970's and early 1980's it is not necessarily reliable to use when looking at possible areas of impact.

The downstream areas and parcels within a half mile of the State Hazard Class 1 dams and a number of the State Hazard Class 2 dams in the planning area have been mapped (Figures 4.37B-L). All figures were created using the same scale. Inundation information is not available at this time so it is not possible to know the severity or distance affected by a dam failure. More information should be available in 2016 when the information from the inundations studies of the state regulated high hazard dams is made available.

Figure 4.37A		
Location Guide for Aerial View Maps of High Hazard Dams		
Map ID #	Dam Name	Figure 4.37
103	B & C Subdivision Dam	C
20	BOCO Mo Dam	J
32	Cedar Lake Dam	C
22	Columbia Municipal Golf Course Lower Dam	I
33	Columbia Municipal Golf Course Upper Dam	I
118	Demarco Lake Dam	D
28	Fairview Lake Dam	F
31	Hagan Lake Dam	K
107	Highlands Lake Lower Dam	B
27	Hulen Lake East Dam	F
14	Hulen Lake West Dam	F
115	Lake Champetra Dam	D
1	Lake Chateau Dam	G
74	Lake Cyrene Dam	K
104	Limerick Lake Dam	I
128	McNew Lake Dam	L
36	Moores Lake Dam	E
3	Philips Park Lake Dam (Perry Philips Dam)	G
76	Shady Lake Dam	E
35	Stephens Lake Dam	H
97	Waters Edge Estates Lake Dam	K
17	Welch Lake Dam	K
7	Windmill Dam #1	B
95	Windmill Dam #2	B
79	Woodrail Lake Dam	I

Figure 4.37B

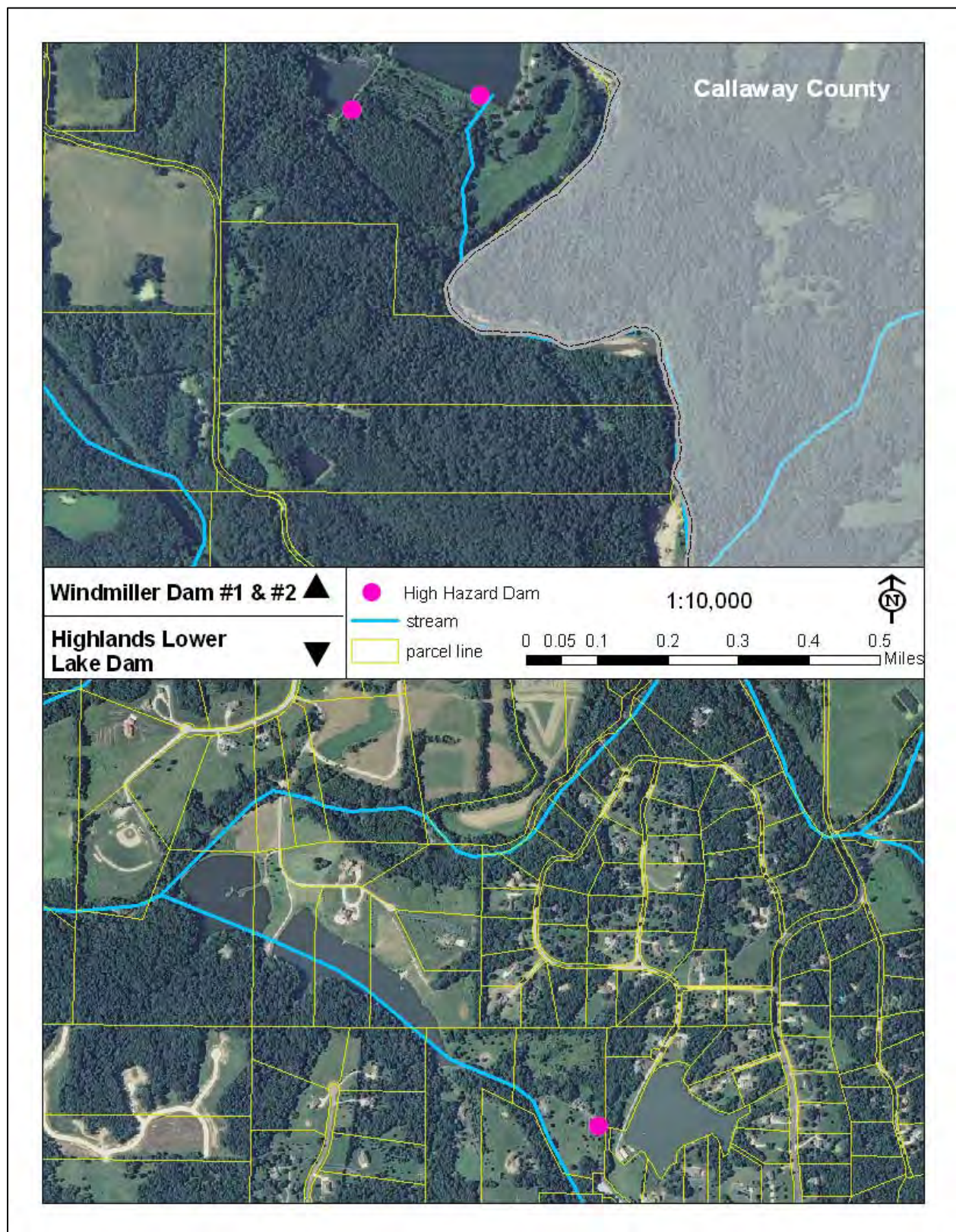


Figure 4.37C

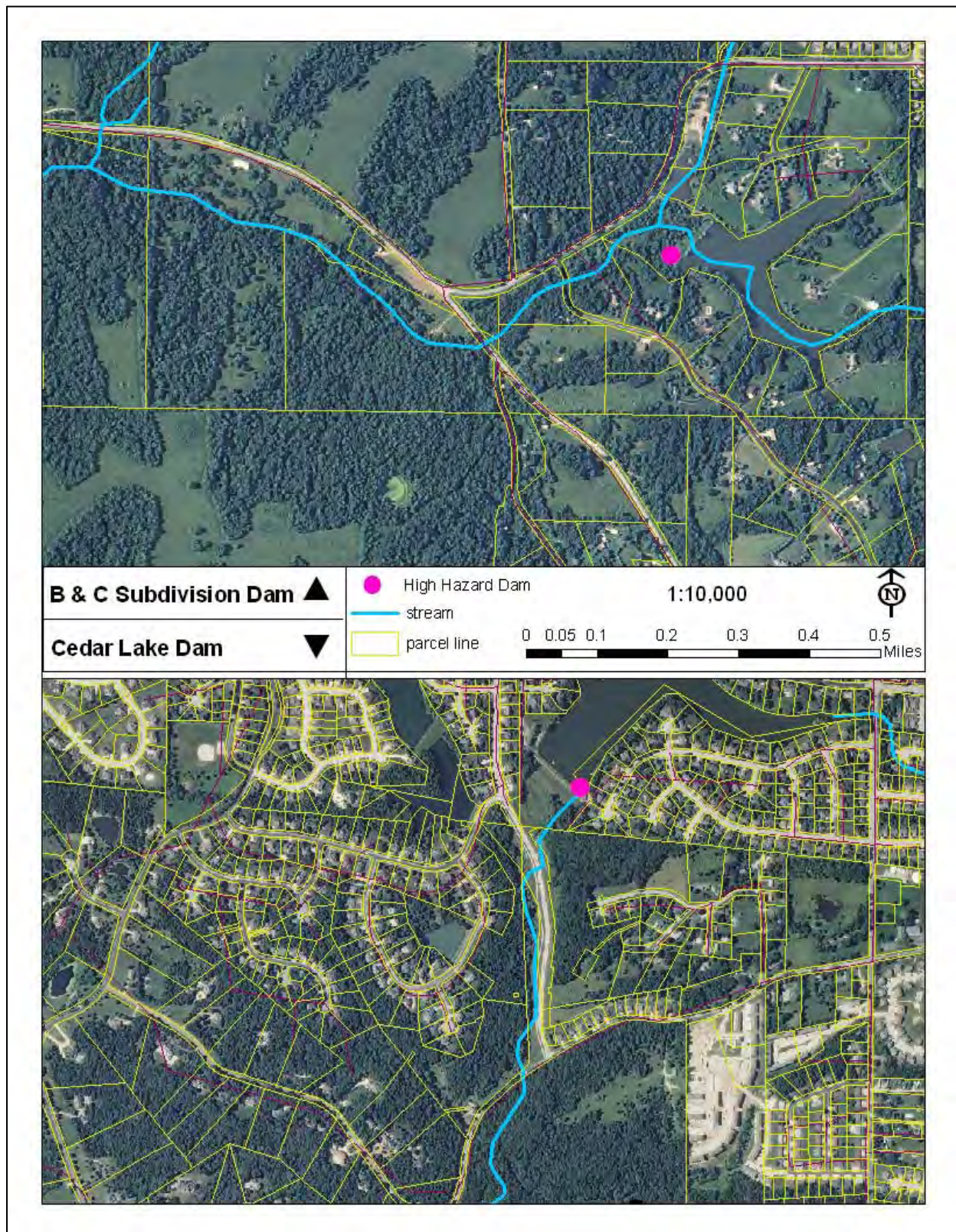


Figure 4.37D

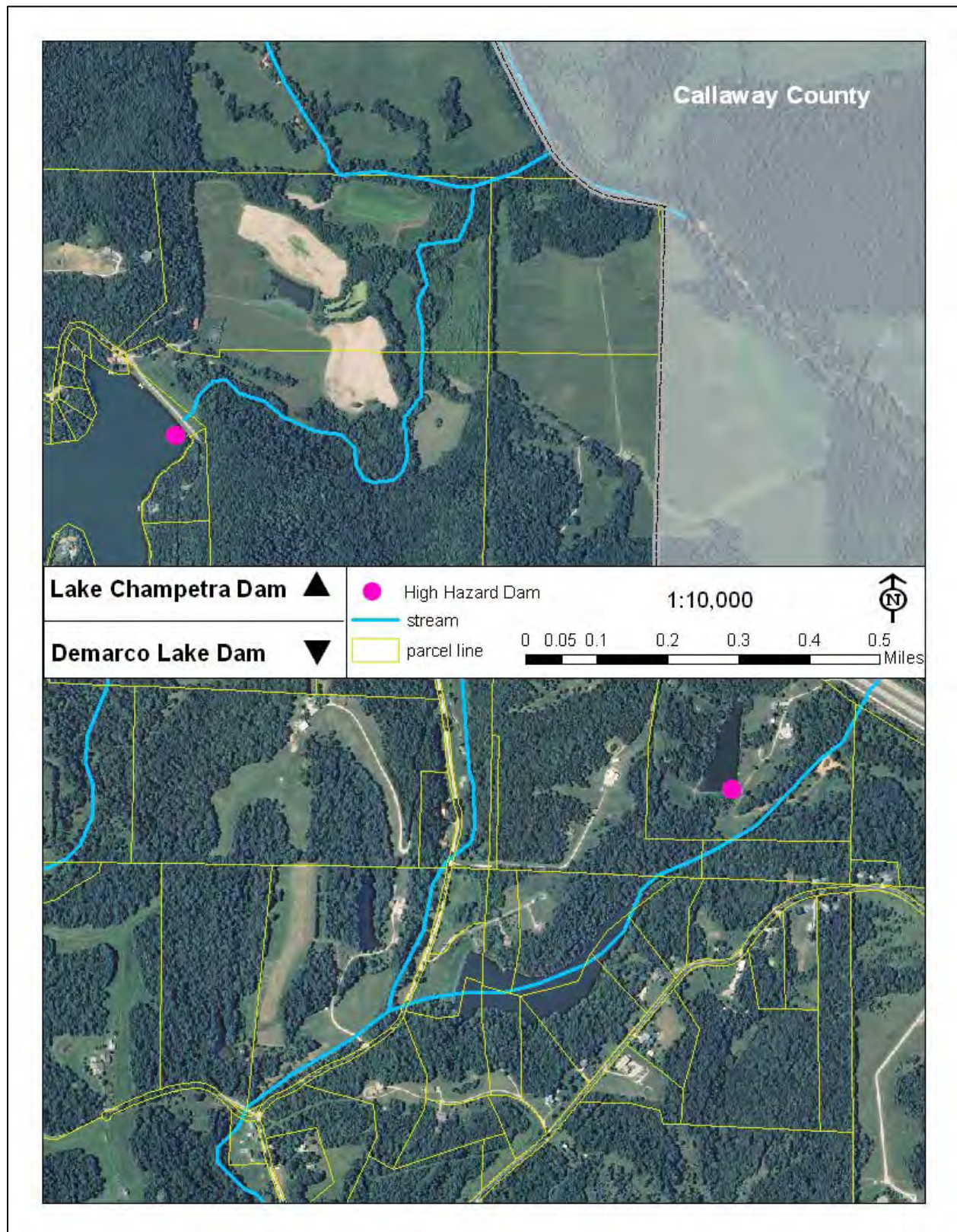


Figure 4.37E

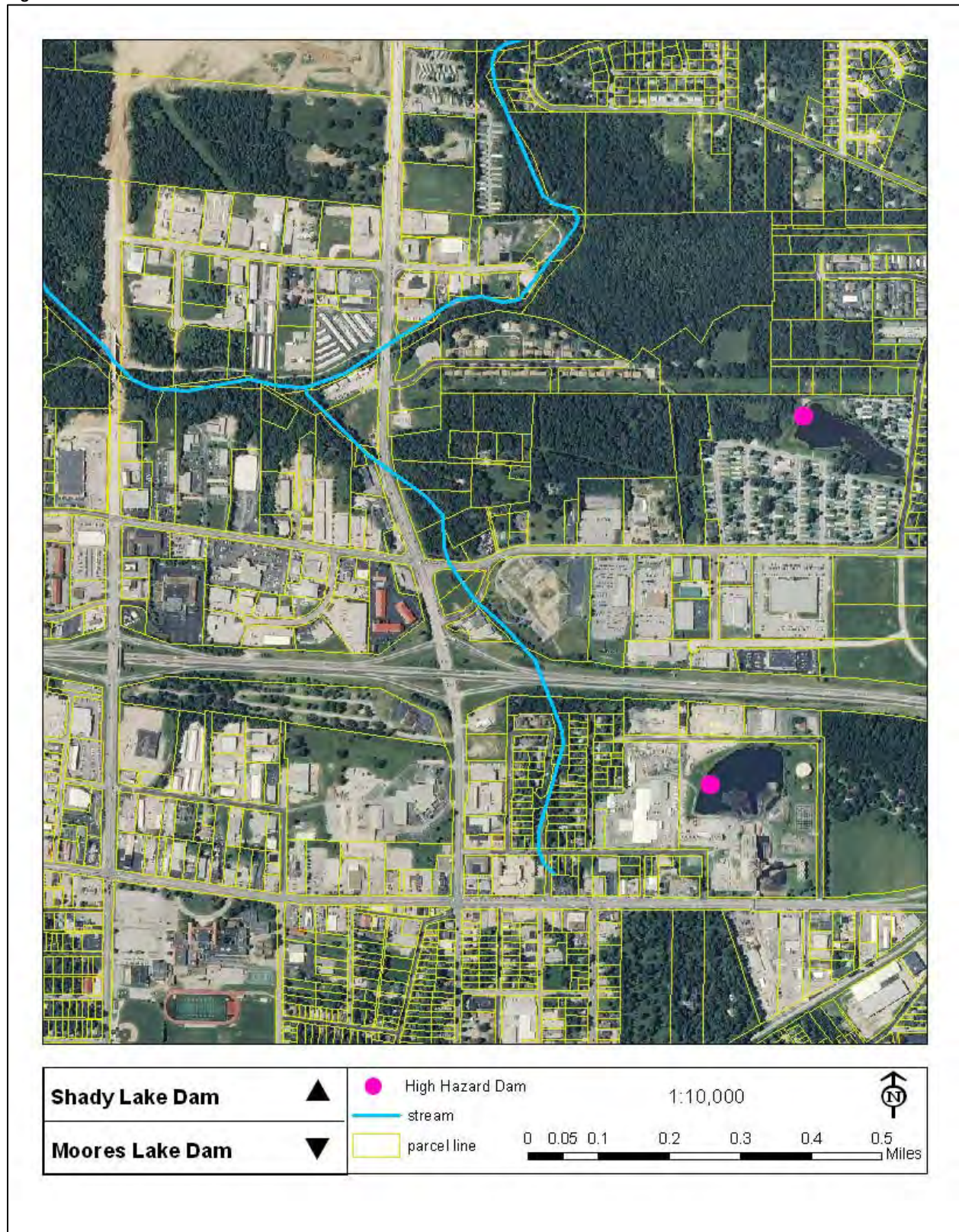


Figure 4.37F



Figure 4.37G

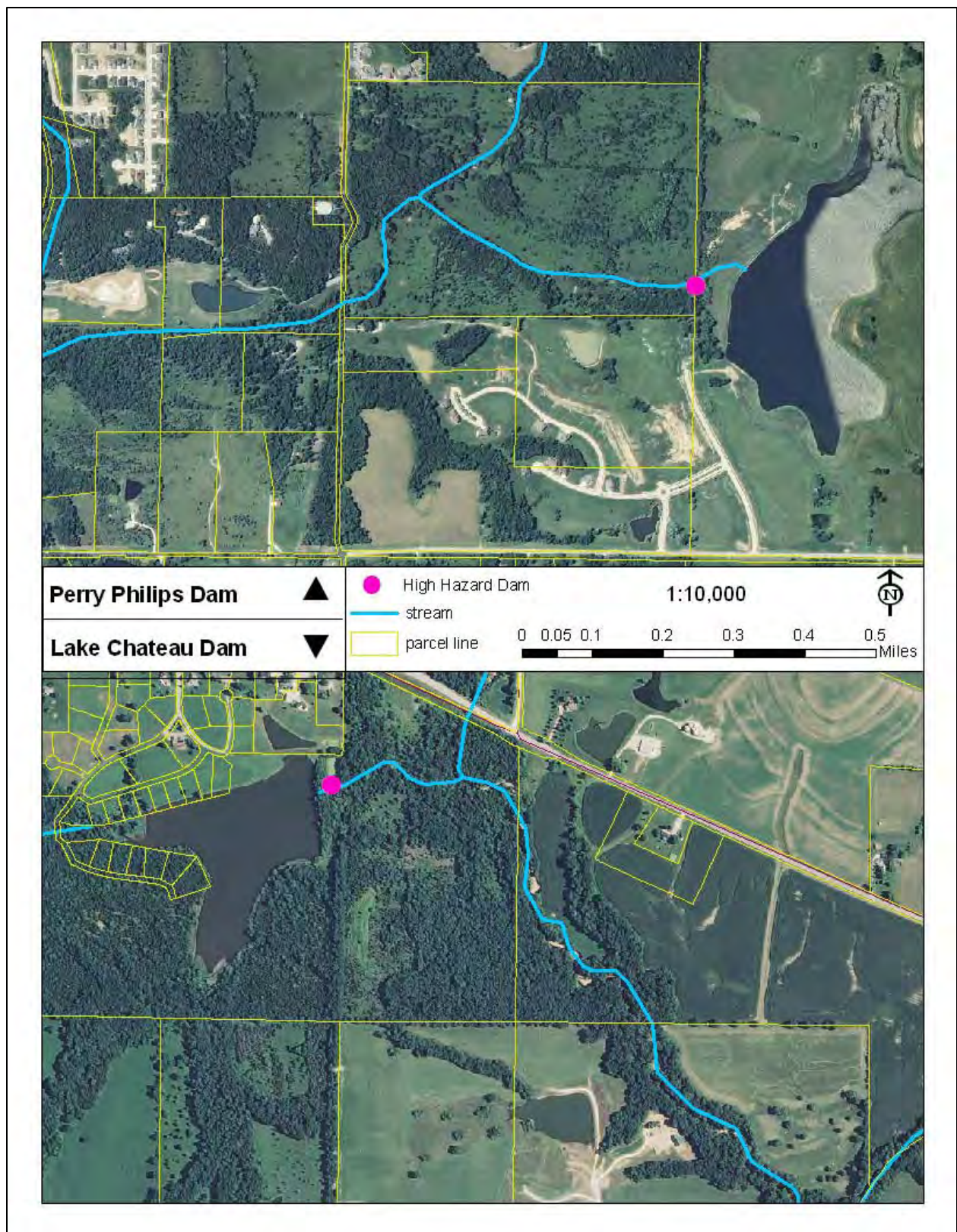


Figure 4.37H

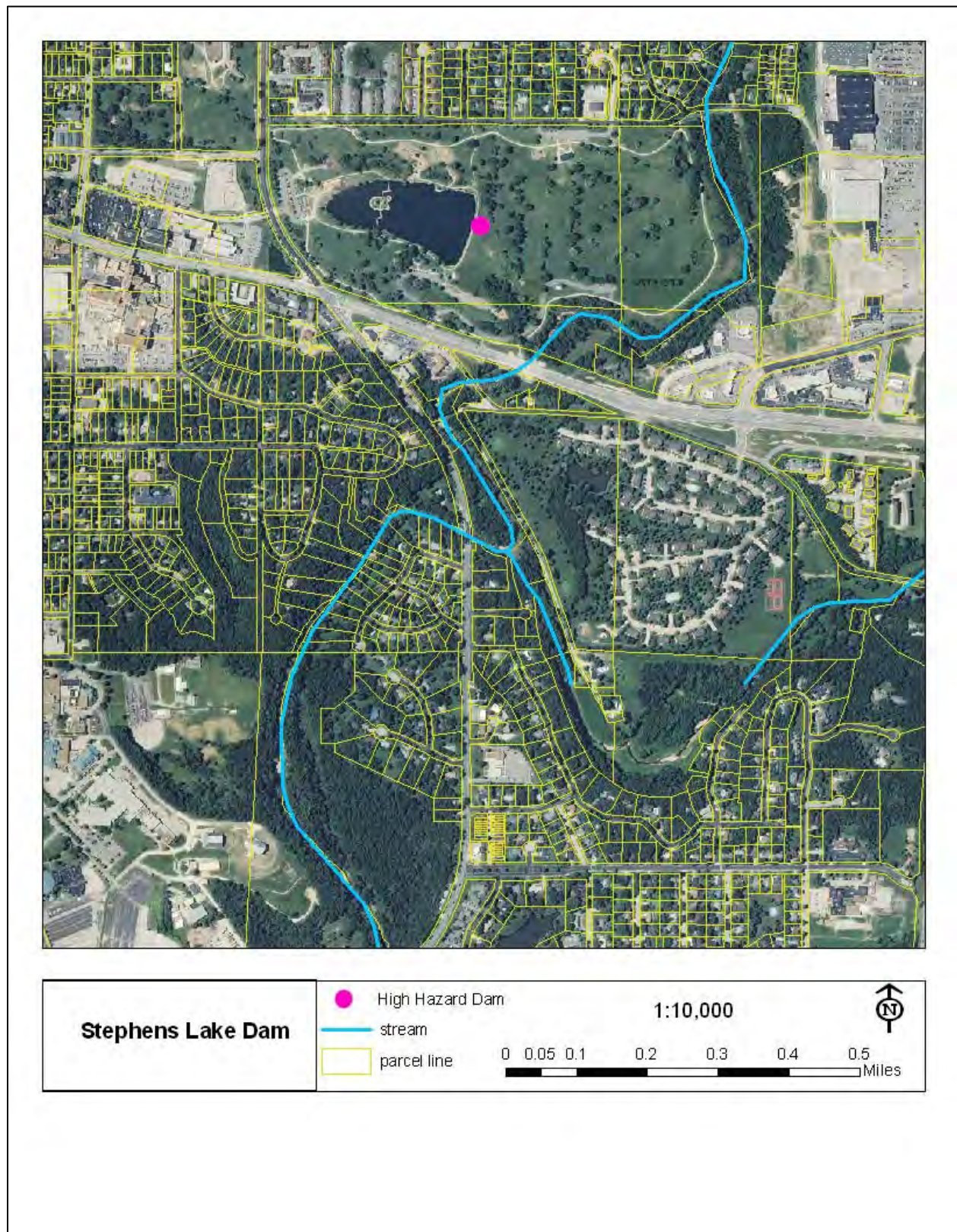


Figure 4.371

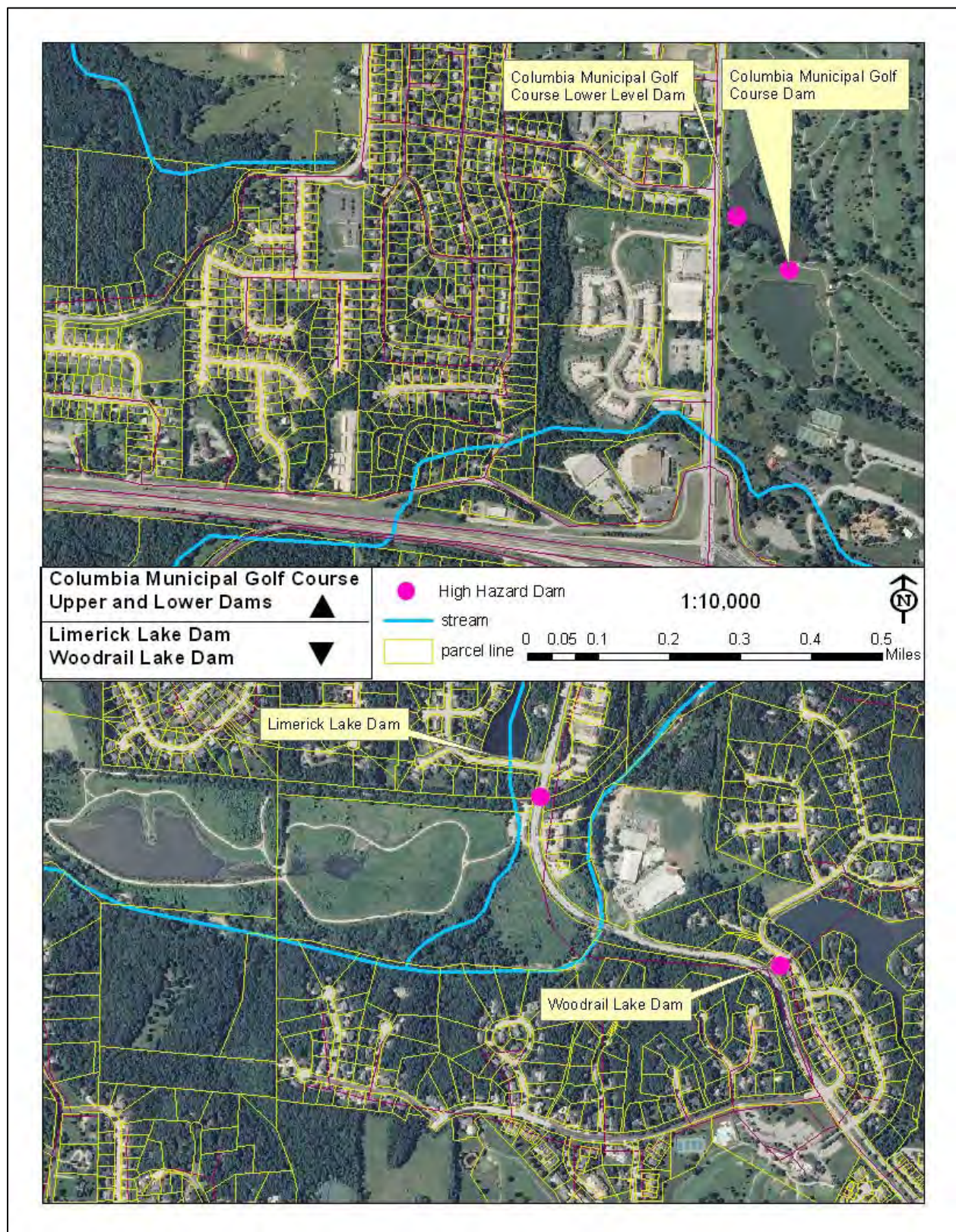


Figure 4.37J

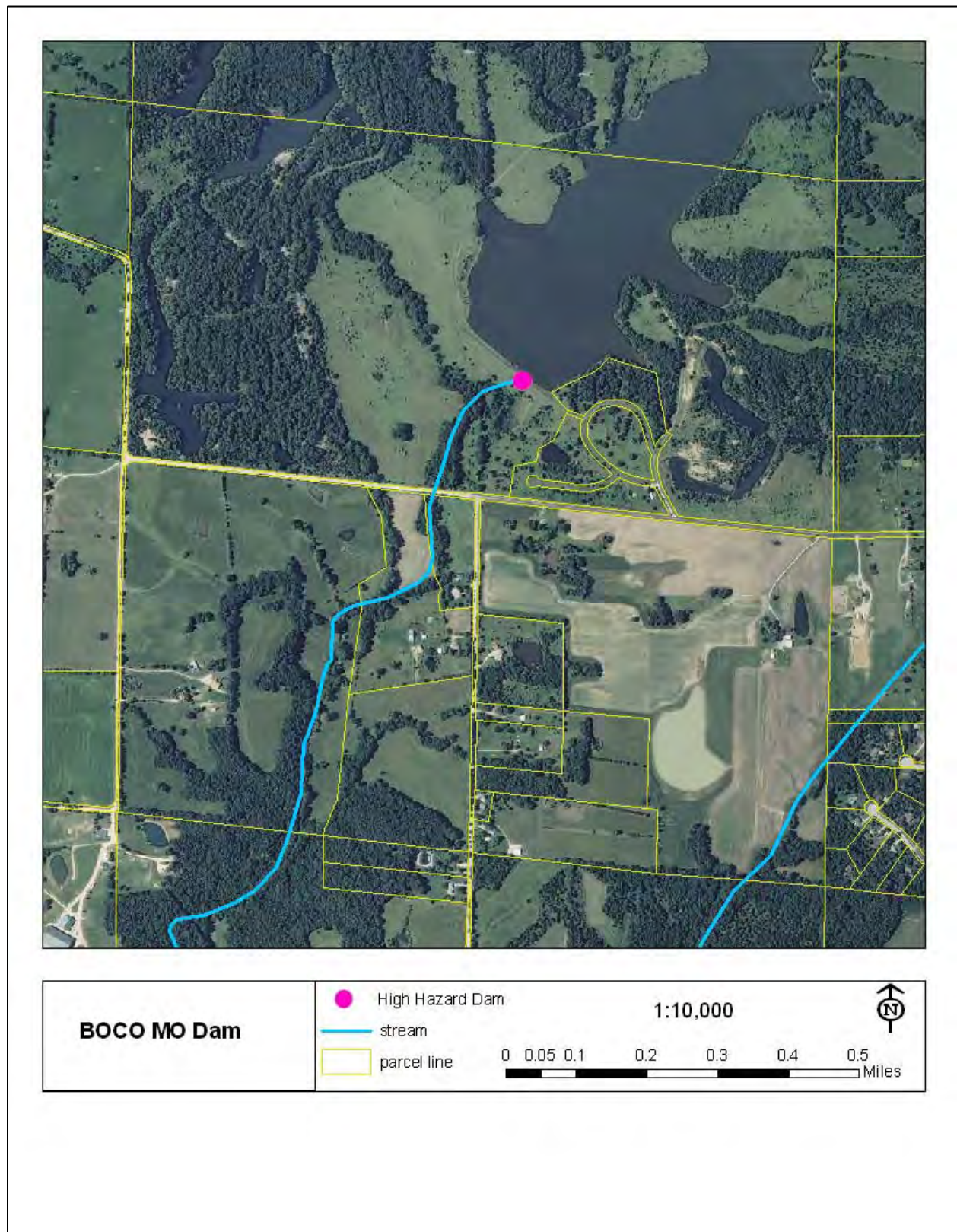


Figure 4.37K

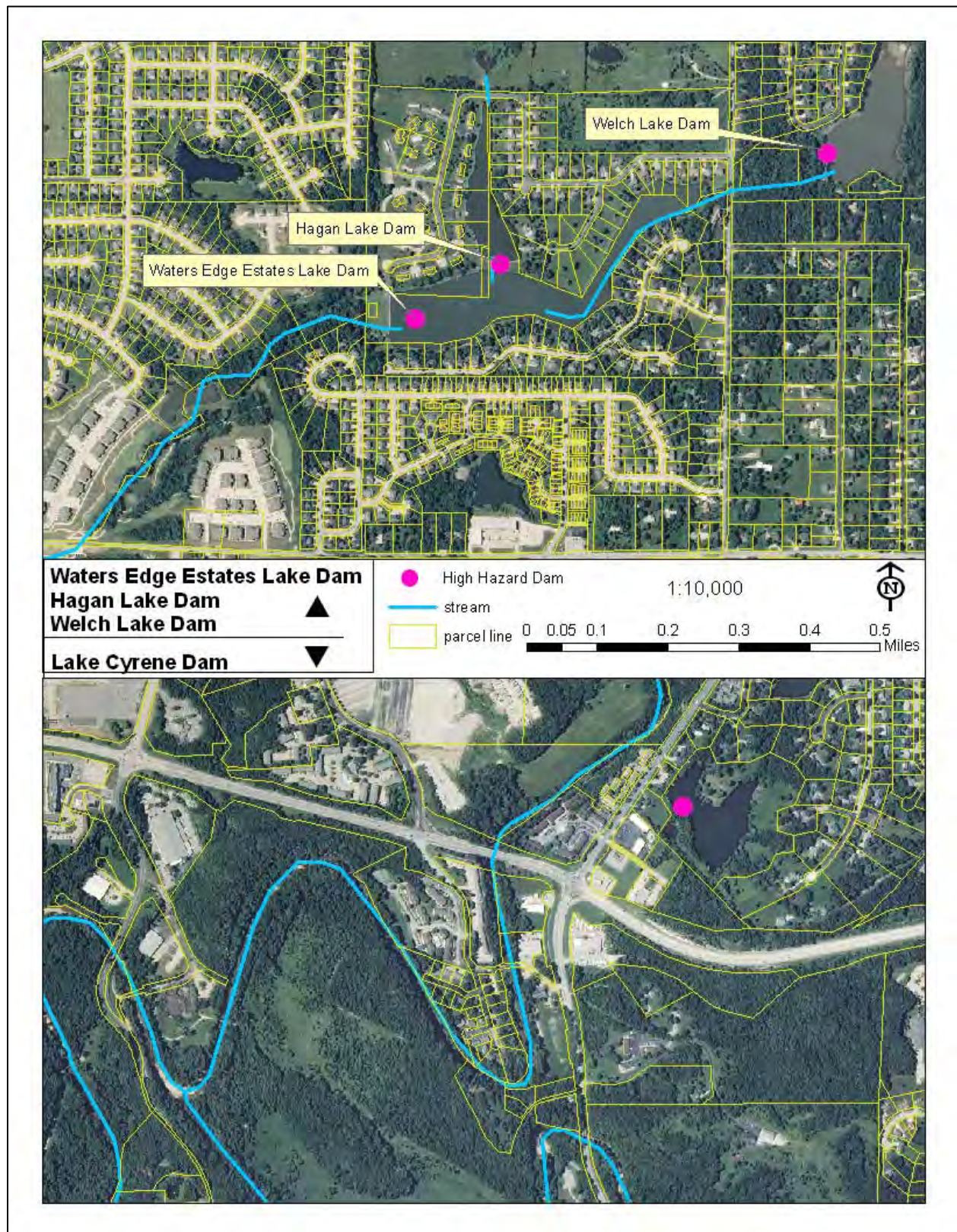
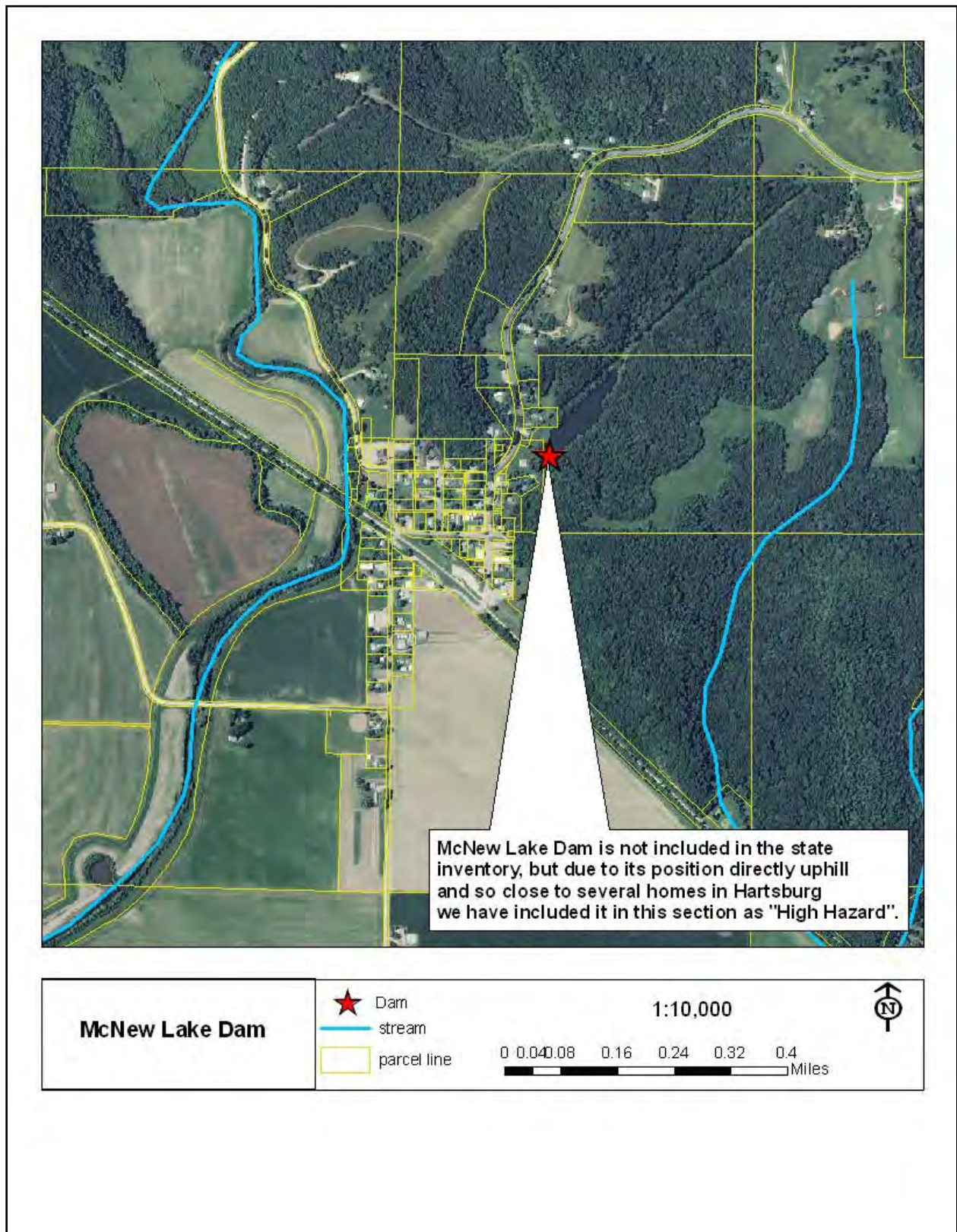


Figure 4.37L



Impact - Future Development

Since many dams in Boone County are privately owned and not regulated by the state, the dangers of development below aging or unsafe dams is an issue that needs to be addressed. If development occurs without knowledge of a potentially unsafe dam upstream, both lives and the development are put in jeopardy.

Better information for the inundation areas of the state regulated high hazard dams will be available in the near future. Inundation studies are being carried out by the Natural Resources Conservation Service's Water Resources Center and Emergency Action Plans (EAPs) are being written for the dams; this project is nearing completion. Future federal funding of state dam safety programs will be linked to the completion of these EAPs for regulated dams.

As of April 2015, EAPs have been written for all but one or two of the state regulated high hazard dams in the planning area, according to Glenn Lloyd, Civil Engineer and Dam Safety Inspector with the Dam Safety Program of the MO Department of Natural Resources (DNR). The inundation studies and EAPs will be finalized in the near future and information will be available in 2016. The information from these inundation studies will be of great use when assessing the potential and dangers of future development in the planning area.

Existing Mitigation Activities

State regulated dams are inspected, according to classification, through the Dam Safety Program of the DNR.

Boone County updated its subdivision regulations in May 2014 to include the following regulations on Dams (Appendix B, 1.7):

Dams to be constructed in excess of 25 feet tall within or adjacent to any subdivision or development must be designed by a registered professional engineer and built in accordance with accepted engineering standards and existing dams shall be certified by a registered professional engineer as safe for inhabitants within or near the subdivision. Design and as-built drawings for any newly constructed dam in excess of 25 feet tall shall be submitted to the County engineer for permanent county records. Roads may not be constructed on dams except upon review and approval of the County engineer. Dams in excess of 35 feet tall shall be inspected and approved by the Missouri Department of Natural Resources or other governmental regulatory agency having jurisdiction prior to the issuance of any building permits for lots situated below the lake formed by such dam. The provisions for maintenance and supervision of common lands contained in this Appendix shall be applicable to all dams within or adjacent to subdivisions or developments when owned or controlled by the subdivider.

The provisions for maintenance and supervision of common lands referred to are found in Section 1.4 and read as follows:

When common land is to be included in or adjacent to a subdivision or development, a private trust agreement shall be recorded concurrently with the plat which shall provide for the proper and continuous maintenance and supervision of said common land by a trustee and payment for such maintenance and supervision by means of annual or more frequent assessments against lots and provision for assessment secured by assessment liens enforceable by foreclosure. No common land shall be dedicated to public use or otherwise conveyed to the public or any public

agency or other public or private entity without recorded contractually binding agreement conferring financial responsibility and liability for maintenance and supervision of such common land with any such agency or entity.

The Dam Safety Program is offering to assist County Emergency Management Agencies who are interested in having EAPs written for non-regulated high hazard dams. If the county is able to persuade dam owners to participate, Dam Safety Program personnel will attend a County-hosted meeting and explain the EAP template to the dam owners. It would then be the responsibility of the EMA to conduct follow up. Boone County has included an action in the mitigation strategy to promote the writing of these EAPs.

SUMMARY OF VULNERABILITY

The jurisdictions of Boone County, Centralia, Columbia, Hallsville, and Hartsburg are all vulnerable to dam failure. There are 127 known dams in the planning area; of these, only 17 are regulated by the state. (A dam must be 35 feet or higher to fall under state regulations.) The rest of the 127 dams do not fall under any regulatory authority.

Boone County, Columbia, Hallsville, and Hartsburg all have high hazard dams which would affect their jurisdictions if failure occurred. (The high hazard classification indicates the presence of permanent dwellings in the downstream environment and the probable loss of human life from dam failure.) The non-regulated dam situated on the city limits of Centralia poses less of a threat due to its downstream environment.

The Dam Safety Program of the Missouri Department of Natural Resources has been working with the owners of state regulated high hazard dams to develop Emergency Action Plans (EAPs). Inundation studies on these dams, and the EAPs, will be available in 2016. This will be a great aid for local governments in planning for growth and development.

A major looming issue remains concerning the unregulated dams in the planning area. The data for unregulated dams in the DNR National Dam Inventory, including their ownership and hazard classification, dates back to the late 1970s and early 1980s. A high number of these unregulated dams are in Boone County and Columbia where the pace of growth and development is strong; their classifications may not accurately reflect current downstream conditions. In addition, there is a lack of knowledge of the physical condition and maintenance of these dams.

The DNR Dam Safety Program has offered to assist county governments in conducting meetings for owners of non-regulated dams who are interested or willing to develop EAPs. A mitigation action has been included in this plan for the jurisdiction of Boone County to follow up on this offer and work with the owners of these dams.

In 2014, Boone County updated its subdivision regulations to regulate the construction and maintenance of new dams greater than 25 feet in height located within or adjacent to new subdivisions or developments. These regulations will help mitigate the risk posed by some new dams in the future.

4.4 EARTHQUAKE

DESCRIPTION OF HAZARD

The United States Geological Society (USGS) describes an earthquake as “a sudden movement of the earth’s crust caused by the release of stress accumulated along geologic faults or by volcanic activity.” Earthquakes can be one of the most destructive forces of nature causing death, destruction of property, and billions of dollars of damage.

The New Madrid Seismic Zone (NMSZ), which runs through southeastern Missouri, is the most active seismic zone east of the Rocky Mountains. Any hazard mitigation planning in Missouri must, of necessity, take possible earthquakes into account.

Missouri and much of the Midwest can feel earthquakes from very far away because the geology of the area is more amenable to ground shaking than the California geology. New Madrid earthquakes can cover up to twenty times the area of typical California earthquakes because of this differing geology.

Location

The entire planning area is at risk for the effects of an earthquake along the New Madrid Seismic Zone. Areas close to the Missouri River may be particularly vulnerable. The soil, or alluvium, along river channels is especially vulnerable to liquefaction from earthquake waves; river alluvium also tends to amplify the waves.

Extent

The magnitude of an earthquake is a measurement of the actual energy released by the quake at its epicenter. In the U.S., it is commonly measured by the Richter Scale denoted with an Arabic numeral (e.g. 4.0).

Earthquakes along the New Madrid Seismic Zone with magnitudes around 6.0 or greater would be of concern for the planning area.

Previous Occurrences

Historical quakes along the New Madrid Seismic Zone in southeastern Missouri have been some of the largest in U.S. history since European settlement. The Great New Madrid Earthquake of 1811-1812 was a series of over 2000 quakes which caused destruction over a very large area. According to information from Missouri SEMA’s Earthquake Program, some of the quakes measured at least 7.6 in magnitude and five of them measured 8.0 or more.

The 1811-1812 quakes changed the course of the Mississippi River. Some of the shocks were felt as far away as Washington D.C. and Boston.

The first federal disaster relief act was a result of the Great New Madrid Earthquake of 1811-1812. President James Madison signed an act into law which issued “New Madrid Certificates” for government lands in other territories to residents of New Madrid County who wanted to leave the area.

Probability of Future Events - Moderate

It is difficult to predict the probability of an earthquake occurring along the New Madrid Seismic Zone which would be significant enough to affect the planning area. The following information from MO DNR helps to illustrate why this is difficult:

The active faults in the NMSZ are poorly understood because they are not expressed at the ground surface where they can be easily studied. The faults are hidden beneath 100- to 200-foot thick layers of soft river deposited soils called alluvium.

Microseismic earthquakes (magnitude less than 1.0 to about 2.0), measured by seismographs but not felt by humans, occur on average every other day in the NMSZ (more than 200 per year).

Active faults that have generated dangerous earthquakes in historic times or the recent geologic past (the last 10,000 years) are not always microseismically active. In fact, in some settings these quiet faults are considered the most dangerous ones because high built up stress has locked the two sides of the fault together thereby preventing the microseismic earthquakes. This is thought to happen as a prelude to a major rupture of the fault. It is not known if faults of this type exist in the NMSZ. If they do exist there is no easy way to locate them.

If one looks strictly at the historical record for earthquakes of 6.5 magnitude or greater, there have been 2 years (1811 and 1812) out of the last 204 years in which such earthquakes have occurred. This equals less than 1% probability in any given year ($\text{Probability} = 2/204 \times 100 = 0.98\%$). However, there were many serious quakes in just the two years of 1811 and 1812, according to MO DNR.

In 2002, U.S. Geological Survey (USGS) and the Center for Earthquake Research and Information (CERI) at the University of Memphis released the following expectations for earthquakes in the NMSZ in following 50 years:

- 25-40% percent chance of a magnitude 6.0 and greater earthquake.
- 7 -10% chance of a magnitude 7.5 - 8.0 quake (magnitudes similar to those in 1811-1812)

According to information provided by MO SEMA, the above expectations can be translated into the following likelihoods for a given year in the 50 year period:

- 1.0-1.6% likelihood of a magnitude 6.0 and greater earthquake
- 0.28-0.40% likelihood of a magnitude 7.5-8.0 earthquake

Since a magnitude 6.0 earthquake would affect the planning area (see Figures 4.38-4.39 for an estimate of the effects in the planning area of a 6.7 earthquake in the NMSZ), the probability has been determined to be moderate.

ANALYSIS OF RISK

Severity: High

Potential Impact - Existing Structures

The intensity of an earthquake refers to the potentially damaging effects of a quake at any particular site. An earthquake of a specific magnitude will have different intensities depending on a location's distance from the epicenter of the quake, intervening soil type, and other factors.

Intensity is measured by the Modified Mercalli Intensity Scale (MMI) and expressed by a Roman numeral (Figure 4.38).

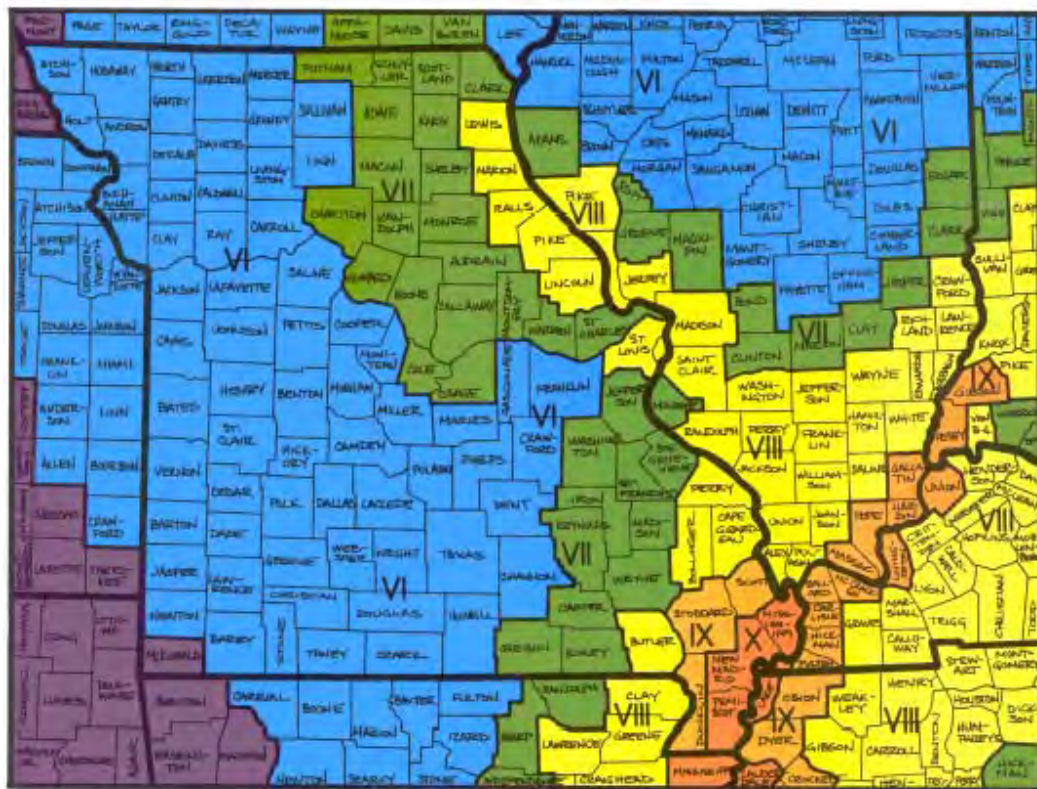
Figure 4.38	
Modified Mercalli Intensity Scale	
I. Instrumental	Not felt by many people unless in favorable conditions.
II. Feeble	Felt only by a few people at best, especially on the upper floors of buildings. Delicately suspended objects may swing.
III. Slight	Felt quite noticeably by people indoors, especially on the upper floors of buildings. Many do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.
IV. Moderate	Felt indoors by many people, outdoors by few people during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rock noticeably. Dishes and windows rattle alarmingly.
V. Rather Strong	Felt outside by most, may not be felt by some outside in non-favourable conditions. Dishes and windows may break and large bells will ring. Vibrations like large train passing close to house.
VI. Strong	Felt by all; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or overturned; a few instances of fallen plaster. Damage slight.
VII. Very Strong	Difficult to stand; furniture broken; damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. Noticed by people driving motor cars.
VIII. Destructive	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture moved.
IX. Ruinous	General panic; damage considerable in specially designed structures, well designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X. Disastrous	Some well built wooden structures destroyed; most masonry and frame structures destroyed with foundation. Rails bent.
XI. Very Disastrous	Few, if any masonry structures remain standing. Bridges destroyed. Rails bent greatly.
XII. Catastrophic	Total damage - Almost everything is destroyed. Lines of sight and level distorted. Objects thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move position.
Source: http://en.wikipedia.org/wiki/Mercalli_intensity_scale	

According to the USGS, Boone County is one of the 47 counties in Missouri that would be severely impacted by a 7.6 magnitude earthquake with an epicenter on or near the New Madrid Seismic Zone.

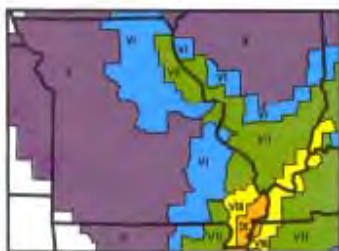
The State Emergency Management Agency (SEMA) has made projections of the highest earthquake intensities which would be experienced throughout the state of Missouri should various magnitude quakes occur along the New Madrid Seismic Zone (Figure 4.39).

Figure 4.39

Highest Projected Modified Mercalli Intensities by County

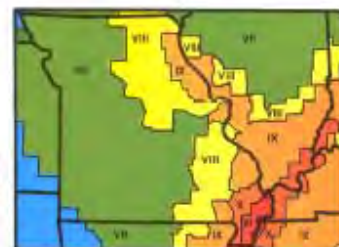


This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude - 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.



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

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



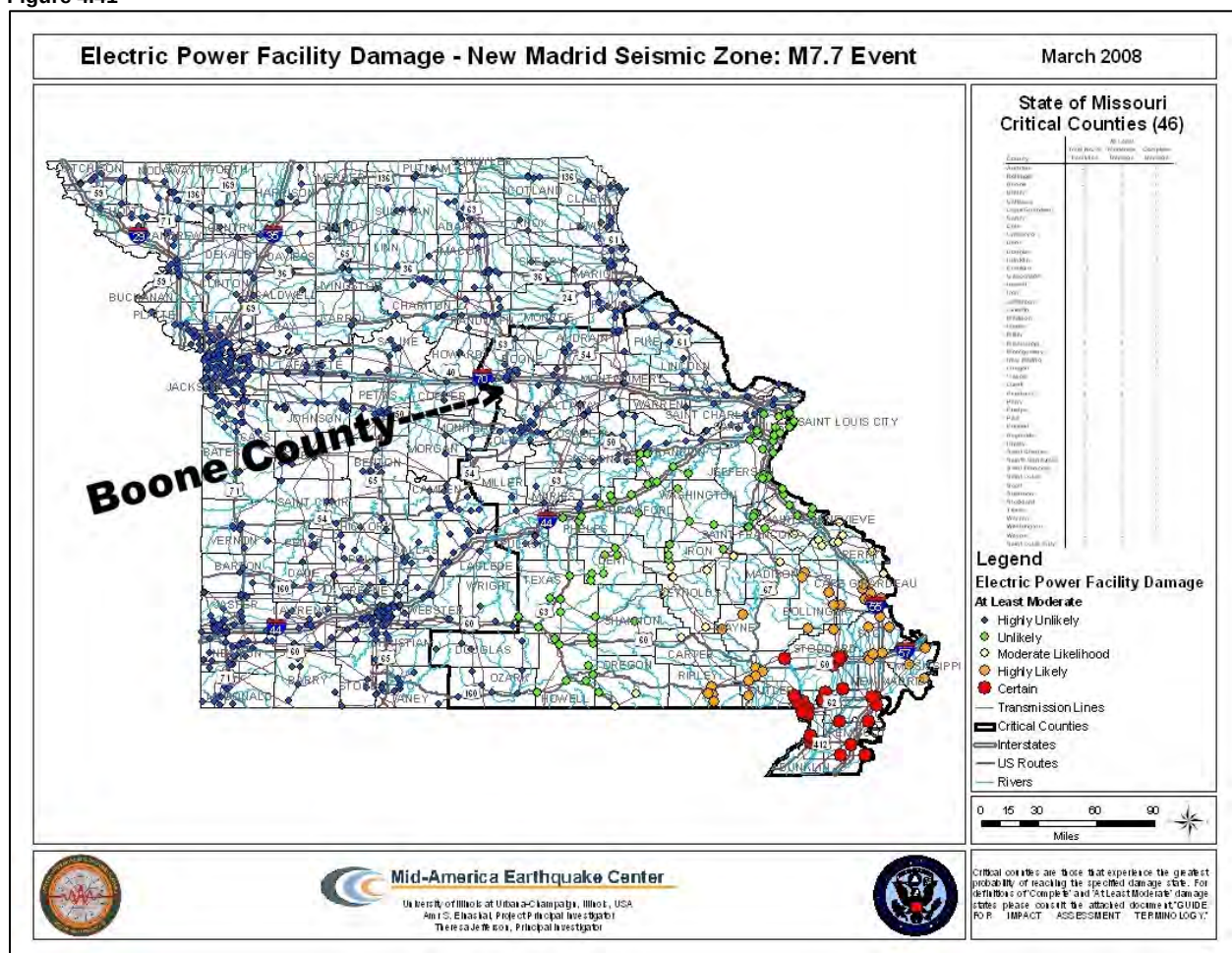
The pertinent information for Boone County is summarized in Figure 4.40.

Figure 4.40

Magnitude at NMSZ	Probability of Occurrence (2002 -2052)	Intensity (MMI)	Expected Damage
6.7	25-40%	VI	Slight
7.6	7-10%	VII	Significant damage to poorly built structures

In 2008, the Mid-America Earthquake Center mapped the expected probability of at least moderate damage to electric power facilities from a 7.7 magnitude earthquake in the NMSZ; such damage was considered “highly unlikely” in the planning area (Figure 4.41). This correlates well with the projected damage to *poorly* built structures from a 7.6 magnitude quake.

Figure 4.41



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

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

Annualized Loss Scenario based on eight earthquake return periods (100, 200, 500, 750, 1000, 1500, 2000, and 2500 years)

2% Probability of Exceedance in 50 Years Scenario – a “worst case scenario”

Annualized Loss Scenario

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

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

The results of the modeling for Boone County are shown in Figure 4.42.

Figure 4.42 HAZUS-MH Earthquake Loss Estimation Annualized Loss Scenario for Boone County				
Building Loss Total	Loss Ratio %*	Income Loss Total	Economic Loss to Buildings Total **	Loss Ratio Rank***
\$611,000	0	\$235,000	\$846,000	107
* Loss ratio equals the sum of structural and nonstructural damage divided by the entire building inventory value within the county.				
** Total economic loss includes inventory loss, relocation loss, capital-related loss, wages loss, and rental income loss				
*** Out of 115 (114 counties and the City of St. Louis)				
Source: MO State Hazard Mitigation Plan (2013)				

While Boone County has among the lowest loss ratios in the state, it's estimated building damage in actual dollars ranks 20th. (For a comparison, the modeling estimates the annualized total economic loss to buildings in St. Louis (ranked #1) at \$29,748,000.)

The building inventory in Boone County is both relatively large and high in value so there is the potential for costly damage even at a considerable distance from the New Madrid Fault. However the percentage of buildings sustaining damage and/or the level of damage sustained would be much lower than in a county adjacent to the fault. The loss ratio reflects this and gives an indication of both the potential economic impact of an earthquake and the difficulty of recovery in the county. Boone County is better equipped to deal with the economic loss it would be expected to incur than most other counties in the state.

2% Probability of Exceedance in 50 Years Scenario

This analysis models a worst case scenario using a level of ground shaking recognized in earthquake design. The *MO State Hazard Mitigation Plan (2013)* gives the following explanation of the modeling:

The methodology is based on probabilistic seismic hazard shaking grids developed by the U.S. Geological Survey (USGS) for the National Seismic Hazard Maps that are included with HAZUS-MH. The USGS maps provide estimates of peak ground acceleration and spectral acceleration at periods of 0.3 second and 1.0 second, respectively that have a 2% probability of exceedance in the next 50 years. The International Building Code uses this level of ground shaking for building design in seismic areas. This scenario used a 7.7 driving magnitude in HAZUS-MH, which is the magnitude used for typical New Madrid fault planning scenarios in Missouri. While the 2% probability of exceedance in the next 50 years ground motion maps incorporate the shaking potential from all faults with earthquake potential in and around Missouri, the most severe shaking is predominately generated by the New Madrid Fault.

The results of the modeling for Boone County are shown in Figure 4.43.

Figure 4.43 HAZUS-MH Earthquake Loss Estimation 2% Probability of Exceedance in 50 Years Scenario for Boone County						
Structural Damage	Non-Structural Damage	Contents Damage and Inventory Loss	Loss Ratio %*	Income Loss	Total Economic Loss to Buildings**	Loss Ratio Rank***
\$73,438,000	\$258,341,000	\$98,964,000	1.91	\$138,339,000	\$569,082,000	58
* Loss ratio equals the sum of structural and nonstructural damage divided by the entire building inventory value within the county.						
** Total economic loss includes inventory loss, relocation loss, capital-related loss, wages loss, and rental income loss						
*** Out of 115 (114 counties and the City of St. Louis)						
Source: MO State Hazard Mitigation Plan (2013)						

It can be seen that in the modeling of a “worst case scenario”, Boone County’s loss ratio and loss ratio rank get higher. In addition, Boone County moves to the #19 rank in estimated building damage in actual dollars.

The modeling suggests that damages from a worst case scenario earthquake in the NMSZ (7.7 magnitude) would be greater in Boone County than the Modified Mercalli map of Missouri suggests. Caution indicates that mitigation and preparedness be focused on the most conservative estimates (in this case, those which predict greater injury and damage) unless these have been shown to be incorrect.

Even a significant earthquake event in the NMSZ which does not cause great damage in Boone County could still very possibly cause cascading economic losses in the county. There is the very real potential for disruption of road and rail traffic to the eastern part of the state, including the metropolitan area of St. Louis. Regions of the state outside of the severely damaged areas would probably be called upon for emergency and recovery assistance.

Potential Impact - Life

Social impacts have also been modeled through HAZUS-MH for this 2% Probability of Exceedance in 50 Years (Worst Case) Scenario. The modeling was done for displacement of households, sheltering needs, and the following four levels of casualty severity:

Level 1 – Injuries will require medical attention but hospitalization is not needed

Level 2 – Injuries will require hospitalization but are not considered life-threatening

Level 3 – Injuries will require hospitalization and can become life threatening if not promptly treated.

Level 4 – Victims are killed by the earthquake.

The data in Figure 4.44 shows the estimated social impact in Boone County of an earthquake occurring at 2 a.m. when most people would be in their homes.

Figure 4.44					
Social Impact Estimates (HAZUS-MH Modeling)					
2% Probability of Exceedance in 50 Years Scenario for Boone County					
2 a.m. Time of Occurrence					
Level 1	Level 2	Level 3	Level 4	Displaced Households	Short-Term Shelter Needs
88	14	1	3	243	175
Source: MO State Hazard Mitigation Plan (2013)					

The potential for “emotional aftershocks” also exists with any earthquake event. Major earthquake events require mental health services for people dealing with loss, stress, anxiety, fear, and other difficult emotions. Even a smaller quake, however, has the potential for emotional repercussions; the sudden movement of something experienced as stable for one’s entire life (the earth itself) can be very traumatic.

Potential Impact - Future Development

The standards followed in new construction will impact vulnerability to earthquake damage. Building new structures according to more stringent earthquake resistant codes will lessen the potential damage should an earthquake occur, just as poor construction will increase vulnerability. However, this type of mitigation activity may not be cost effective for many communities.

Boone County, Ashland, Centralia, Columbia, Hallsville all have building codes so there is a mechanism whereby earthquake resistant codes could be put in place. The Boone County Building Code does cover building earthquake resistant structures.

Existing Mitigation Activities

School Districts The Revised Statutes of MO, Section 160.451 require that:

The governing body of each school district which can be expected to experience an intensity of ground shaking equivalent to a Modified Mercalli of VII or above from an earthquake occurring along the New Madrid Fault with a potential magnitude of 7.6 on the Richter Scale shall establish an earthquake emergency procedure system in every school building under its jurisdiction.

All educational institutions in Boone County are subject to these statutory requirements and must provide training and exercises to students in preparation for a large earthquake. This is implemented throughout the county.

Public Information The Office of Emergency Management (OEM) maintains materials which address earthquake preparedness. A press release to educate the public about earthquake preparedness and the availability of educational materials was issued in July 2009. OEM focuses on earthquake preparedness in February each year during “Earthquake Awareness Month”.

County Bridges All county bridges are inspected by the MODOT on a 2 year cycle; if an earthquake impacted the planning area, MODOT would be in charge of county bridge inspection post-earthquake.

State-funded buildings RSMo Section 319.200 requires that, for “cities and counties subject to earthquake”, all state-funded buildings built after January 1, 2000 must “comply with the standards for seismic design and construction of the 1990 or later edition of either the uniform building code or the building officials and code administrators code.” (The statute established a percentage schedule for state-funded buildings constructed between January 1, 1994 and December 31, 1999 which were also subject to this requirement.) As a result of this statute, many of the newer buildings at the University of MO are built to seismic standards.

SUMMARY OF VULNERABILITY

The entire planning area is vulnerable to the risk of damage from an earthquake in the New Madrid Seismic Zone (NMSZ) located in southeastern Missouri. Boone County is one of 46 “critical counties” where school districts are required by state law to establish earthquake emergency procedure systems in every school.

Studies and predictions indicate that there would be significant damage to poorly built structures in the planning area from a 7.6 magnitude (Richter) quake in the NMSZ. In addition to structural damage, and possible injury/loss of life, the planning area could be affected by an influx of people needing sheltering, disruption of the flow of goods, calls for assistance from other areas, and the psychological traumatization of the population.

There is extensive ongoing education and preparation in the planning area for the possibility of an earthquake event.

4.5 LAND SUBSIDENCE/SINKHOLES

DESCRIPTION OF HAZARD

“Land subsidence is sinking of the earth’s surface due to the movement of earth materials below the surface. This sinking can be sudden or gradual...In Missouri, subsidence is primarily associated with sinkholes but...can also occur from void space left by mining and natural caves...” (*MO State Hazard Mitigation Plan, 2013*)

Gradual or sudden land subsidence is a key sign of sinkhole formation. The Boone County Stormwater Design Manual distinguishes between two types of sinkholes associated with karst topography:

- Depression sinkholes which have a defined drainage area and are generally shown as closed contours on a topographic map; best management practices are required to protect groundwater when runoff from development drains into these areas
- Collapse sinkholes are areas of “karst-related subsidence with no defined drainage area when occurring outside of a depression sinkhole. Collapse sinkholes can occur in the bottom of a depression sinkhole and are commonly referred to as the ‘eye’ of the sinkhole”

Construction excavation and well drilling can also cause sinkholes, according to the Missouri Department of Natural Resources (DNR).

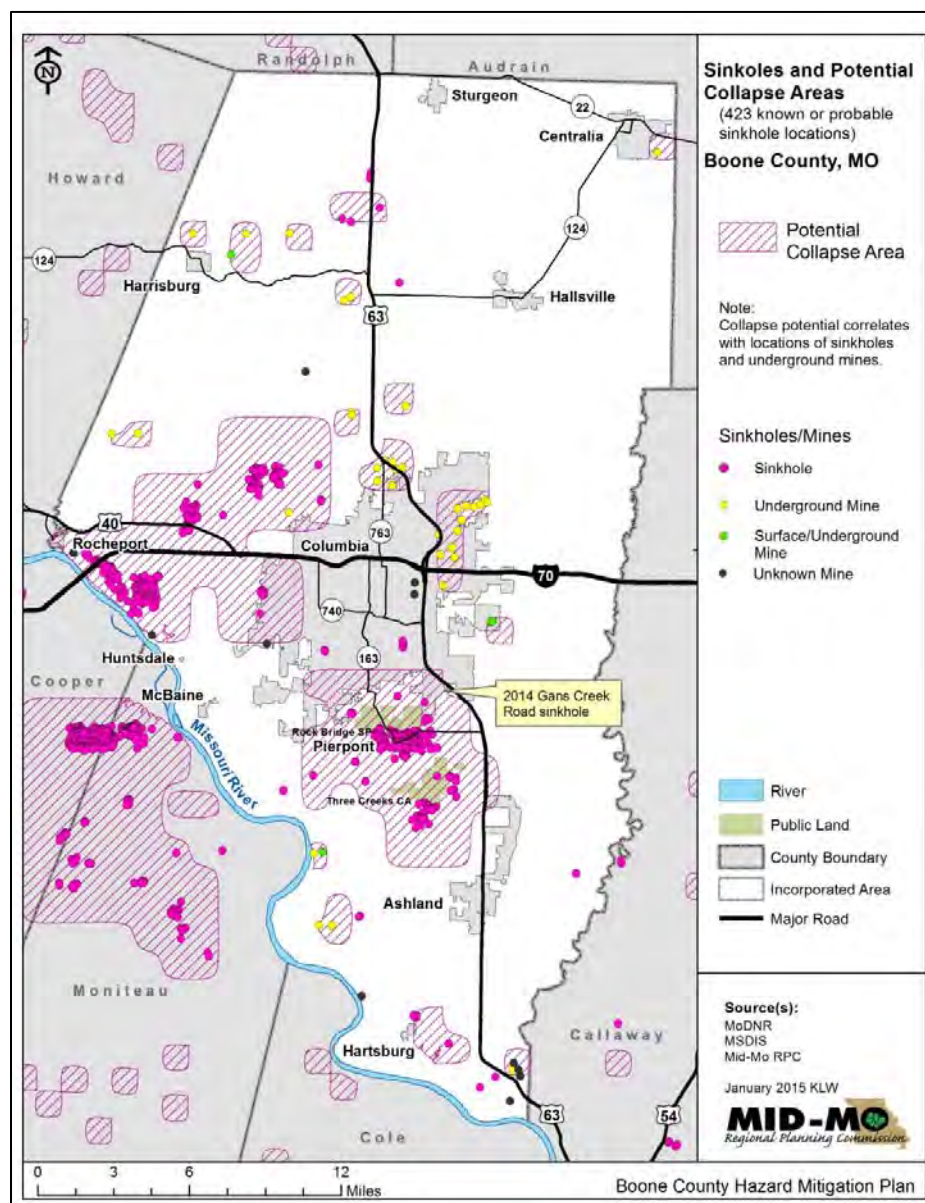
In addition to being at risk for land subsidence and sinkhole collapse associated with karst topography, the planning area is at risk from land subsidence/collapse associated with underground mining and exploratory drilling for petroleum.

Location

There are over 400 known sinkholes in the planning area. The karst areas of the Ozark Highlands in the western and southern sections of the planning area (Figure 2.3) are where the majority of sinkholes are located (Figure 4.45). Large clusters exist southeast of Rocheport and to the northwest and south of Columbia. Eight known sinkholes are located within the city limits of Columbia.

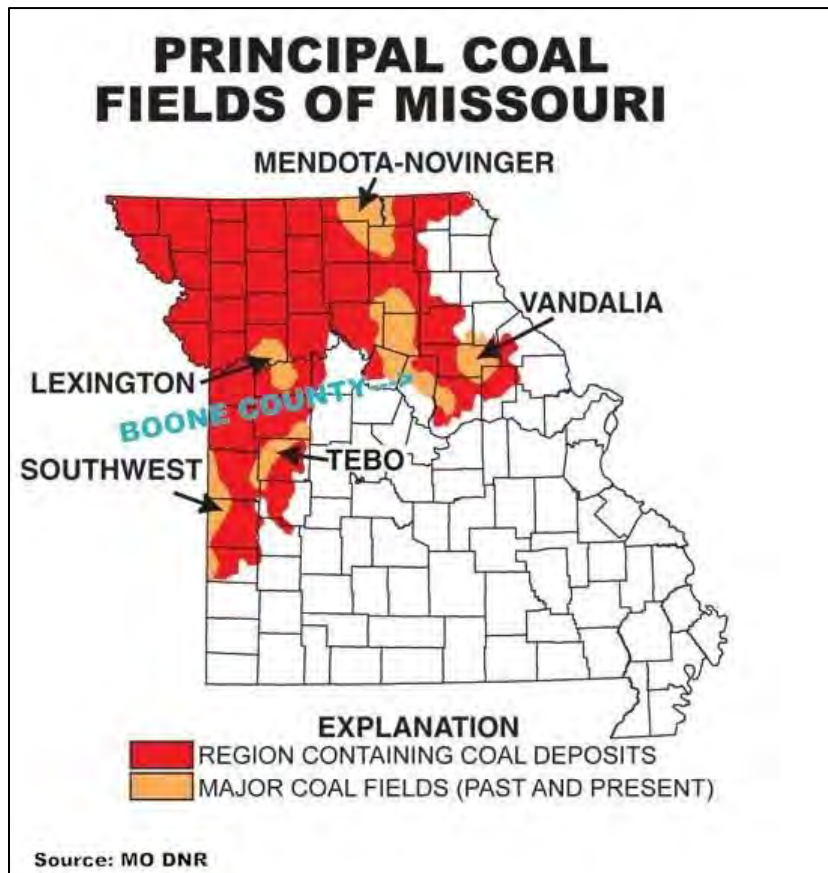
The MO DNR has mapped potential collapse areas around the known sinkholes and underground mines (Figure 4.45). These may not be the only potential sinkhole collapse areas however; further development may bring to light previously unknown sinkhole areas in the karst regions and also more abandoned underground mines.

Figure 4.45



The potential for collapse from underground mining is primarily in the northern part of Boone County and associated with coal fields (Figure 4.4.5a). Prior to larger open pit mining activities in Boone County, there were numerous “Mom and Pop” underground coal mining operations; these were small mines using a series of tunnels and pillars.

Figure 4.45a



There is very little documentation on where these operations were located; they do not appear, for the most part, on the collapse potential areas mapped by the DNR (Figure 4.45). In 2011, the Missouri Geological Survey (MO DNR) received funding from the Department of the Interior’s Office of Surface Mining to “investigate, collect and scan maps of underground coal mines to make the national inventory of Missouri mine lands as complete as possible.” They solicited the public’s help in finding old mine maps which might be kept in family records through public announcements, including a YouTube video.

In addition to coal mines, there were also test holes for petroleum drilled in northern Boone County in the Browns Station Anticline (Figure 2.2) and a few underground lead mines in the southern part of Boone County.

Extent

Sinkholes can vary “from a few feet to hundreds of acres and from less than one to more than 100 feet deep,” according to the USGS.

There have been 15,891 sinkholes identified in the State of Missouri. One hundred and sixty sinkhole collapses examined by the MO Department of Natural Resources between 1970 and 2007 were less than 10 feet in diameter and less than 10 feet deep. However, there were also some very large collapses within the state: one collapse drained a lake near St. Louis, one drained a sewage lagoon in West Plains, and one in Nixa swallowed a garage with a car in it.

Petroleum drill holes such as found in northern Boone County could be the cause for a localized collapse; one would not want to set a foundation on top of one of them.

Previous Occurrences

There is ample evidence of sinkhole collapse in the planning area but most of it is on public land or in less developed areas. A hiking trail in Rockbridge State Park, located south of Columbia, winds its way around collapsed sinkholes; it is aptly named “The Sinkhole Trail”.

A recent sinkhole collapse in the planning area did impact the built environment. On May 12, 2014, a sinkhole collapsed a roadway in southern Columbia (see labeled location on Figure 4.45). East Gans Creek Road between Ponderosa St. and Discovery Parkway was closed for a day by the Columbia Public Works Department for evaluation of the sinkhole and repair of the roadway.

Engineers from the Public Works Department measured the sinkhole at about 6 feet in diameter and 8 feet deep and assessed its formation as due to the karst topography in the area. There were no buried utilities under the section of roadway and storm water under the roadway did not appear to be a causative factor. The sinkhole was filled with concrete and rock before the road was repaired.

Probability of Future Events

High – Boone County, Columbia

Low – Ashland, Centralia, Hartsburg, Rocheport

Not applicable - All other participating jurisdictions

New analysis and mapping by MO DNR indicates either close proximity to or overlap of potential collapse areas with the jurisdictions of Ashland, Centralia, Hartsburg and Rocheport. In Ashland, Hartsburg and Rocheport, the collapse potential is associated with known sinkholes; in Centralia, it is associated with underground mines.

The City of Rocheport is actually located completely within a mapped collapse potential area associated with a large number of sinkholes. However, according to information from the city, there is no known history of sinkhole collapse within Rocheport.

ANALYSIS OF RISK

Severity: Low to High

It is very difficult to predict the severity of a sinkhole collapse due to their great variance in size, varying speeds of collapse onset, and proximity to the built environment.

Potential Impact – Life

Sinkhole collapse poses a potential threat to human life; there have been numerous news stories in recent years of collapsing sinkholes swallowing up people. In 2013, a man hunting in southern Missouri lost his life when he stepped in a sinkhole which had possibly opened up due to recent heavy rain.

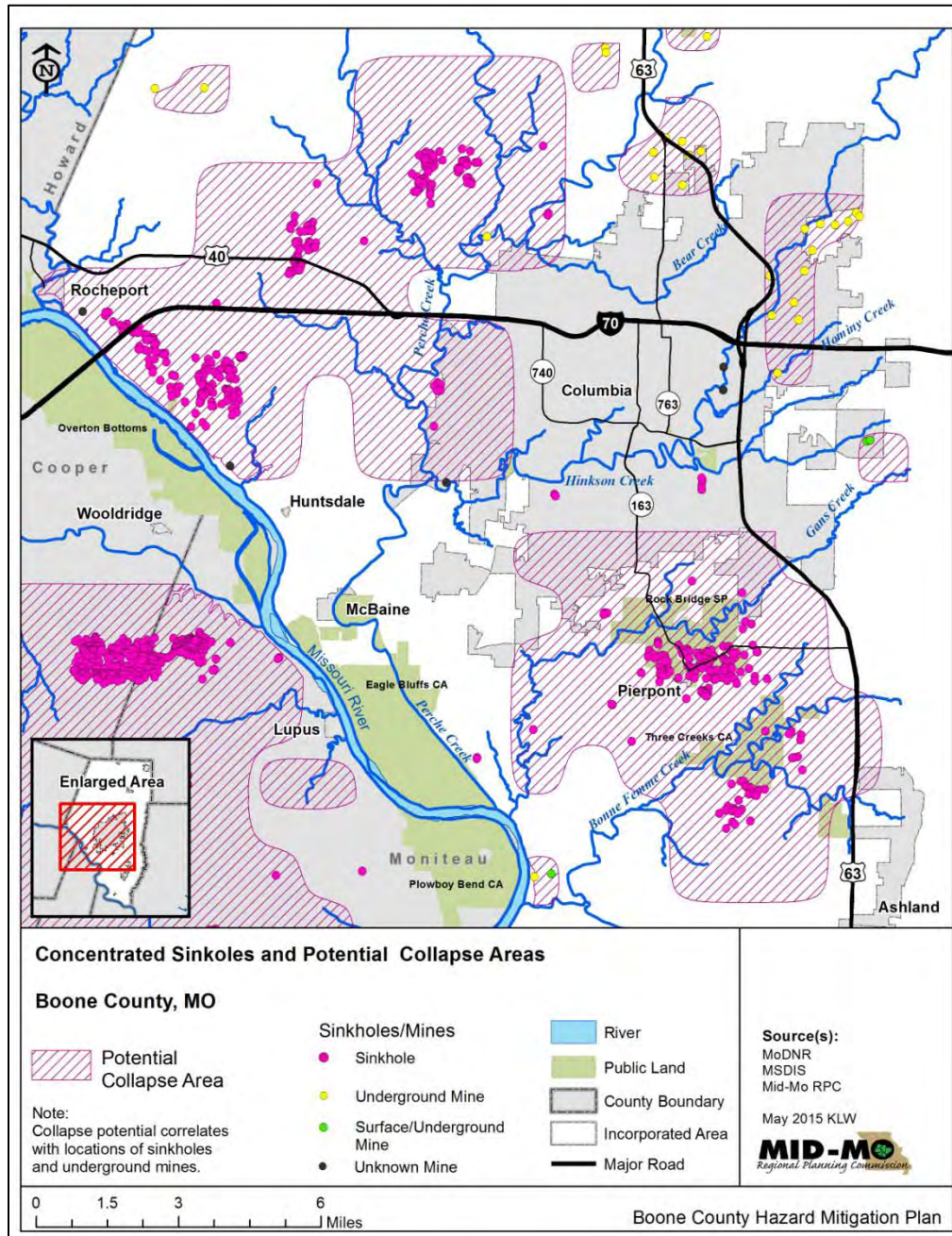
Sinkhole collapse potentially poses a threat to public health via contamination of the water supply. According to information from the Missouri DNR, a 1978 sinkhole collapse in southern Missouri drained the West Plains lagoon, resulting in sewage draining directly into underground water sources. More than 800 local residents reported illness and Mammoth Spring in Arkansas was contaminated.

According to the Boone County Stormwater Design Manual, groundwater in karst systems can move as much as a mile per day; this is contrasted to non-karst areas where groundwater may only move a few feet per year. Obviously, the potential for quick and widespread contamination of groundwater is a major concern in karst areas; “a contaminant may reach some springs or wells within a few hours after entering the groundwater system.”

Another characteristic of karst topography is the presence of losing streams. A losing stream is a surface stream with a direct connection to the groundwater in a local area; this connection has often been formed by the collapse of a sinkhole. According to the Stormwater Design Manual, “Protection of water quality in and near losing streams is critical for protection of groundwater quality in wells and springs.”

The proximity of clusters of sinkholes, and associated potential collapse areas, to losing streams in the planning area is shown in Figure 4.46.

Figure 4.46



Potential Impact - Existing Structure

Sinkholes vary in size and can potentially cause damage to roads, water/sewer lines, buildings, and lagoons. It is difficult to determine the potential impact of land subsidence and sinkholes on existing structures for a number of reasons:

There is a lack of data on historic damages caused by land subsidence and sinkhole collapse in Missouri.

Even with the mapping of known and possible sinkhole locations, it is difficult to predict where a sinkhole will collapse and if the collapse will be significant enough to damage any structures in the vicinity.

Because sinkhole collapse is not predictable there is no direct way to assess a cost impact for this hazard. Vulnerable structures, roads, or property could potentially be impacted by a sudden and usually localized drop in elevation. The resulting damage incurred from the sinkhole could result in broken roads, building collapse, compromises to water sources, environmental impacts, and/or loss of life. While loss of life could occur, it would most likely be minimal.

Potential Impact - Future Development

The threat of sinkhole collapse is poised to potentially become a more serious issue for Boone County and the city of Columbia. The areas to the south and west of Columbia had over 50% population growth in the period 2000-2010 (Figure 2.12). Much of this area is considered to have sinkhole collapse potential (Figure 4.46) and there is every reason to believe that the growth trend in these areas will continue.

Construction in these karst topography areas can cause shifts in soil, change drainage patterns, and promote the sinkhole formation. In addition, soil disturbance and changes in drainage patterns may lead to blockage of sinkholes and unforeseen flooding problems.

Existing Mitigation Activities

Boone County adopted a new Stormwater Ordinance in 2010. The ordinance contains provisions that seek to mitigate the impact of construction on sensitive areas such as sinkholes. The ordinance requires a land disturbance permit for any land disturbance activity within a sinkhole.

The Boone County Stormwater Design Manual addresses the possible concerns with development and sinkholes:

Development concerns related to depression sinkholes that must be addressed include flood hazards and soil stability within the geologic rim. When runoff from a development is draining to a depression sinkhole, impacts to groundwater quality must be addressed through on-site Best Management Practices (BMPs).

The Boone County subdivision regulations, updated in May 2014, include the following (Appendix B, Section 1.6):

Any portion of land which is located within the limits of a designated sink hole area as shown in the Boone County Zoning Regulations adopted September 1991 shall be subdivided and developed to insure that the plat is designed to minimize the flow of

stormwater into and erosion of areas in and around existing sinkholes as a result of construction. The plat shall also be designed to prevent wastewater from contaminating existing sinkholes or groundwater.

SUMMARY OF VULNERABILITY

Boone County, Columbia, Ashland, Centralia, Hartsburg, and Rocheport are all vulnerable to land subsidence/sinkholes.

The majority of the known sinkholes and potential collapse areas in the planning area are in unincorporated Boone County. The southern part of the planning area is especially vulnerable to this hazard due to the karst topography. A number of the mapped potential collapse areas overlap the boundaries of the City of Columbia. The presence of potential collapse areas in and around the City of Columbia (especially to the south, west, and north) is an important consideration for the jurisdictions of both Boone County and the City of Columbia due to vigorous growth and development in those areas.

Mapped potential collapse areas associated with known sinkholes also overlap the boundaries of a number of other jurisdictions. However, none of these jurisdictions have known sinkholes located within their boundaries.

- Ashland – There is a mapped potential collapse area in the northwest part of the city associated with a large number of known sinkholes.
- Hartsburg – There is mapped potential collapse area in the easternmost part of the city associated with known sinkholes to the north and southeast.
- Rocheport – The city is located within a potential collapse area associated with a large number of sinkholes to the southeast. However, according to city officials, there has never been a known collapse within the city.

Sinkhole collapse in karst areas poses the threat of contamination of the groundwater over a wide region. The new Boone County Stormwater Ordinance, adopted in 2010, has put permitting regulations in place for any type of land disturbance within sinkhole areas.

Mapped potential collapse areas associated with underground mines exist in the northern part of the planning area. One of these areas lies adjacent to the southeast boundary of the City of Centralia and another within a quarter mile of the northern boundary of the Village of Harrisburg; others lie within the northern and northeastern parts of the City of Columbia.

The potential for land subsidence or collapse from underground mines in northern Boone County is greater than the current mapping would indicate. Historically, there were numerous small underground coal mining operations in the area but the locations of most of these operations are unknown.

4.6 SEVERE THUNDERSTORMS (INCLUDING DAMAGING WINDS, HAIL, AND LIGHTNING)

DESCRIPTION OF HAZARD

A thunderstorm is a rainstorm with thunder and lightning present. Warm, humid climates, such as that in mid-Missouri, are favorable for the formation of thunderstorms. Thunderstorms can occur during any season in Missouri but they are more frequent in the spring and summer.

The average Missourian is well aware of the hazards of the thunderstorm season; these include heavy rains and, potentially, strong winds, tornadoes, hail, and lightning strikes. The effects of heavy rains have been considered in the section on flood (Section 4.1) and tornadoes are covered in Section 4.7.

Thunderstorms can range in complexity from single cell storms through multicell cluster storms, multicell line storms (squall lines), and on to supercell storms. A single cell thunderstorm typically lasts 20-30 minutes but when numerous cells are generated, as in a multicell storm, the thunderstorm can last for hours. Supercell storms include rotation and are responsible for the generation of severe tornadoes.

Severe and damaging winds in the planning area are usually, but not always, associated with thunderstorms. Thunderstorm winds can reach speeds up to 100 mph and produce damage paths for hundreds of miles. According to the National Oceanic and Atmospheric Administration (NOAA), property and crop damage from thunderstorm winds is more common, and can be more severe, than damage from tornadoes. Thunderstorm wind damage accounts for half of all the NOAA reports of severe weather events in the lower 48 states.

Thunderstorm winds are often called "straight-line" winds to distinguish them from tornadoes, which have a rotational element. The following are the distinctions made between different thunderstorm winds:

- Gust front - Gusty winds out ahead of a thunderstorm; characterized by a wind shift and temperature drop.
- Downbursts – A strong downdraft with a width of greater than 2.5 miles which results in an outward burst of damaging winds near the ground; may possibly produce damage similar to that of a strong tornado.
- Microbursts – A small concentrated downburst with a width less than 2.5 miles; generally short-lived, lasting only 5-10 minutes, with maximum wind speeds up to 168 mph.

A derecho is a widespread, massive, and violent thunderstorm wind event producing straight-line winds in excess of 70 mph and moving quickly over large areas. These are not common events; however, in the spring of 2009, a massive derecho almost as large as the state of Missouri caused extensive damage in southern Missouri and Illinois.

Much of the damage caused by high winds occurs because of falling trees; people, buildings, and vehicles may be damaged by falling trunks and branches. Power lines may be blown or knocked down and people left without electricity. In some cases, roofs are directly blown off buildings and windows are shattered.

Hail is formed when updrafts in thunderstorms carry raindrops up to very high and cold areas where they freeze into ice. Hail, especially large sized hail, can cause severe damage and presents a threat to automobiles, airplanes, roofs, crops, livestock, and even humans.

Lightning, a massive electrical discharge, is produced by all thunderstorms. The electrical discharge can be within a cloud, between clouds, or between a cloud and the ground.

Location

The entire planning area is at risk from severe thunderstorms and all the related threats accompanying them.

Extent

The National Weather Service considers a thunderstorm “severe” when it includes one or more of the following: winds gusting in excess of 57.5 mph, hail at least 0.75 inch in diameter, or a tornado. The NOAA database records thunderstorm events which fall into this severe classification.

For the 10-year period 2004-2013, the average wind gust (measured and estimated) for damaging winds reported in Boone County (Figure 4.47) was 62 mph. For the sixteen events when an actual measurement was taken, the average wind gust was a bit higher at 63 mph.

For the same period, the average measured diameter of severe hail reported in Boone County was 1.16 inches. The largest hail reported measured 4 inches in diameter (Harrisburg, May 2005) and 3-inch hail was reported in Columbia in March 2006. In total, there were 94 reports of hail of 1-inch diameter or larger during the 10-year period.

According to information from NOAA, a lightning bolt can contain 100 million to 1 billion volts of electricity and billions of watts of energy. This energy can heat the air around the lightning 18,000 to 60,000 °F.

Previous Occurrences

Historical data from NOAA for damaging winds (thunderstorm winds), hail, and lightning are shown in Figures 4.47-49. Ten-year data is given for damaging winds and 10-year plus for lightning to allow for more information on damages sustained; only five-year data is shown for hail because of the high number of events reported.

Damaging Winds

Figure 4.47					
Thunderstorm Wind Events in Boone County 11/1/2004-10/31/2014					
Location	Date	Mag (mph)	Location	Date	Mag (mph)
Columbia	4/21/2005	58 EG	Columbia Reg Airport	5/7/2009	63 MG
Midway	5/11/2005	81 EG	Columbia	5/7/2009	68 MG
Centralia	8/13/2005	63 EG	Columbia	5/15/2009	60 MG
Sturgeon	8/13/2005	63 EG	Easley	6/16/2009	60 EG
Columbia	8/13/2005	66 EG	Midway	6/23/2009	60 EG
Columbia	9/19/2005	66 EG	Hallsville	6/27/2009	60 EG
Columbia	9/19/2005	63 EG	Deer Park	4/4/2010	58 EG
Ashland	9/26/2005	66 EG	Woodlandville	6/19/2010	60 EG
Columbia	3/12/2006	60 EG	Sturgeon	7/18/2010	60 MG
Columbia	5/24/2006	66 EG	Columbia	7/20/2010	58 MG
Ashland	6/10/2006	69 EG	Columbia Reg Airport	8/13/2010	61 MG
Columbia Reg Airport	6/10/2006	74 MG	Centralia	8/20/2010	60 EG
Rocheport	7/13/2006	69 EG	Ashland	3/4/2011	64 MG
Columbia	7/21/2006	60 EG	Hallsville	3/4/2011	60 EG
Hallsville	7/21/2006	63 EG	Ashland	4/3/2011	60 EG
Easley	8/2/2006	58 EG	Columbia	4/3/2011	60 EG
Columbia	8/18/2006	60 EG	Sturgeon	4/3/2011	60 EG
Mc Baine	8/18/2006	60 EG	Columbia Reg Airport	5/12/2011	64 MG
Centralia	8/18/2006	59 EG	Harg	5/12/2011	59 MG
Columbia Reg Airport	4/24/2007	61 MG	Hallsville	5/22/2011	64 MG
Columbia	5/6/2007	58 EG	Hallsville	6/18/2011	60 EG
Midway	5/6/2007	63 EG	Columbia	6/18/2011	64 EG
Rocheport	5/6/2007	60 EG	Ashland	6/27/2011	62 MG
Columbia Reg Airport	8/12/2007	60 MG	Columbia	6/27/2011	60 EG
Columbia	8/12/2007	61 MG	Harg	7/3/2011	64 EG
Centralia	8/12/2007	60 EG	Huntsdale	7/28/2011	64 EG
Sturgeon	8/12/2007	60 EG	Columbia Reg Airport	8/7/2011	62 MG
Ashland	1/7/2008	60 EG	Columbia	6/16/2012	60 EG
Centralia	4/10/2008	60 EG	Columbia	3/27/2014	64 EG
Columbia	6/24/2008	60 EG	Columbia Reg Airport	4/24/2014	63 MG
Hallsville	7/2/2008	64 EG	BOONE CO.	6/4/2014	70 EG
Hallsville	7/27/2008	64 EG	BOONE CO.	6/21/2014	64 EG
Cou Cotton Mem Arpt	8/28/2008	55 EG	BOONE CO.	7/7/2014	72 MG
Magnitude definitions: MG=Measured Gust; EG=Estimated Gust; MS=Measured Sustained; ES=Estimated Sustained					
Source: http://www.ncdc.noaa.gov/stormevents/					

The damaging winds in July 2014 resulted extensive tree and property damage in the western portion of the City of Columbia and power loss of up to nearly a week.

Hail

Figure 4.48					
Hail Events in Boone County 1/1/2009-12/31/2013					
Location	Date	Size	Location	Date	Size
Columbia	5/7/2009	0.75 in.	Columbia	5/22/2011	1.00 in.
Columbia	5/7/2009	1.00 in.	Hallsville	5/22/2011	0.75 in.
Columbia	5/7/2009	1.00 in.	Columbia	5/25/2011	0.75 in.
Midway	5/15/2009	1.75 in.	Ashland	5/25/2011	0.88 in.
Columbia	5/15/2009	0.88 in.	Rocheport	5/31/2011	1.25 in.
Ashland	6/8/2009	0.75 in.	Deer Park	5/31/2011	1.00 in.
Hinton	6/17/2009	1.00 in.	Hallsville	6/13/2011	0.75 in.
Columbia	6/17/2009	1.75 in.	Hinton	6/13/2011	0.75 in.
Prathersville	6/17/2009	1.00 in.	Ashland	6/13/2011	0.75 in.
Stephens	6/17/2009	1.00 in.	Mc Baine	6/13/2011	1.50 in.
Hallsville	6/27/2009	1.00 in.	Columbia	7/3/2011	1.75 in.
Woodlandville	4/4/2010	1.00 in.	Columbia	3/15/2012	1.00 in.
Browns	4/4/2010	0.75 in.	Hallsville	4/29/2012	1.00 in.
Columbia	4/4/2010	0.88 in.	Centralia	4/29/2012	1.00 in.
Columbia	4/4/2010	0.75 in.	Rucker	5/28/2012	0.88 in.
Ashland	4/4/2010	1.00 in.	Woodlandville	9/7/2012	1.00 in.
Columbia	5/13/2010	1.75 in.	Midway	9/7/2012	1.75 in.
Sturgeon	6/27/2010	0.88 in.	Columbia	9/7/2012	2.75 in.
Hallsville	3/4/2011	1.75 in.	Harg	9/7/2012	1.50 in.
Centralia	3/4/2011	1.00 in.	Mc Baine	4/17/2013	0.88 in.
Ashland	4/3/2011	0.88 in.	Columbia	4/17/2013	2.75 in.
Columbia	4/10/2011	1.00 in.	Woodlandville	4/17/2013	1.25 in.
Columbia	4/19/2011	0.88 in.	Woodlandville	4/17/2013	1.00 in.
Ashland	4/22/2011	1.75 in.	Columbia	5/20/2013	1.50 in.
Hartsburg	4/22/2011	2.00 in.	Centralia	5/20/2013	0.88 in.
Columbia	5/13/2011	0.88 in.	Midway	5/26/2013	1.00 in.
Hallsville	5/22/2011	0.88 in.	Sapp	5/31/2013	1.00 in.
Midway	5/22/2011	1.25 in.			
Source: http://www.ncdc.noaa.gov/stormevents/					

Lightning

According to data from the NWS, lightning ranked as the third leading cause of weather-related fatalities over the 30-year period of 1983-2012, causing an average of 52 fatalities in the U.S. each year. According to the *Missouri State Hazard Mitigation Plan (2013)*, lightning was responsible for 8 deaths in Missouri during the period 2006-2012 and cause over \$2.37 Million in property damages in Missouri over that same period.

Figure 4.49						
Lightning Events in Boone County 8/25/2004-10/31/2014						
Location	Date	Deaths	Injuries	Damage		Incident Details
				Property	Crops	
Columbia	8/25/2004	0	0	0 K	0	Lighting strike melted power lines at Providence and Green Meadows roads. About 5000 people were affected by the resulting power outage including New Haven Elementary School.
Columbia	8/25/2004	0	0	15 K	0	Lightning strike started house fire.
Columbia	6/6/2005	0	0	30 K	0	Lightning strike started house fire.
Columbia	8/26/2006	0	0	25 K	0	Five radio stations were knocked off the air when lightning struck a Cumulus Broadcasting transmitter tower. Control boards in the studios, computers, and magnetic door locks in the building were also damaged by the strike.
Columbia	7/19/2007	0	0	150 K	0	Lightning strike started fire at photography studio.
Sapp	4/23/2008	0	0	100 K	0	Lightning strike started house fire.
Columbia	5/30/2008	0	0	100 K	0	Lightning strike started house fire.
Cou Cotton Mem Arpt	6/13/2008	0	0	10 K	0	Lightning strike started house fire.
Browns	6/17/2009	1	0	0 K	0	Lightning strike killed woman in open field at Rocky Fork Lakes Conservation Area.
Harg	7/3/2011	0	0	25 K	0	Lightning strike started house fire.
Columbia	7/23/2011	0	1	0 K	0	Lightning struck cell phone being used by woman in Cosmo Park.
Totals:		1	1	455 K	0	
Source: http://www.ncdc.noaa.gov/stormevents/						

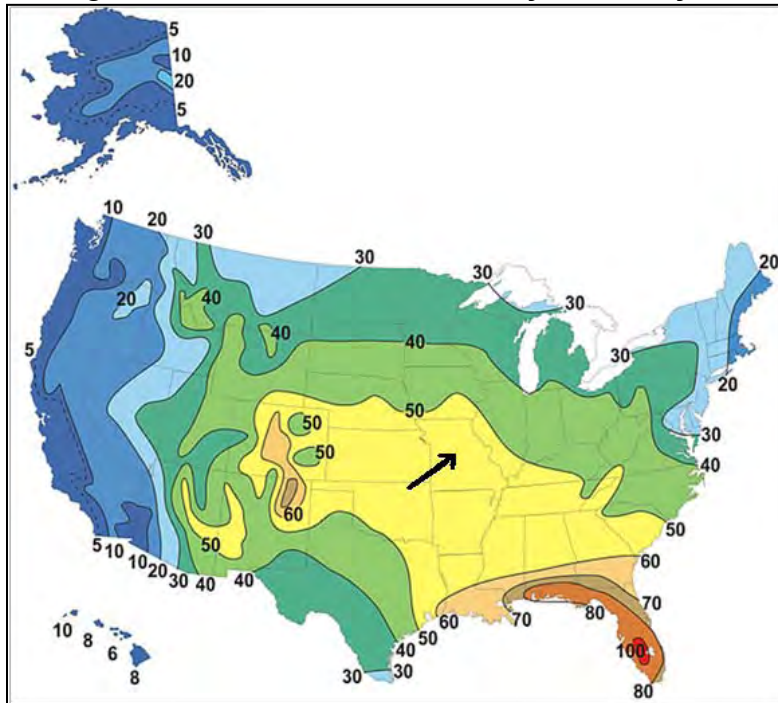
Probability of Future Events

High for damaging winds, hail, and lightning – All participating jurisdictions

National Weather Service data indicates an average 50-60 thunderstorm days per year in Missouri (Figure 4.50).

Figure 4.50

Average Number of Thunderstorm Days Annually in U.S.



Source: NOAA

Data from NOAA for the 10 year period (Nov. 2004 through Oct. 2014) indicates 66 severe thunderstorm wind events in Boone County (Figure 4.47). There was only one year in this period (2013) without a reported severe thunderstorm wind event in the planning area. Based on this data, the calculated probability of a future severe thunderstorm wind event in any given year is 90%.

Data from NOAA for the 5 year period 2009-2013 indicates 55 severe hail events in Boone County (Figure 4.48). There were numerous severe hail events in the planning area each of these years. Based on this data, the calculated probability of a future severe hail event in any given year is 100%.

Data from NOAA for the 10 year period 2004-2014 indicates 11 lightning events in Boone County which caused property damage, injury, or death (Figure 4.49). There were three years during this period without such a reported event in the planning area. Based on this data, the calculated probability of a future lightning event causing property damage, injury, or death in any given year is 70%.

ANALYSIS OF RISK

Measure of Severity –

Moderate to High for damaging winds, hail, and lightning – all participating jurisdictions

Potential Impact - Life

Severe thunderstorms and their related hazards pose a threat to both people and animals. Windblown debris, falling trees and branches, and lightning are very dangerous to those who are exposed. Excessive damage to utilities can leave people without electricity for long periods – an especially dangerous situation for vulnerable populations.

In the NOAA data examined for Boone County (Figures 4.47-4.49), there were 24 recorded injuries due to damaging winds in a 10-year period. The most injuries occurred in August 2008 when a tent collapsed at a revival north of Columbia; 20 people were injured – most with minor injuries but two with moderate injuries. The other four injuries in the period were minor and associated with either damage to very vulnerable structures (mobile home, camper, tent) or to flying debris.

The NOAA data also indicates that a woman was struck and killed by lightning in 2009 while crossing a field at Rocky Forks Conservation area, located north of Columbia. Another woman was injured in 2011 when lightning struck her cell phone in Cosmo Park in Columbia.

Hail also presents a potential bodily threat. In 2000, a man in Texas died from softball size hail. (The 4-inch hail recorded in Harrisburg in 2005 was only slightly smaller than this.) According to NOAA's National Severe Storms Laboratory, it has been estimated that a 3.25 inch hailstone weighing 1.5 pounds has a falling velocity of about 106 mph.

Potential Impact - Existing Structures

There is a wide range of possible impact from severe thunderstorms. Non-permanent and wood framed structures are very vulnerable to destruction. While high winds are the force behind damage, it is the windblown debris and falling trees and branches that cause the most damage.

An overview of the damages due to severe thunderstorms from recent 10-year NOAA data, along with annualized losses calculated for the *Missouri State Hazard Mitigation Plan (2013)*, are shown in Figure 4.51. The annualized losses were calculated by combining historical loss data from the NOAA database and paid crop insurance claims from USDA's Risk Management Agency (RMA) for the period 1993 to July 2013.

Figure 4.51 Property Damage - Severe Thunderstorm in Boone County		
	NOAA data total damages 2004-2014	Annualized Property Loss and Crop Claims
Damaging Wind	\$105,000	\$9,421
Hail	\$0	\$3,248
Lightning	\$455,000	\$46,000*
Total	\$560,000	\$58,669
* Property damage alone		
Sources: http://www.ncdc.noaa.gov/stormevents/ **Missouri State Hazard Mitigation Plan (2013)		

The NOAA data, from which the annualized losses are calculated, vastly underestimates the cost of these hazards in the planning area. Local information indicates many instances of property damage are not reflected in the NOAA data. For example, the damaging wind on July 7, 2014 caused widespread damage in Columbia. Six 80-foot transmission line poles were snapped in half and large trees were uprooted over a widespread area. There were 14,000 residents who lost power in the storm; some were without power for a little over 100 hours/4.5 days. The area most badly hit included commercial businesses.

The NOAA data for severe hail events in the period 2004-2013 does not indicate any property or crop damage in the planning area. There was significant and costly hail damage in the planning area during that period. A large hailstorm in 2006 caused widespread damage in many areas. The *Boone County Public Works Annual Report 2007* lists the following expenses for hail damage repairs in 2006: Jail Roof (\$790,841), Columbia Health Facility Roof and Walkway Cover (\$41,950), Fairgrounds Roofs (\$199,225), Reality House Roof & Misc. (\$18,050), Public Works Misc. (\$8,800). This totals to over \$1million in damage incurred by county buildings in a one year period which is not included in the NOAA data. A large number of vehicles and private homes were also damaged in the 2006 hailstorms. Hailstorms of the magnitude that caused such damage in 2006 do not occur every year, but hail is a very costly hazard for the planning area.

The NOAA data (Figure 4.49) indicates property damage due to fires started by lightning strikes ranging from \$15,000 to \$150,000 per incident. In addition to the damages recorded, there was \$25,000 in damage when a radio transmitting tower and its associated building were hit by lightning. There was one incident in the period when power lines were melted by a lightning strike but no damages are recorded for this event.

Potential Impact - Future Development

There has been a rapid growth in population and housing in the planning area in recent years. A larger population and more extensive built environment increase the risk of injury, loss of life, and damage from severe thunderstorms. Census figures indicate an overall population growth rate of 20% in the planning area (Boone County) between 2000 and 2010; housing units increased by 23% during this period (Figure 2.11).

The largest percentage population and housing unit increases were seen in the City of Ashland (98%/87% respectively), Hallsville (52%/40% respectively), and Harrisburg (45%/41% respectively). Columbia, the largest city in the planning area, grew by 28% in population and 30% in housing stock. This was an increase of almost 24,000 people and almost 11,000 housing units in the city.

While the housing growth rate might be expected to be somewhat lower between 2010 and 2020 due to a slow recovery from the recent economic recession, a significant growth rate overall is still expected; construction is once again vigorous. In Columbia, home to the University of Missouri, there has been a recent tremendous growth in housing development for student rental. Recent and planned student housing developments are transforming the downtown area of the city.

It would be wise to consider mitigation strategies for severe thunderstorms during the planning phase of any new development. The type of construction affects vulnerability to damaging winds, hail, lightning, and tornadoes. Design and construction choices, inclusion of safe rooms in projects, adequate warning sirens, and NOAA radios can all save lives.

Existing Mitigation Activities

There are a variety of strategies in place in the planning area by which the public can be informed of severe weather conditions resulting from thunderstorms.

The Office of Emergency Management is proactive in educating the public about the dangers of severe thunderstorms and tornadoes.

Boone County has been recognized by the National Weather Service as a StormReady® Community. In order to become recognized as StormReady®, the Emergency Management Agency is evaluated on its abilities to do the following:

- receive real time weather information from the NWS
- disseminate that information to the public,
- transmit real time information to the NWS
- educate the public regarding weather hazards/protection

Warning Systems The following warning systems are used in the county:

- Local television weather reports
- Local radio weather reports
- 9-1-1 call center and Public Emergency Broadcast Center
- Outdoor warning sirens

Mobile Homes There is no requirement in Boone County for tie-downs on mobile homes; however, updated electric service cannot be obtained for a mobile home in the county unless the home is tied down.

Shelters There are numerous shelters Red Cross Certified Shelters in the planning area should sheltering become necessary (Figures 3.11-3.13).

Insurance Industry The insurance industry is heavily invested in finding mitigation strategies for hail damage as it is one of the most costly hazards for the industry. The fifth largest payout made by State Farm Insurance (\$245 million) was for a 1992 hailstorm in Texas. (The only higher payouts were for Hurricane Andrew in 1992, a 1994 earthquake in Los Angeles, Hurricane Hugo in 1989 and wildfires in Oakland, California in 1991.)

High insurance claims for hail damage, especially in the Midwestern states, are one reason for an increase in insurance premiums. The type of roofing material used in construction can greatly affect vulnerability to hail. In an effort to have a multifaceted approach to the problem of high damages and increasing premiums, the industry has supported research and testing standards in roofing materials.

In 1996, a testing standard (UL2218) was developed to grade the impact resistance of roofing materials. There are four rated classes of resistant materials with Class IV shingles providing the most resistance against both hail and high winds.

In the past, impact resistant roofing (mostly made of aluminum, copper, plastic and resin) was not affordable for most homeowners. Recent research has resulted in “modified asphalt” shingles which are much more affordable; some of these achieve the Class IV rating.

Installing impact resistant roofing can have an added benefit on insurance rates. In Texas, all insurers subject to Texas rate regulations were required in 1998 to begin offering premium discounts for customers who have installed impact-resistant roofs. In Missouri, some insurers offer these discounts on a voluntary basis.

SUMMARY OF VULNERABILITY

Thunderstorms with damaging winds, hail, and lightning are common, dangerous, and often costly occurrences in the planning area. These weather events can be expected almost every year and every jurisdiction is highly vulnerable to these hazards.

Both human life and the built environment are at risk; the impact on the built environment has been quite costly in the past and this can be expected to continue into the future.

Public awareness education, excellent weather coverage by the local media, an excellent outdoor warning system, and regular emergency exercises in the schools help mitigate the risk to human life. However, there is a great need throughout the planning area for more safe rooms to protect from high wind events; this is especially true in the schools. Additionally, more vigorous promotion of NOAA radio use would help protect the general public. Additional generators and power transfer hookups are needed in case of widespread and/or lengthy power outages. All of these identified needs have been targeted for action in the mitigation strategy; funding remains an issue for the more costly safe rooms and generators/power transfer hookups.

4.7 TORNADO

DESCRIPTION OF HAZARD

A tornado is a violently rotating column of air which is usually generated by a supercell thunderstorm. The movement speed of a tornado is typically around 10-20 mph but can range from almost stationary to more than 60 mph, according to NOAA's National Severe Storms Laboratory. They often travel from southwest to northeast but can move in any direction.

Tornadoes occur most frequently in late afternoon and early evening but can occur at any time; they tend to dissipate as fast as they form. Unlike a hurricane, which can last for multiple hours, tornadoes are often in one place for no more than a few minutes. The seasonal, temporal, and spatial uncertainties surrounding thunderstorms and tornadoes make widespread and year round preparedness essential.

Location

The entire planning area is at risk from tornadoes.

Extent

The Enhanced Fujita or EF-Scale (Figure 4.52) is currently used in the United States to classify tornadoes. It is based on engineering studies of the wind effects on 28 different types of structures (buildings, towers, poles, trees). This indirect measurement of speed is used because it is currently not possible to measure ground-level speeds in strong tornadoes; the winds destroy the instruments needed for measurement.

In addition to estimated wind speeds, averaged data from tornadoes can give an idea of the length and width of tornadoes in the different classifications.

Figure 4.52			
Tornado Extent			
EF-Scale Number	Wind Speed* (mph)	Length** (miles)	Width** (feet)
EF0	65-85	0.9	93
EF1	86-110	2.9	210
EF2	111-135	6.6	413
EF3	136-165	14.0	865
EF4	166-200	27.1	1,511
EF5	Over 200	33.9	1,823
* 3 second gust			
** Source: FEMA Benefit-Cost Analysis Course, Student Manual Version 4.5			

The EF-Scale has been in use since 2007. It uses the same ratings as the original Fujita Scale (F-Scale) which it replaced, but the wind speeds have been adjusted to reflect current knowledge and give a more realistic estimate of wind speeds for all tornadoes, including historical ones in the NOAA database. The ratings of tornadoes prior to 2007 were not changed in the NOAA database with the adoption of the EF-Scale.

There continue to be limitations even with the EF-Scale since the scale is based on sustained damage. As noted on the NOAA website, "...damage rating is (at best) an exercise in educated guessing. Even experienced damage-survey meteorologists and wind engineers can and often do disagree among themselves on a tornado's strength."

Another issue with tornadoes is speed of onset. Technological advances, such as Doppler radar, computer modeling, and Emergency Warning Systems, have increased the amount of time the general public has to respond to a tornado. Despite these advances, tornadoes can still strike an area with little warning. Often people have no more than a few minutes to get to safety. Being able to quickly get to a safe place is absolutely imperative in order to prevent loss of life.

Previous Occurrences

The planning area has experienced thirty-two tornado events since July 1954, as officially recorded by NOAA (Figure 4.53). This includes five "significant" F2 tornadoes and three "severe" F3 tornadoes. The Boone County planning area ranks 9th out of 114 counties for the number of tornadoes during this period, according to the *Missouri State Hazard Mitigation Plan (2013)*.

The historical record in the planning area over this 60+ period indicates tornadoes in the EF0 to EF3 range. While history is informative, it is not necessarily predictive of the future; there is the possibility that the planning area could experience a tornado above the EF3 level in the future.

In addition, many historical tornadoes may have been stronger than the data indicates. According to the NOAA website, "...because the only way we can compare all tornadoes is by whatever damage they caused, and EF5/F5 damage is only possible when tornadoes hit well-built structures, the true 'violence' of most historical tornadoes is unknown—especially before the middle to late 20th century."

Figure 4.53

Tornado Events in Boone County 7/01/1954 - 7/31/2014

Location	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
Boone County	12/04/56	22:30	F2	0	0	250K	0
Boone County	09/28/59	16:00	F1	0	0	3K	0
Boone County	10/04/59	19:40	F0	0	0	3K	0
Boone County	10/04/59	19:40	F0	0	0	3K	0
Boone County	01/25/65	21:50	F0	0	0	0K	0
Boone County	12/08/66	2:30	F1	0	0	25K	0
Boone County	09/07/72	15:15	F1	0	0	25K	0
Boone County	03/13/73	21:46	F1	0	0	25K	0
Boone County	05/26/73	18:50	F2	0	1	250K	0
Boone County	12/04/73	6:30	F0	0	0	25K	0
Boone County	05/12/80	17:43	F2	0	0	25K	0
Boone County	04/16/82	17:05	F0	0	0	0K	0
Boone County	05/29/82	3:00	F1	0	0	3K	0
Boone County	04/03/84	15:15	F1	0	0	0K	0
Boone County	04/29/84	16:45	F1	0	0	25K	0
Boone County	10/16/84	4:30	F1	0	0	25K	0
Boone County	06/17/85	0:04	F1	0	0	2.5M	0
Boone County	06/02/87	13:56	F0	0	1	0K	0
Boone County	11/27/90	11:12	F3	0	0	250K	0
Boone County	11/27/90	11:20	F3	0	3	25.0M	0
Boone County	07/02/92	17:33	F1	0	0	250K	0
Boone County	07/02/92	17:43	F0	0	0	0K	0
Columbia	07/08/95	16:15	F0	0	0	0	0
Columbia	11/10/98	1:58	F3	0	16	6.0M	0
Midway	04/08/99	16:55	F2	0	5	0	0
Hinton	04/08/99	17:05	F2	0	0	0	0
Ashland	02/25/00	15:35	F0	0	0	0	0
Centralia	03/26/00	18:15	F1	0	0	50K	0
Midway	05/17/01	15:30	F0	0	0	0	0
TOTALS:				0	26	34.736M	0

Source: <http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI> (data available as of 10/31/14)

Probability of Future Events

High - all participating jurisdictions

For the period 1954-2014, a 61-year period, the NOAA database reports 18 years with at least one tornado event in the planning area. Based on this historical data, the calculated probability of a future tornado event of any magnitude in a year is 30%.

The probabilities of occurrence of the different magnitudes of tornadoes in any given year, based on historical data, has also been calculated (Figure 4.54). While the calculated probabilities for an EF4 or EF5 tornado are 0%, this does not mean tornadoes of these magnitudes could not occur in the planning area; it just means they have not occurred in the historical record.

Figure 4.54 Probability of Future Tornado Events			
EF-Scale	# of years with tornado event (1954-2014)	Probability	Probability Rating
All	18	30%	High
EF0	9	15%	High
EF1	9	15%	High
EF2	4	7%	Moderate
EF3	2	3%	Moderate
EF4	0	0%	Low
EF5	0	0%	Low

ANALYSIS OF RISK

Measure of Severity

High - all participating jurisdictions

The destructive effects of a tornado depend on the strength of the winds, proximity to people and structures, the strength of structures, and how well a person is sheltered. They are obviously a hazard with the potential to cause both great loss of life and catastrophic destruction.

Potential Impact - Life

While tornadoes can strike anywhere, there is a greater chance of injury and loss of life (and destruction of property) in population centers. This is especially true of a tornado with a large path.

There have been 26 reported injuries associated with recorded tornadoes in the planning area.

Potential Impact - Existing Structures

Tornadoes cause the most costly physical destruction when they touch ground in urban areas. High winds affect all structure types differently; non-permanent and wood framed structures are especially vulnerable to destruction.

In addition to a direct hit on a building by a tornado, damage to trees poses a serious threat. People, buildings, power lines, and vehicles are all at risk from falling branches, uprooted trees and windblown debris.

There has been \$34.736 million in reported property damages associated with recorded tornadoes in the planning area.

The Enhanced Fujita Scale was developed by studying wind effects on various structures types (Figure 4.55). Inspection of this information gives an idea of the damage which might be expected with tornadoes of different magnitudes.

Figure 4.55			
Tornado Strength and Damage			
EF-Scale Number	Intensity Phrase	Wind Speed* (mph)	Type of Damage Done
F0	Gale tornado	65-85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	86-110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	111-135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	136-165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	166-200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel reinforced concrete structures badly damaged.
* 3 second gust			

Impact Assessment on Total Property

An assessment has been developed for the impact of EF0 through EF3 tornadoes in each of the incorporated communities participating in the hazard mitigation plan, with the exception of Huntsdale (Figure 4.57). For the purpose of property value assessment, Huntsdale is included with the Boone County (unincorporated assessment) so the needed data was not available.

The average area of the different magnitudes of tornadoes was calculated from the average length and width of tornado paths established from historical data (Figure 4.56).

Figure 4.56				
Average Tornado Size				
EF Class	Length (miles)	Width (feet)	Width (miles)	Area (square miles)
EF0	0.9	93	0.02	0.02
EF1	2.9	210	0.04	0.12
EF2	6.6	413	0.08	0.53
EF3	14.0	865	0.16	2.24
EF4	27.1	1,511	0.29	7.86
EF5	33.9	1,823	0.35	11.87
Source: FEMA Benefit-Cost Analysis Course, Student Manual Version 4.5				

The following assumptions have been made in developing the assessment:

- The entire tornado path is within the given jurisdiction.
- The total property value in the jurisdiction is the sum of the real, personal, and government-owned property as reported in the jurisdictional profile charts in Section 3.2
- The total property value is evenly distributed in the tornado path.
- The damage factor is 25%. Information from FEMA indicates that damage in the path of an F2 tornado will range from minimal to approximately 50%. From this information, an average damage factor of 25% was assumed. This assumption was applied to all magnitudes of tornadoes in the analysis.

Figure 4.57						
Tornado Vulnerability Analysis - Major Population Areas						
Jurisdictional Data			Estimated Property Damage - Real and Personal (25% damage factor assumed)			
Jurisdiction	Area (square miles)	Total Market Value of Property*	EF0	EF1	EF2	EF3
Ashland	4.8	\$239,317,294	\$249,289	\$1,495,733	\$6,606,154	\$27,920,351
Centralia	2.8	\$216,827,495	\$381,739	\$2,290,431	\$10,116,072	\$42,754,717
Columbia	60.2	\$8,688,651,994	\$721,289	\$4,327,736	\$19,114,169	\$80,784,412
Hallsville	1.3	\$72,717,552	\$273,374	\$1,640,246	\$7,244,418	\$18,179,388
Harrisburg	0.8	\$11,390,029	\$74,934	\$449,606	\$1,985,762	\$2,847,507
Hartsburg	0.2	\$3,819,582	\$19,098	\$114,587	\$506,095	\$954,896
Rocheport	0.3	\$12,779,906	\$63,900	\$383,397	\$1,693,338	\$3,194,977
Sturgeon	0.8	\$31,972,409	\$204,951	\$1,229,708	\$5,431,210	\$7,993,102
*Total of Personal and Real Property Market Values plus Government Owned Property Values (Section 3.2 - Property and Valuation Charts);						

There are some obvious limitations to this assessment. Some of these are:

- The analysis is based on numerous assumptions and estimates.
- Property value is not distributed evenly in jurisdictions.
- Conversion of the length and width of a tornado path into area will cause an overestimation of damage in smaller jurisdictions.
- The analysis does not take into account the type of construction; this is a major factor in structure vulnerability.

Missouri State Hazard Mitigation Plan (2013) Analysis: The State Hazard Mitigation Plan looked at four variables to determine tornado vulnerability in the counties of Missouri:

- Likelihood of future tornado impacts
- Average annual property loss ratio (total building exposure value divided by average annualized historic losses)
- Population change percentage (2000-2010)
- Housing change percentage (2000-2010)

The State then ranked the counties by total vulnerability. Since tornadoes are random in their location, it was decided to consider the low end of the vulnerability scale to have a Moderate

Risk and the high end to have a Very High Risk. The planning area/Boone County was among thirteen counties identified as having a Very High Risk for tornadoes.

The State Plan set the Total Building Exposure in the planning area at \$17,363,239,000.

Potential Impact - Future Development

There has been a rapid growth in population and housing in the planning area in recent years. A larger population and more extensive built environment increase the risk of injury, loss of life, and damage from tornadoes. Census figures indicate an overall population growth rate of 20% in the planning area (Boone County) between 2000 and 2010; housing units increased by 23% during this period (Figure 2.11).

The largest percentage population and housing unit increases were seen in the City of Ashland (98%/87% respectively), Hallsville (52%/40% respectively), and Harrisburg (45%/41% respectively). Columbia, the largest city in the planning area, grew by 28% in population and 30% in housing stock. This was an increase of almost 24,000 people and almost 11,000 housing units in the city.

While the housing growth rate might be expected to be somewhat lower between 2010 and 2020 due to a slow recovery from the recent economic recession, a significant growth rate overall is still expected; construction is once again vigorous. In Columbia, home to the University of Missouri, there has been a recent tremendous growth in housing development for student rental. Recent and planned student housing developments are transforming the downtown area of the city.

It would be wise to consider mitigation strategies for tornadoes and other high wind situations during the planning phase of any new development. The type of construction greatly affects vulnerability to tornadoes and high winds. Design and construction choices and the inclusion of hardened areas for safe rooms can save lives.

Existing Mitigation Activities

There are a variety of strategies in place in the planning area by which the public can be informed of the threat of tornadoes.

The Office of Emergency Management is proactive in educating the public about the dangers of tornadoes and severe thunderstorms.

Boone County has been recognized by the National Weather Service as a StormReady® Community. In order to become recognized as StormReady®, the Emergency Management Agency is evaluated on its abilities to do the following:

- receive real time weather information from the NWS
- disseminate that information to the public,
- transmit real time information to the NWS
- educate the public regarding weather hazards/protection

Warning Systems The following warning systems are used in the county:

- Local television weather reports
- Local radio weather reports
- 9-1-1 call center and Public Emergency Broadcast Center
- Outdoor warning sirens

Mobile Homes There is no requirement in Boone County for tie-downs on mobile homes; however, updated electric service cannot be obtained for a mobile home in the county unless the home is tied down.

Tornado Safe Areas The City of Hallsville uses the large basement of the Hallsville Baptist Church as a tornado safe room. There is one mobile home park in the city which is located very close to the church; all residents of the park are aware that this is the safe location in event of a tornado.

Shelters There are numerous shelters Red Cross Certified Shelters in the planning area should sheltering become necessary after a tornado event (Figures 3.11-3.13).

SUMMARY OF VULNERABILITY

The entire planning area is highly vulnerable to the potentially devastating impact of tornadoes. Their random nature and potentially quick speed of onset pose particular risks for human life. Tornadoes of the magnitude known to historically occur in the area can wreak extensive and costly structural damage.

Public awareness education, excellent weather coverage by the local media, an excellent outdoor warning system, and regular emergency exercises in the schools help mitigate the risk to human life. However, there is a great need throughout the planning area for more safe rooms to protect from high wind events; this is especially true in the schools. Additionally, more vigorous promotion of NOAA radio use would help protect the general public. Additional generators and power transfer hookups are needed in case of widespread and/or lengthy power outages. All of these identified needs have been targeted for action in the mitigation strategy; funding remains an issue for the more costly safe rooms and generators/power transfer hookups.

4.8 SEVERE WINTER WEATHER (INCLUDING ICE, SNOW, AND SEVERE COLD)

DESCRIPTION OF HAZARD

Winter storms in central Missouri contain ice, snow, severe cold, sleet, and wind; each of these associated factors has the potential to disrupt life in the region by making normal activity difficult and/or dangerous.

Location

The entire planning area is at risk from severe winter weather.

Extent

The historical data for the planning area (Figure 4.58) provides information regarding both the duration and severity of winter weather events.

Duration: Severe winter weather events involving some type of precipitation (freezing rain, sleet, ice, or snow) have an average duration involving at least part of 2 calendar days. The longest winter precipitation event in recent years was an ice storm in December of 2007 which took place over 5 days.

In terms of extreme cold, there was a period of cold and wind chills in January 2010 which lasted for 12 days.

Severity: The data indicates that winter weather events involving snowfall average 5-8 inches of snow. These averages are for the entire region affected by the storm and may differ slightly for Boone County itself. Freezing rain or sleet often precedes snowfall in the region.

Recorded events of extreme cold are not numerous. During a 2-day cold snap in December 2000, wind chills reached -20° to -40° F. The winter of 2013-2014 was, in general, very cold. A 2-day cold period in January 2014 had the coldest recorded temperatures in 20 years, according to the NOAA data. The thermometer read -11° F. in Columbia and wind chills in the region on the morning of the 6th ranged from -25° to -33° F.

Previous Occurrences

Figure 4.58			
Severe Winter Weather Events in Boone County (1996-2014)			
Date	Storm Type	Duration (days)	Description
01/02/96	Winter Storm	1	6-9 inches of snow in region
01/03/96	Winter Storm	2	
11/25/96	Ice Storm	1	Numerous traffic accidents
01/08/97	Winter Storm	2	5-7 inches of snow, strong winds, very cold temperatures
01/15/97	Winter Storm	2	Freezing rain and sleet with 1/4 - 1/2 inch of ice accumulation followed by 3-8 inches of snow in the region
01/27/97	Winter Storm	1	Freezing rain with 1/2 to 1 inch of ice accumulation
04/10/97	Winter Storm	1	2-6 inches of snow in the region
12/08/97	Winter Storm	1	2-4 inches of snow in region
01/12/98	Winter Storm	1	Freezing drizzle resulting in thin glaze of ice on roads
03/08/98	Winter Storm	2	4-6 inches of snow in region
12/21/98	Winter Storm	2	Light freezing drizzle, sleet, and snow left a thin coating of ice on roads
01/01/99	Winter Storm	2	6-10 inches of snow across region with about an inch of freezing rain and sleet; very cold temps
01/27/00	Winter Storm	3	4-5 inches across region
03/11/00	Winter Storm	1	4-7 inches of snow
12/13/00	Heavy Snow	1	6-12 inches across region
12/16/00	Extreme Cold/Wind Chill	2	Wind chills from -20 to -40
01/29/02	Ice Storm	2	1/4 - 1/2 inch ice accumulation; power outages
03/02/02	Winter Storm	1	1/2 inch of sleet followed by 4-6 inches of snow; winds of 20-30 mph
03/25/02	Winter Storm	2	Sleet followed by snow; 3-4 inches accumulation of the mix
12/04/02	Winter Storm	1	2-5 inches of snow across region
12/24/02	Winter Storm	1	4-8 inches of snow across region
01/01/03	Winter Storm	2	Sleet accumulation up to 1 inch followed by 6-8 inches of snow across the region
02/23/03	Winter Storm	2	3-6 inches of snow across the region
12/09/03	Winter Storm	2	3-5 inches of snow across the region
12/13/03	Winter Storm	1	3-6 inches of snow across the region
01/25/04	Winter Storm	1	Freezing rain followed by 1-2 inches of sleet and then 1-2 inches of snow
11/24/04	Winter Storm	1	4-6 inches of snow across region
12/08/05	Winter Storm	1	2 inches of snow
11/29/06	Winter Storm	3	Over a foot of snow in some areas
01/12/07	Ice Storm	3	Up to 1.5 inches of sleet and .25-.5 inches of ice accumulation in region
Sources: Source: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI (available data as of 10/31/14)			

Figure 4.58 (cont.)**Severe Winter Weather Events in Boone County (1996-2014)**

Date	Storm Type	Duration (days)	Description
12/01/07	Winter Weather	1	Ice
12/06/07	Winter Weather	1	2- 4 inches of snow
12/08/07	Ice Storm	5	Up to 1 inch of sleet with up to 0.5 inches of ice accumulation
02/11/08	Winter Weather	1	Light coating of freezing rain and sleet
02/23/08	Winter Weather	2	Snow
01/26/09	Winter Storm	3	
01/01/10	Cold/Wind Chill	12	One of the coldest outbreaks in years
01/06/10	Winter Weather	2	Snow and wind gusts
01/19/11	Heavy Snow	2	9-11 inches
01/31/11	Winter Storm / Blizzard	2	Freezing rain and sleet accumulating to 1 inch followed by snow up to 20 inches in region; strong winds, very cold wind chill values
02/21/13	Heavy Snow	1	Freezing rain and sleet followed by 10-12 inches of snow; thunder snow
02/25/13	Heavy Snow	2	6-7 inches; thunder snow
12/21/13	Ice Storm	1	Ice storm caused scattered power outages and travel problems. Average ice accumulation was .25-.30 inch. About .5 inch of sleet also fell in some locations.
03/24/13	Heavy Snow	1	6-11 inches in region; thunder snow
01/05/14	Winter Storm	1	6-9 inches of snow in region; drifts of 2-5 feet. All schools and most businesses were closed for at least 2 days; some schools remained closed longer due to cold temps and wind chills.
01/06/14	Cold/Wind Chill	2	Coldest temperatures in 20 years; -11° F. in Columbia; wind chills in the region on the morning of the 6th ranged from -25° to -33° F.
2/4/2014	Winter Storm	1	6-13 inches in region; travel was difficult and most schools in rural areas were closed for several days.
Sources: Source: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=29%2CMISSOURI (available data as of 10/31/14)			

Probability of Future Events – High for all participating jurisdictions

The historical data indicates there were only 2 years (2001 and 2012) without a severe winter weather event in the period 1996-2014, a 19 year period; most years witnessed numerous events. Based on this historical data, the calculated probability of a severe winter weather event in any year is 89%. (Probability calculation: $1 - (2/18) = .89$)

ANALYSIS OF RISK

Measure of Severity - Moderate to High for all participating jurisdictions

Severe winter weather presents a risk to both life and property in the planning area. Some of the damage is direct but some comes in the form of economic losses due to closed businesses and schools and slowed or halted transportation (Figure 4.59).

Figure 4.59

Reported Injuries and Damages - Severe Winter Weather Events Boone County, Missouri 1996-2013			
Date	Storm Type	Duration (days)	Injuries and Damages
01/08/97	Winter Storm	2	Schools closed for several days
01/27/97	Winter Storm	1	Trees and powerlines down
12/08/97	Winter Storm	1	Numerous auto accidents with one death in Columbia; schools closed
01/12/98	Winter Storm	1	Numerous vehicle accidents; schools, including the University of MO-Columbia, closed
03/08/98	Winter Storm	2	An 84 year old woman in Columbia died of a heart attack while shoveling snow; numerous auto accidents;
01/01/99	Winter Storm	2	Schools closed
01/29/02	Ice Storm	2	Federal Disaster Declaration; Individual Assistance in Boone County
03/02/02	Winter Storm	1	Transportation mostly halted
12/04/02	Winter Storm	1	Numerous accidents
01/25/04	Winter Storm	1	Transportation brought to a halt
11/29/06	Winter Storm	3	Federal Disaster Declaration; several carports at an apartment complex collapsed from the weight of the snow; \$539,000 in Public Assistance
01/12/07	Ice Storm	3	Federal Disaster Declaration; \$653,000 in Public Assistance damages
12/08/07	Ice Storm	5	Federal Emergency and Disaster Declarations; trees and powerlines down; Ashland, Hartsburg, Holts Summit lost power; schools and some businesses closed
02/11/08	Winter Weather	1	At least 130 accidents in Boone County - 35 injuries
01/26/09	Winter Storm	3	Disaster Declaration entire state
01/31/11	Winter Storm/Blizzard	2	Federal Emergency and Disaster Declarations; I-70 shut down (across most of state); region brought to standstill for a number of days; all schools closed; University of MO - Columbia closed for 3 days
02/21/13	Heavy Snow	1	Power outages
12/21/13	Ice Storm	1	Scattered power outages and travel problems
01/05/14	Winter Storm	1	All schools and most businesses were closed for at least 2 days; some schools remained closed longer due to cold temps and wind chills
2/4/2014	Winter Storm	1	Most schools in rural areas were closed for several days
Sources: http://www.ncdc.noaa.gov/stormevents/ ; http://www.fema.gov/disasters			

Potential Impact - Life

Many deaths and injuries from winter storms are a result of traffic accidents caused by a combination of poor driving surfaces and speeds too fast for the conditions. One death and 35 injuries from auto accidents were reported in the NOAA data (1996-2013) for the planning area during the period 1996-2013 (Figure 4.59). Accidents during winter storms can be particularly devastating because of multiple car involvement. Response times for emergency vehicles may also be slowed by poor road conditions.

Strenuous outdoor activity in extreme cold can also be life threatening. In March 1998, an 84-year old woman in Columbia died of a heart attack while shoveling snow (Figure 4.59). The elderly are especially vulnerable to excessive and/or prolonged cold or heat. The 2010 Census recorded 15,072 citizens (9.3% of the population) as 65 years and older in Boone County.

Potential Impact - Existing Structures

Much of the property damage that occurs from severe winter weather is due to some type of utility failure:

Power Lines - Ice storms often adversely impact consistent power supplies. Ice buildup on wires can cause them to fall; downed tree limbs can knock out power lines. Prolonged power outages can be a threat for those relying on electricity for heat. This is a particular concern for more vulnerable populations such as the elderly.

Water Lines - Winter storms and the associated cold weather can be problematic for water lines, especially if a rapid freeze/thaw cycle is involved. As the ground freezes and thaws, pipes can shift and sometimes break causing a lack of potable water. Broken pipes can cause extensive and expensive damage to property. Frozen and burst water pipes are a real concern for the homeowner; the pipes in many homes in the planning area were not insulated in the past to protect from the low temperatures currently experienced.

Severe winter weather is responsible for the most Presidential Disaster Declarations in the planning area. A review of the disaster declarations since 2002 gives an idea of the cost of the hazard to the built environment (Figure 4.60).

Figure 4.60

**Federal Emergency and Disaster Declarations for Severe Winter Weather
Boone County, Missouri 2002-2014**

Emergency (EM) or Disaster (DR) Declaration	Incident Period	Event Type	# of Counties	Public Assistance (PA) Grants*		Type of Assistance Provided in Boone County
				Emergency Work Categories A-B	Permanent Work Categories C-G	
DR-1403	1/29/02-2/13/02	Ice Storm	43 counties	\$34,013,640	\$9,715,547	IA (Individual Assistance)
DR-1673	11/30/06-12/2/06	Winter Storm	13 plus City of St. Louis	\$5,436,752	\$1,193,597	PA (A through G)
DR-1676	01/12/07	Ice Storm	38 plus City of St. Louis	\$50,424,684	\$55,998,359	PA (A through G)
EM-3281	12/6/07-12/15/07	Ice Storm	entire state	na	na	PA (A,B)
DR-1736		Severe Winter Storms	42 counties	\$17,434,937	\$7,315,054	PA (A through G)
EM-3303	1/26/2009-1/28/2009	Severe Winter Storm	entire state	na	na	PA (B)
EM-3317	1/31-2/5/2011	Severe Winter Storm	entire state	na	na	PA (B)
DR-1961		Storm and Snowstorm	62 counties	\$6,947,657	\$2,489,040	PA (A through G)
* Money obligated for all counties in disaster declaration						
Source: http://www.fema.gov/disasters						

SEMA Situation Reports give a fuller picture of the severe winter weather events in the first half of December 2007 and the effect in the planning area. An extensive ice storm and other severe winter weather resulted in both a Presidential Emergency Declaration and a Presidential Disaster Declaration. SEMA activated the State Emergency Operations Center and the Governor of Missouri declared a State Emergency which made state resources available to assist local governments.

The ice storm caused widespread power outages in Southern Boone County. About 200 power outages were addressed in the Ashland area; Hartsburg was without power. Shelter was made available in both Ashland and Hartsburg. A man was killed by a falling tree in Southern Boone County while cutting a tree down with a chainsaw.

These December storms resulted in \$24,749,991 in Public Assistance for the 42 counties involved in the Disaster Declaration. And earlier ice storm in January 2007 resulted in \$106,423,042 in Public Assistance for the 38 declared counties and the City of St. Louis. So in 2007 alone, there was over \$131 Million in Public Assistance to Missouri counties which suffered damages from severe winter weather.

Missouri State Hazard Mitigation Plan (2013) Analysis:

The *Missouri State Hazard Mitigation (2013)* analyzed data for all counties in the state to develop vulnerability ratings for Severe Winter Weather.

The following data was analyzed:

- National Climatic Data Center (NCDC) storm event data (1993 to December 2012)
- U.S. Census Data (2000)
- Total building exposure from HAZUS-MR4
- FEMA Public Assistance (PA) funds from Disasters #1672, #1736, #1748, #1822, and #1961
- Census of Agriculture 2007 (USDA)
- Crop Insurance Claims data (1998-2012) from the Risk Management Agency of the USDA
- Calculated Social Vulnerability Index (SoVI™) for Missouri Counties from the Hazards and Vulnerability Research Institute of the Geography Department at the University of South Carolina

The results for Boone County and its communities as a whole (the planning area) are shown in Figure 4.61.

Figure 4.61 Impact Assessment - Severe Winter Weather - Boone County					
Total Incidents 1993-2012	Housing Units/ sq. mile	Total Building Exposure (\$)	Total Property Loss (\$)	2007 Crop Exposure (\$)	Total Crop Insurance Paid (\$)
47	101.5	\$17,363,239,000	\$4,940,103	\$29,169,000	\$325,339
Source: <i>Missouri State Hazard Mitigation Plan (2013)</i>					

Each factor analyzed was given a vulnerability rating from 1 to 5 with 1 indicating Low Vulnerability and 5 indicating High Vulnerability and an overall Vulnerability Rating for Severe Winter Weather was determined. The results for Boone County are shown in Figure 4.62.

Figure 4.62 Vulnerability Analysis - Severe Winter Weather - Boone County							
Incident Likelihood Rating	Housing Density Rating	Property Loss Ratio Rating	Crop Exposure Rating	Crop Loss Ratio Rating	Social Vulnerability Index	Total Score and Vulnerability	Vulnerability Rating
4	2	1	3	3	1	14	Medium
Source: <i>Missouri State Hazard Mitigation Plan (2013)</i>							

The *Missouri State Hazard Mitigation Plan (2013)* analysis determined an overall Medium Vulnerability rating for Boone County in regards to Severe Winter Weather. However, the Property Loss Ratio rating was Low; this reflects relatively low property losses associated with Severe Winter Weather events (\$4,940,103) compared to a high value for Total Building Exposure (\$17,363,239,000).

The actual cost of structural damage associated with winter storm events is most probably higher than the data indicates. The data is a combination of the Public Assistance for Presidential Disaster Declaration events and NCDC data for undeclared events. It should be remembered that PA only covers uninsured losses; any individual private losses due to these winter storm events would not be recorded in this data. In addition, the NCDC data is based on early estimates and local knowledge indicates that the NCDC data does not contain significant losses associated with many events.

Potential Impact - Future Development

The rapid growth in the planning area, especially in and around the cities of Ashland and Columbia is increasing the vulnerability to severe winter weather. As utility and infrastructure increases, so does the vulnerability to this hazard.

Existing Mitigation Activities

Shelters: The planning area is well prepared with Red Cross certified shelters (Figures 3.11-3.13).

The Office of Emergency Management is proactive in alerting the public to the dangers of winter storms. The Emergency Operations Procedures (EOP) includes a snowplowing plan whereby streets critical for emergency procedures are cleared as a first priority.

Utility Companies: The Boone County Electric Cooperative, City of Centralia, and City of Columbia Water and Light Department have policies regarding tree trimming and brush removal around power lines. Consistent maintenance of trees and brush around utility lines limits the possibility of power outages during a severe winter storm. Maintenance also makes financial sense because repairing fallen utility lines and poles is costly and dangerous.

National Weather Service and Local Media: The St. Louis Office of the National Weather Service coordinates with local jurisdictions and media outlets to disperse information regarding severe winter storm watches and warnings. Early warning allows the public to prepare for a severe storm. Should a storm reach catastrophic proportions and officials need to communicate directly with the public, the Emergency Alert System exists to spread that information.

The National Weather Service sets up winter weather warnings in stages of severity. These stages are shown in Figure 4.63.

Figure 4.63

National Weather Service Winter Warnings	
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.
Winter Storm Watch	Severe winter conditions, such as heavy snow and/or ice, are possible within the next day or two.
Winter Storm Warning	Severe winter conditions have begun or are about to begin in your area.
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.

SUMMARY OF VULNERABILITY

Severe winter weather is one of the most common and costly natural hazards to affect the planning area; it has been responsible for three federal Emergency Disaster Declarations and five Presidential Disaster Declarations for Boone County since 2002. In addition, climate data indicates that winter storms are increasing due to changes in the climate. All participating jurisdictions are vulnerable to this hazard.

Some of the worst problems from severe winter weather occur when ice storms affect the area; widespread and lengthy power outages can occur. In addition, traffic accidents are a major source of injuries during severe winter weather.

The planning area has numerous mitigation activities in place which help mitigate the hazards associated with severe winter weather: active tree trimming programs to protect power lines; excellent media coverage of winter weather advisories and warnings; a snowplowing plan whereby streets critical for emergency procedures receive first priority; and abundant Red Cross certified shelters.

4.9 DROUGHT

DESCRIPTION OF HAZARD

The National Weather Service defines a drought as “a period of abnormally dry weather which persists long enough to produce a serious hydrologic imbalance (for example crop damage, water supply shortage, etc.) The severity of the drought depends upon the degree of moisture deficiency, and the duration and the size of the affected area.”

Droughts occur either through a lack of precipitation (supply droughts) or through overuse of water which outpaces what the surrounding environment can naturally support (water use droughts). Water use droughts can theoretically happen anywhere but are generally seen in arid climates, not humid places such as Missouri. At the present time, Missouri is most vulnerable to supply droughts brought on by a lack of precipitation.

The period of lack of precipitation needed to produce a supply drought will vary between regions and the particular manifestations of a drought are influenced by many factors. As an aid to analysis and discussion, the research literature has defined different categories of drought (Figure 4.64). The most common type of drought in Mid-Missouri is the agricultural drought.

Figure 4.64	
Drought Categories	
Agricultural	Defined by soil moisture deficiencies
Hydrological	Defined by declining surface and groundwater supplies
Meteorological	Defined by precipitation deficiencies
Hydrological and land use	Defined as meteorological drought in one area that has hydrological impacts in another area
Socioeconomic	Defined as drought impacting supply and demand of some economic commodity
Source: <i>Missouri Drought Plan, 2002</i> (Mo DNR)	

Location

The entire planning area is potentially at risk for drought. However, since agricultural drought is most common in Missouri, the unincorporated agricultural areas of Boone County are most at risk. Drought can mean crop failure in these areas and the resulting immediate, and potentially severe, economic loss.

Extent

Numerous indices have been developed to measure drought severity; each tool has its strengths and weaknesses.

Palmer Drought Severity Index: One of the oldest and most widely used indices is the Palmer Drought Severity Index (PDSI, Figure 4.65), which is published jointly by NOAA and the U.S. Department of Agriculture (USDA).

Figure 4.65 Palmer Drought Severity Index (PDSI)			
Score	Description	Score	Description
Greater than 4	Extreme moist spell	0 to -0.4	Near normal conditions
3.0 to 3.9	Very moist spell	-0.5 to -0.9	Incipient drought
2.0 to 2.9	Unusual moist spell	-1.0 to -1.9	Mild drought
1.0 to 1.9	Moist spell	-2.0 to -2.9	Moderate drought
0.5 to 0.9	Incipient moist spell	-3.0 to -3.9	Severe drought
0.4 to 0	Near normal conditions	Below -4.0	Extreme drought

According to the National Integrated Drought Information System (NIDIS), the PDSI “...uses temperature and precipitation data to calculate water supply and demand, incorporates soil moisture, and is considered most effective for unirrigated cropland. It primarily reflects long-term drought and has been used extensively to initiate drought relief.”

Missouri is divided into six regions of similar climactic conditions for PDSI reporting; Boone County is located in the Northeast Region.

Standardized Precipitation Index: A newer index currently being used by The National Drought Mitigation Center (NDMC) is the Standardized Precipitation Index (SPI). This index is based on the probability of precipitation; the time scale used in the probability estimates can be varied and makes the tool very flexible. The SPI is able to identify emerging droughts months sooner than is possible with the PDSI.

The NDMC uses the PDSI, SPI, and three other indicators to classify the severity of droughts throughout the country on a 5-point scale ranging from DO Abnormally Dry to D4 Exceptional Drought for reports on the U.S. Drought Monitor (Figure 4.66).

Figure 4.66

U.S. Drought Monitor - Drought Severity Classification

Category	Description	Ranges					
		Possible Impacts	Palmer Drought Index	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Short and Long-term Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	21-30
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	11-20
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	6-10
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	3-5
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less	0-2	0-2	-2.0 or less	0-2

Source: <http://droughtmonitor.unl.edu>

Based on the Drought Severity Classification from the NDMC, Boone County is subject to droughts ranging from D1 (Moderate Drought) to D4 (Exceptional Drought). The most common droughts are in the D1-D2 range.

Based on data from 2000-2013, the average drought in the planning area lasts 4.4 months.

Due to its central location in the state and southern border defined by the Missouri River, the extent of drought varies in different parts of Boone County. The Missouri Department of Natural Resources has defined different regions of drought susceptibility in the *Missouri Drought Plan, 2002* (Figure 4.67).

Figure 4.67



As can be seen by the map, the northwestern part of Boone County is in Region C and shares characteristics with the northern and western parts of the state which have the highest susceptibility to drought. The southern part of Boone County along the Missouri River has only a slight susceptibility to drought.

More specific information for all three regions is shown in Figure 4.68.

Figure 4.68 Missouri Drought Susceptibility Regions		
Region	Description	Location in planning area
A	“...minor surface and groundwater supply drought susceptibility. It is a region underlain by saturated sands and gravels (alluvial deposits). Surface and groundwater resources are generally adequate for domestic, municipal, and agricultural needs.”	Southern Boone County area bordering the Missouri River
B	“...moderate drought susceptibility. Groundwater resources are adequate to meet domestic and municipal water needs, but due to required well depths, irrigation wells are very expensive. The topography generally is unsuitable for row-crop irrigation.”	Majority of the planning area
C	“...severe drought vulnerability. Surface water resources usually become inadequate during extended drought. Groundwater resources are normally poor, and typically supply enough water only for domestic needs. Irrigation is generally not feasible. When irrigation is practical, groundwater withdrawal may affect other uses. Surface water sources are used to supplement irrigation supplied by groundwater sources.”	Northwest Boone County
Source: <i>Missouri Drought Plan, 2002</i>		

Previous Occurrences

The Dust Bowl years of the 1930s and early 1940s were dry in Missouri but not as dry as the period 1953-57. A major nationwide drought in the late 1980s resulted in low water and decreased barge traffic on the Mississippi and Missouri Rivers. The fall of 1999 was another serious drought period in the state; in October of that year, all counties in Missouri were declared agricultural disaster areas by the USDA.

Information for droughts since the year 2000 is available online via weekly maps prepared by the U.S. Drought Monitor. Drought events for Boone County, and information about their severity, are shown in Figure 4.69. The drought which affected the entire state beginning in the summer 2012 was the worst drought in 30 years, according to the *MO State Hazard Mitigation Plan (2013)*.

Figure 4.69**Drought in Boone County 2000-2014**

Year(s)	Months	Duration (months)	Highest Severity	Details
2000	Jan.-June	6	D2	Moderate Drought (D1) in January through March turned into Severe Drought (D2) in April and May; by the end of June, conditions were back to Abnormally Dry (D0).
2002-2003	Oct-April	7	D1	Moderate Drought (D1) conditions from October through April.
2003	August	1	D3	Abnormally Dry (D0) conditions in July turned into Extreme Drought (D3) by August. By September, conditions were back to Abnormally Dry (D0).
2005	June-Sept.	4	D3	Abnormally Dry (D0) and Moderate Drought (D1) conditions in June turned into Extreme Drought (D3) by July. Boone County was put in Phase 3 (Conservation Phase) in July. Extreme Drought continued through the first two weeks of August. All 114 MO counties and the City of St. Louis were designated as natural disasters for physical and/or production loss loan assistance from the Farm Service Agency (FSA) in August. By the beginning of September only the eastern part of the County was still experiencing (Moderate) drought (D1).
2006	March-June	4	D2	Moderate Drought (D1) conditions February through mid-June with a week of Severe Drought (D2) in April.
2006	Aug.-Nov.	4	D2	Moderate Drought (D1) returned in July and continued through November. The County was upgraded to Severe Drought (D2) for most of the month of August. In October, the County was among 85 MO Counties designated by the USDA as primary natural disaster areas due to losses from drought conditions. In November, the County was put in Phase 3 (Conservation Phase).
2011	November	1	D1	Northern Boone County experienced a Moderate Drought (D1) in November.
2012-2013	June-March	10	D4	Moderate Drought (D1) conditions in June turned into an Extreme Drought (D3) by mid-July. By August, the western and central parts of the County were experiencing Exceptional Drought (D4). Rainfall from Hurricane Isaac in September helped ease drought conditions somewhat; by the end of the month, most of the county had been lowered to Severe (D2) status with a strip across the central part of the County still experiencing Extreme (D3) drought. Severe (D2) to Moderate (D1) Drought conditions persisted through February. By Mid-March, the drought was over although Abnormally Dry (D0) conditions persisted for a few more weeks.
2013	Aug.-Oct.	3	D1	Northern Boone County was in a Moderate Drought (D1) from late August through October. Abnormally Dry (D0) conditions persisted throughout the County through November.
2014	March	1	D1	By mid-March, southern Boone County had moved into Moderate Drought (D1) which lasted through the end of the month.
Sources: http://droughtmonitor.unl.edu ; http://www.ncdc.noaa.gov/stormevents (Data complete through year 2014.)				

Probability of Future Events – High for all participating jurisdictions

In the 15-year period 2000-2014, there were 6 years without any level of drought in the planning area, according to the U.S. Drought Monitor. Based on this data, the calculated probability of having at least a Moderate (D1) drought in some month of the year is 60%. (Probability calculation: $1 - (6/15) = .60$)

The probability of occurrence of the different drought severities in any given year, based on the 2000-2014 data, has also been calculated (Figure 4.70).

Figure 4.70				
Probability of Future Drought Events				
Severity Scale	Drought Description	# of years with drought event (2000-2014)	Probability	Probability Rating
D1	Moderate	5	36%	High
D2	Severe	2	14%	High
D3	Extreme	2	14%	High
D4	Exceptional	1	7%	High

ANALYSIS OF RISK

Severity

Moderate – Boone County (unincorporated)

Low - all other participating jurisdictions

The primary affect of drought in the planning area is on the economic livelihood of those in the agricultural sector. According to the *2012 US Census of Agriculture*, 54.9% of Boone County land use is tied to farming activities. In 2012 the market value of Boone County farm products was estimated at \$52.2 Million.

Information on claims paid for crop damage due to drought is shown in Figure 4.71.

Figure 4.71 Crops and Drought Insurance - Boone County 1998-2012			
Total Insurance Claims Paid for Drought Damage	Annualized Claims for Drought Damage	Crop Exposure (2007 Census of Agriculture)	Annual Crop Claims Ratio
\$12,258,483	\$817,232	\$29,169,000	2.80%
Source: <i>Missouri State Hazard Mitigation Plan (2013)</i>			

Both crops and livestock are at risk from drought. During the Exceptional Drought conditions in 2012, there were large sell-offs of livestock in some counties surrounding the planning area.

Potential Impact – Life

While drought itself does not have a direct affect on human health or life, its impacts can indirectly cause damage to health. The psychological and economic stresses involved for those working directly in the agricultural sector can be great in times of drought. Uncertainty, high stress and fear are not compatible with optimal health.

Potential Impact - Existing Structures

Excessive drought can cause damage to roads, streets, water mains, and building foundations. This is especially true in the Claypan Till Plains area (Figure 2.3) which includes the jurisdictions of Ashland, Centralia, Hallsville, Sturgeon and eastern portions of Columbia. The clay soils expand and contract to a high degree depending on moisture or lack thereof; this soil movement can cause structural movement, settlement, and breaks. During the drought of 2012, local media carried stories encouraging homeowners to water their foundations.

The arid conditions created by drought also pose an increased risk of fire and wildfire.

Drought can also have far reaching economic consequences beyond the agricultural sector; businesses dependent upon that sector can also suffer serious losses. A severe drought can affect the economics of an entire region.

Potential Impact - Future Development

Drought is primarily an issue of water supply for the rural and agricultural parts of the planning area. Almost 55% of the land in Boone County is agricultural and agriculture plays an important role in the life and economy of the area. This makes drought mitigation an especially important concern as population increases.

Boone County experienced 20% population growth between 2000 and 2010, according to the U.S. Census. This growth rate is far above the Missouri state average (7%). However, census data indicates that almost all of this growth occurred in the incorporated cities. There was only a 1% growth rate in unincorporated Boone County, the area most affected by drought.

Were there to be a large increase in growth in the rural areas of the county, the interconnection of water supplies and good land management techniques would become increasingly important in mitigating the impacts of drought.

Existing Mitigation Activities

Drought Insurance:

Data from the USDA Risk Management Agency's 2011 Missouri Crop Insurance Profile indicates that 81.2% of crops in Missouri were insured for drought damage in 2011. An assumption could be made that the percentage of insured crops in the planning area is at least that high, if not higher, due to the importance of agriculture in the planning area.

University of Missouri Extension has a number of publications for both farmers and homeowners to help mitigate the effects of drought. They are available at:
<http://extension.missouri.edu/main/DisplayCategory.aspx?C=257>

The Missouri Department of Natural Resources (MoDNR): *The Revised Statutes of Missouri* (RSMo 640.415) require that the MoDNR "...ensure that the quality and quantity of the water resources of the state are maintained at the highest level practicable to support present and future beneficial uses. The department shall inventory, monitor and protect the available water resources in order to maintain water quality, protect the public health, safety and general and economic welfare."

MoDNR has a drought response system based on the PDSI and has four phases of increasing severity:

- Phase 1: Advisory Phase - Water monitoring analysis indicates anticipated drought.
- Phase 2: Drought Alert - PDSI reads -10 to -20; and stream flow, reservoir levels and groundwater levels are below normal over a period of several months.
- Phase 3: Conservation Phase - PDSI reads between -2 to -4; stream flow, reservoir levels and groundwater levels continue to decline; and forecasts indicate an extended period of below-normal precipitation.
- Phase 4: Drought Emergency - PSDI reads lower than -4.

MoDNR also publishes the weekly Missouri map from The Drought Monitor on their website at:
<http://www.dnr.mo.gov/env/wrc/drought/nationalcondition.htm>.

The Drought Monitor is a comprehensive drought monitoring effort involving numerous federal agencies, state climatologists, and the National Drought Mitigation Center. It is located at the National Drought Mitigation Center in Lincoln, Nebraska. The new Drought Monitor Map, based on analysis of data collected, is released weekly on Thursday at 8:30 a.m. Eastern Time. The map focuses on broad-scale conditions and is linked to the data sets analyzed.

The National Drought Mitigation Center (NDMC) is located at the University of Nebraska-Lincoln. The following is a description of their activities from their website (drought.unl.edu/):

“The National Drought Mitigation Center (NDMC) helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management. Most of the NDMC’s services are directed to state, federal, regional, and tribal governments that are involved in drought and water supply planning....The NDMC’s activities include maintaining an information clearinghouse and drought portal; drought monitoring, including participation in the preparation of the U.S. Drought Monitor and maintenance of the web site (drought.unl.edu/dm); drought planning and mitigation; drought policy; advising policy makers; collaborative research; K-12 outreach; workshops for federal, state, and foreign governments and international organizations; organizing and conducting seminars, workshops, and conferences; and providing data to and answering questions for the media and the general public.”

USDA Farm Service Agency (FSA) Low –interest emergency loans are available in USDA designated natural disaster areas.

SUMMARY OF VULNERABILITY

Drought of some degree is a common occurrence in the planning area. The unincorporated agricultural areas of Boone County are the most vulnerable but all jurisdictions are potentially vulnerable to both direct structural damage and cascading economic effects during extended and serious drought conditions.

Based on recent data (2000-2103), the most common drought in the planning area is a Moderate Drought (D1); the average drought during this period lasted 4.4 months. Droughts in the planning area can be more severe and long-lasting, however. An extended nine month drought in 2012-2013 was rated D4 (Exceptional Drought) at its severest point.

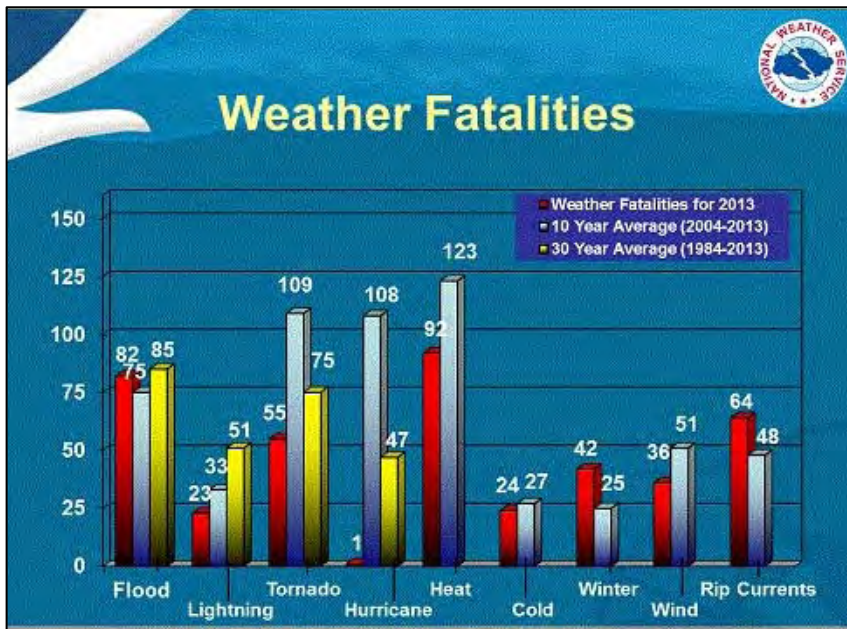
Drought conditions are carefully monitored at the state and national levels; state law requires the Missouri Department of Natural Resources to implement a drought response system to ensure the quantity and quality of available water resources.

4.10 EXTREME HEAT

DESCRIPTION OF HAZARD

Extreme heat is the number one weather-related killer in the United States, according to the National Weather Service (Figure 4.72). In contrast to the visible, destructive, and violent nature of floods, hurricanes, and tornadoes, extreme heat is a silent killer.

Figure 4.72



As can be seen in the NWS graph, there are no 30-year averages for heat fatalities or a number of other weather-related fatalities. Fatality data on these hazards began to be recorded more recently than fatalities from the more dramatic causes of death such as flood, lightning, tornado, and hurricane.

As the data shows, extreme heat resulted in an average of 92 deaths per year when looked at

over a 10-year period; this is 10 more deaths per year than the number cause by flood, the next most frequent cause of death.

Location

The entire planning area is at risk from extreme heat events.

Extent

The planning area routinely experiences prolonged periods with temperatures in the 90s and 100s (Figure 4.73). The duration of these periods of extreme heat can range from just one day to weeks. During the period 2007-2014, the average length of an extreme heat event was 6 days.

Previous Occurrences

Figure 4.73 Periods of Extreme Heat in Boone County, 2007-2014					
Date	Air Temp	Heat Index	Deaths*	Injuries*	Length (days)
08/05/07	100-103	na	8	1300+	12
06/21/09	90s	100 -107	0	0	7
06/18/10	mid 90s	100 -105	0	0	6
07/14/10	100 - 103	na	8	941	3
07/17/10	mid-90s	105	0	13	1
07/22/10	mid-upper 90s	105 -110	0	23	3
08/02/10	100 -102	110	0	13	3
08/08/10	upper 90s - 100	110 -115	2	85	7
07/17/11	lower 90s - 100	105 -115	8	100+	18
06/27/12	100 -109	very dry air	19	212	11
07/16/12	100 -106	102 -108	1	53	4
07/22/12	up to 108	up to 110	0	75	6
07/31/12	105	105-110	0	6	2
Total Deaths/Injuries and Average Length			46	2821+	6
* Deaths and injuries are for entire area in MO affected by extreme heat event.					
Source: www.ncdc.noaa.gov/stormevents/ (Available data as of 10/31/2014)					

In recent years, there have been some notable periods of extreme heat and new temperature records set in the planning area:

- 2007 - Over 100 on six days in August (Columbia)
- 2007 - New record for August 16th of 103 degrees (Columbia)
- 2011 - New record for August 2nd of 108 degrees (Columbia)
- 2012 - Over 100 degrees from June 27-July 7 (Columbia)

Probability of Future Events – High for all participating jurisdictions

NOAA data dating back to 1994 indicates only 5 years without extreme heat events (1996, 1997, 2008, 2013 and 2014). In most years during that period, there were multiple extreme heat events. Based on this historical data, the calculated probability of an extreme heat event in any year is 76%. (Probability calculation: $1 - (5/21) = .76$)

ANALYSIS OF RISK

Measure of Severity - Moderate for all participating jurisdictions

Potential Impact – Life

Heat kills by overloading a body's capacity to cool itself. The human body cools itself by perspiring; the evaporation of perspiration carries excess heat from the body. High humidity often accompanies heat in Missouri and increases the danger to warm-blooded humans and animals. High humidity makes it difficult for perspiration to evaporate and thus interferes with this natural cooling mechanism.

The Heat Index devised by the NWS (Figure 4.74) is a measure of how hot it really feels. The Heat Index takes into account both air temperature and relative humidity. It also gives an indication of the added risk presented by high humidity to bodies attempting to cool.

Figure 4.74

		HEAT INDEX												
		Relative Humidity (%)												
Air Temperature (°F)		40	45	50	55	60	65	70	75	80	85	90	95	100
	110°	136												
	108°	130	137											
	106°	124	130	137										
	104°	119	124	131	137									
	102°	114	119	124	130	137								
	100°	109	114	118	124	129	136							
	98°	105	109	113	117	123	128	134						
	96°	101	104	108	112	116	121	126	132					
	94°	97	100	102	106	110	114	119	124	129	135			
	92°	94	96	99	101	105	108	112	116	121	126	131		
	90°	91	93	95	97	100	103	106	109	113	117	122	127	132
	88°	88	89	91	93	95	98	100	103	106	110	113	117	121
	86°	85	87	88	89	91	93	95	97	100	102	105	108	112
	84°	83	84	85	86	88	89	90	92	94	96	98	100	103
	82°	81	82	83	84	84	85	86	88	89	90	91	93	95
	80°	80	80	81	81	82	82	83	84	84	85	86	86	87

Source: <http://www.nws.noaa.gov/om/heat/index.shtml>

Since 2009, there have been 38 deaths and over 3,703 injuries in Missouri from the extreme heat events affecting the planning area. The recorded deaths and injuries occurred in St. Louis and St. Louis County.

While these most recent deaths and injuries took place in a major metropolitan area, research shows that residents of both urban and rural areas are vulnerable to excessive heat. Data from the MO Department of Health and Senior Services (DHSS) indicates that 39% of the 214 deaths in the state from extreme heat in the years 2000-2009 occurred outside of the counties of the two major metropolitan areas (Kansas City and St. Louis). This percentage correlates fairly closely

with the percentage of the population residing outside those metropolitan areas, according to the 2010 U.S. Census. It cannot be said that extreme heat is a concern only for major cities.

Many factors, such as age, general level of health, outdoor activity level, alcohol and drug consumption, and availability of air conditioning, affect the actual risk level. The elderly in general are vulnerable to the effects of extreme and/or prolonged heat; the 2010 Census recorded 15,072 citizens in Boone County (9.3% of the population) as 65 years and older. However, any residents without access to air conditioning, or shade and water if outside, are very vulnerable to this hazard. One known death occurred in the planning area in August 2002 when a 59 year old Boone County man died from heat exhaustion after collapsing while doing yard work.

Extreme heat events can also result in livestock deaths and fish kills; drought in conjunction with extreme heat exacerbates the situation.

Potential Impact - Existing Structures

While illness and loss of life are of the most concern with extreme heat, structural impacts may also occur. Structural impacts depend on the length of the period of extreme heat and exacerbating factors such as concurrent drought. Road damage and electrical infrastructure damage may occur with intense and prolonged heat.

Potential Impact - Future Development

Thoughtful future development has the potential to include mitigation for extreme heat in its design. This is true on all levels ranging from actions by individual homeowners to larger redevelopment projects planned by cities. Properly placed shade trees can contribute greatly to lowering inside temperatures and the load placed on cooling systems. Planning for adequate green space as cities infill allows for air movement and shaded locations.

Existing Mitigation Activities

The following locations in Columbia are used as cooling centers during business hours:

- Activity & Recreation Center (ARC)
- Armory Sports and Community Center
- Boone County Government Center
- Columbia/Boone County Health Department
- Columbia Public Library
- Salvation Army
- Salvation Army Harbor House
- St. Francis House

The following departments, agencies, and organizations all are involved in educating the public about the dangers of extremely hot weather and/ or issuing alerts when the threat of extreme heat is imminent:

The Boone County/City of Columbia Health Department alerts the public on the dangers of extreme heat.

The Missouri State High School Activities Association (MSHSAA) provides coaches with educational pamphlets on the dangers of excessive heat.

The Missouri Department of Health and Senior Services announces statewide hot weather health alerts according to the following criteria:

Hot Weather Health Alert – Heat indices of 105°F in a large portion of the state are first reached (or predicted)

Hot Weather Health Warning – Heat indices have been 105°F or more for two days in a large portion of the state, or weather forecasts call for continued heat stress conditions for at least 24 to 48 hours over a large portion of the state.

Hot Weather Health Emergency – When extensive areas of the state meet all of the following criteria:

- High sustained level of heat stress (Heat Index of 105°F for 3 days)
- Increased numbers of heat-related illnesses and deaths statewide
- The NWS predicts hot, humid temperatures for the next several days for a large portion of the state.

The National Weather Service (NWS) has devised a method to warn of advancing heat waves up to seven days in advance. The new Mean Heat Index is a measure of how hot the temperatures actually feel to a person over the course of a full 24 hours. It differs from the traditional Heat Index in that it is an average of the Heat Index from the hottest and coldest times of each day.

The National Weather Service initiates alert procedures when the Heat Index is expected to exceed 105°- 110°F for at least two consecutive days. (The exact Heat Index temperature used depends on specifics of the local climate.) The following are released to the media and over NOAA All-Hazard Weather Radio:

- Heat Index values are included in zone and city forecasts.
- Special Weather Statements and/or Public Information Statements are issued which present a detailed discussion of the Heat Index Values, who is most at risk, and safety rules for reducing risk.
- In severe heat waves, State and local health officials are assisted in preparing Civil Emergency Messages which include Special Weather Statements and more detailed medical information, advice, and names and telephone numbers of health officials.

Weather Forecast Offices of the National Weather Service (NWS) can issue the following warnings about excessive heat:

Excessive Heat Outlook: Potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

Excessive Heat Watch: Conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

Excessive Heat Warning/Advisory: An excessive heat event is expected in the next 36 hours. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

SUMMARY OF VULNERABILITY

All jurisdictions are vulnerable to the effects of extreme heat. Extreme heat is already responsible for more weather-related deaths than any other hazard in the country; it is also one of the hazards shown to be increasing with changes in the climate.

Heat stroke and loss of life are the most significant consequences of extreme heat. While heat-related illness and death can occur due to exposure to intense heat in just one afternoon, heat stress on the body has a cumulative effect. The persistence of a heat wave increases the danger.

The elderly in general are vulnerable to the effects of extreme and/or prolonged heat; the 2010 Census recorded 15,072 citizens in Boone County (9.3% of the population) as 65 years and older. However, any residents without access to air conditioning, or shade and water if outside, are very vulnerable to this hazard.

The City of Columbia, the major population center in the planning area, is well equipped with cooling centers to help protect those most vulnerable. Warnings regarding the dangers of extreme heat are widely broadcast during times of threat.

In addition to the human toll, prolonged extreme heat can result in livestock deaths, fish kills, and infrastructure damage; drought in conjunction with extreme heat exacerbates the situation.

4.11 WILDFIRE

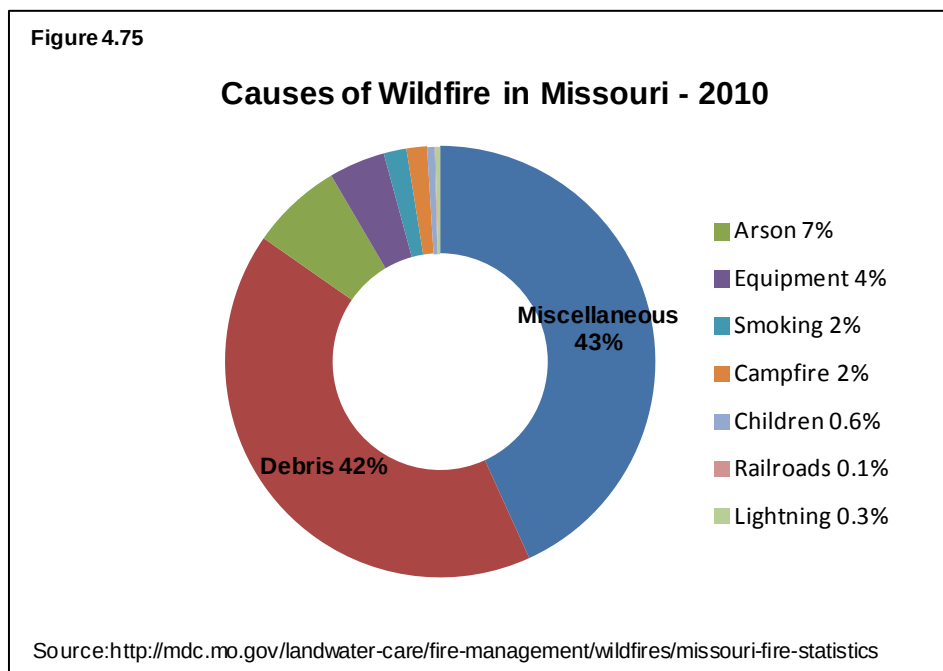
DESCRIPTION OF HAZARD

Large and widespread wildfires, such as occur in the western United States, have not been a problem in Boone County in recent history. However, smaller wildfires/natural cover fires occur every year.

These fires may take place at any time of the year but the majority occur during the spring fire season (February 15 - May 10). Spring is the time of the year when rural residents burn garden spots and brush piles. Many landowners also believe it is necessary to burn the woods in the spring to grow more grass, kill ticks, and get rid of brush. These factors, combined with low humidity and high winds, result in higher fire danger at this time of year. The spring fire season abates with the growth of the new season's grasses and other green vegetation.

Numerous fires also occur in October and November due to the dryness associated with fall in Missouri. Many rural residents use this time of year to burn leaves and debris thus raising the possibility of a fire which burns out of control.

The major causes of wildfires in Missouri are various human activities, according to statistics from the Missouri Department of Conservation (Figure 4.75).



Location

The rural areas of Boone County are most at risk from wildfires because that is where the primary causative factor, debris burning, is most common.

In addition to the risk faced by rural areas, there is an increased risk of wildfire in areas called the Wildland Urban Interface (WUI). The National Wildfire Coordinating Group (NWCG) defines the WUI as "...the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuel."

Within the WUI there are three defined Community types vulnerable to Wildfire:

Interface Community - Structures directly abut wildland fuels. There is a clear line of demarcation between wildland fuels and residential, business, and public structures. Wildland fuels do not generally continue into the developed area. The development density for an interface community is usually three or more structures per acre, with shared municipal services.

Intermix Community - Structures are scattered throughout a wildland area. There is no clear line of demarcation; wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to one structure per 40 acres.

Occluded Community - Often found within a city, structures abut an island of wildland fuels (e.g. park or open space). There is a clear line of demarcation between structures and wildland fuels. The development density is usually similar to those found in the interface community, but the occluded area is usually less than 1,000 acres in size.

An overview of the WUI for the planning area is shown in Figure 4.76. Columbia, Harrisburg, Hartsburg, and Rocheport all incorporate significant areas of medium or high density wildland interface and/or intermix (Figures 4.76-4.80). Huntsdale incorporates only a small portion of medium density intermix (Figure 4.81).

Figure 4.76

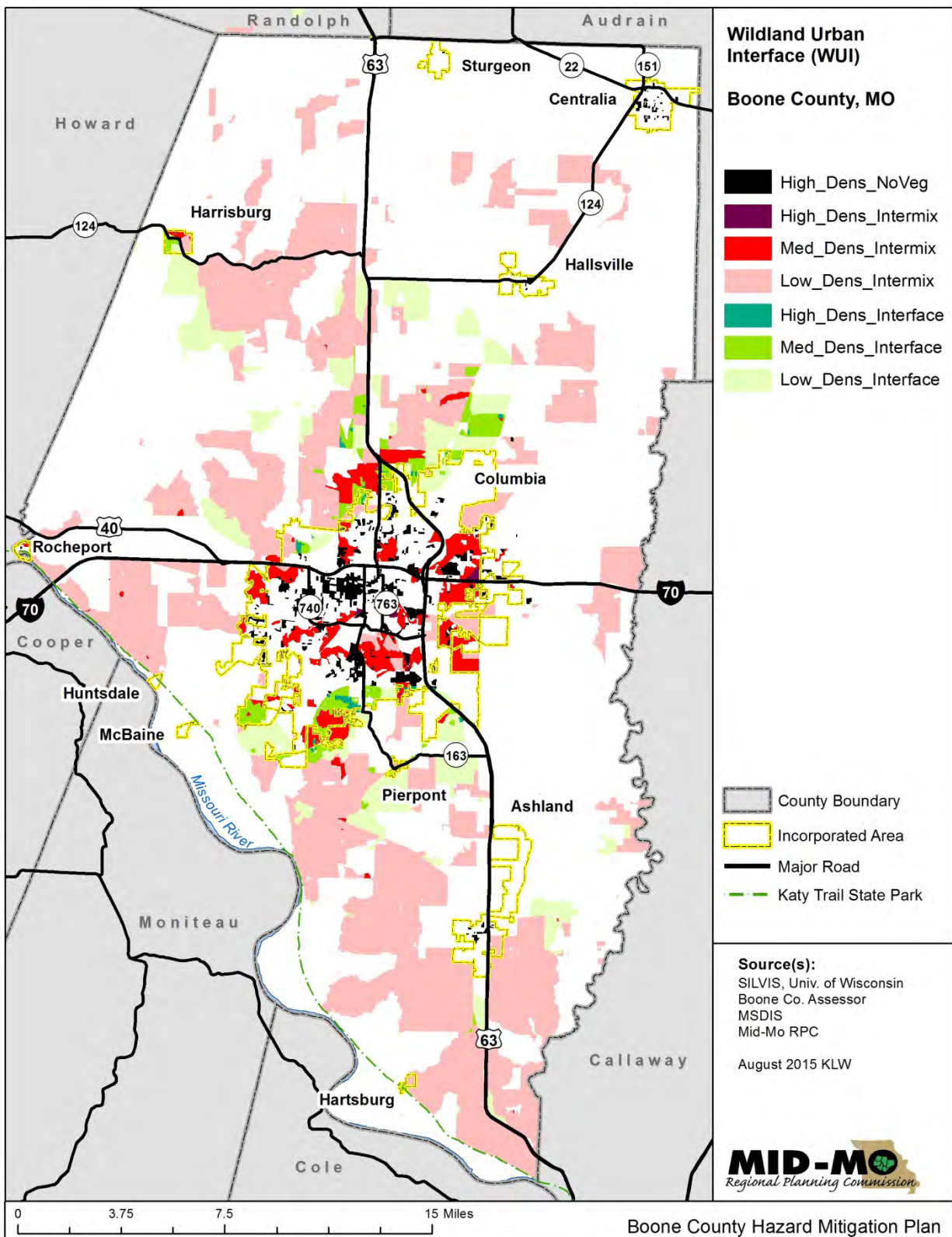


Figure 4.77

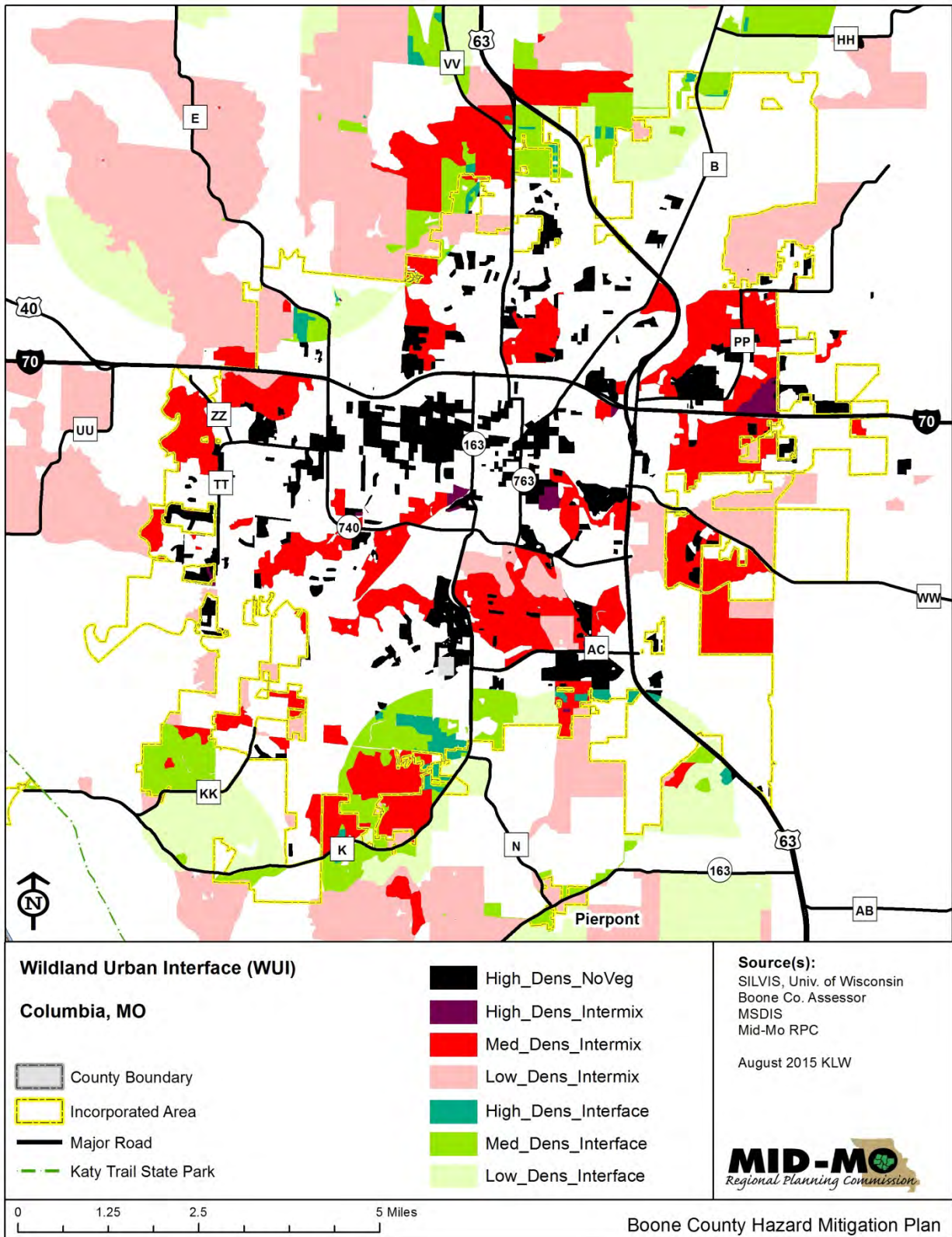


Figure 4.78

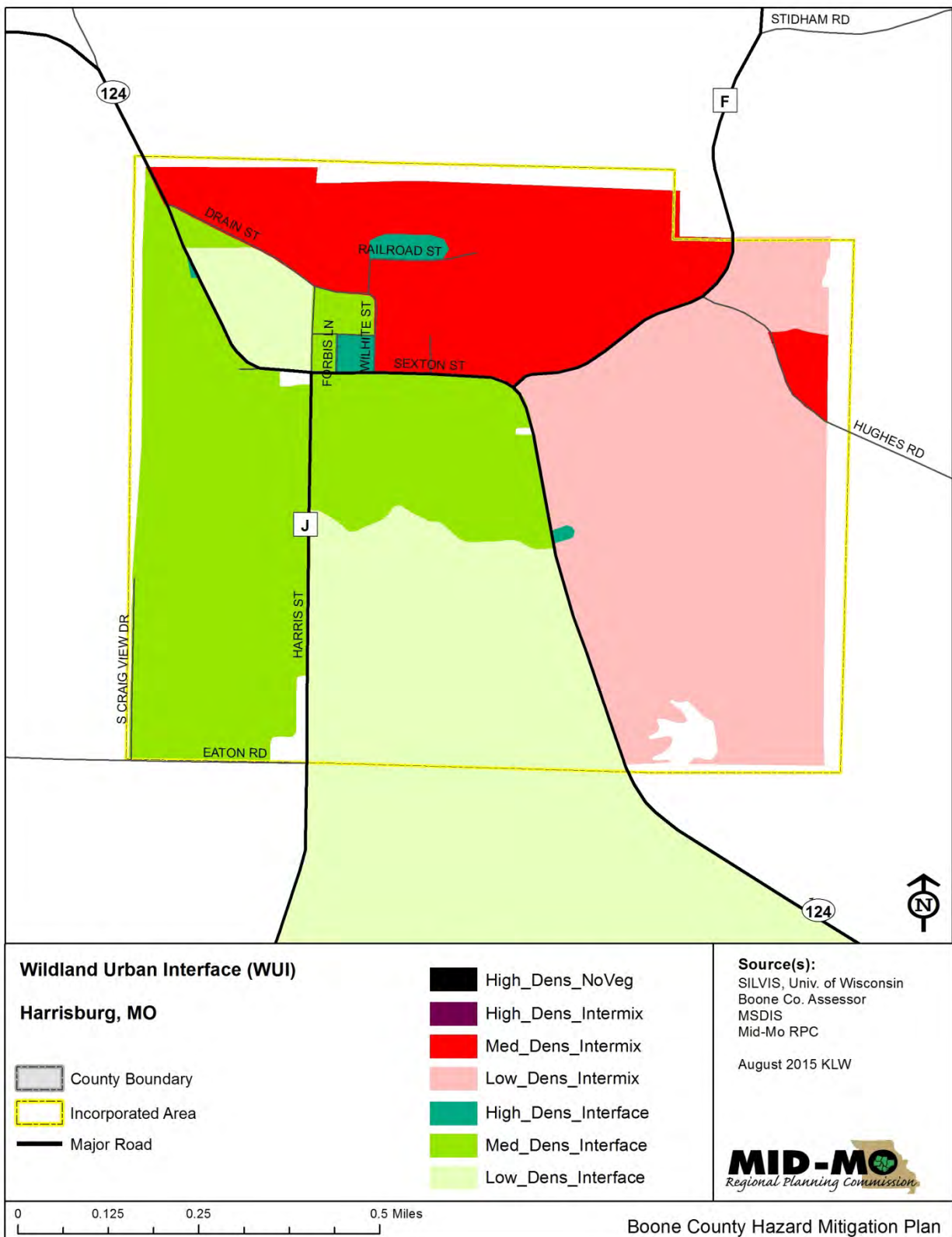


Figure 4.79

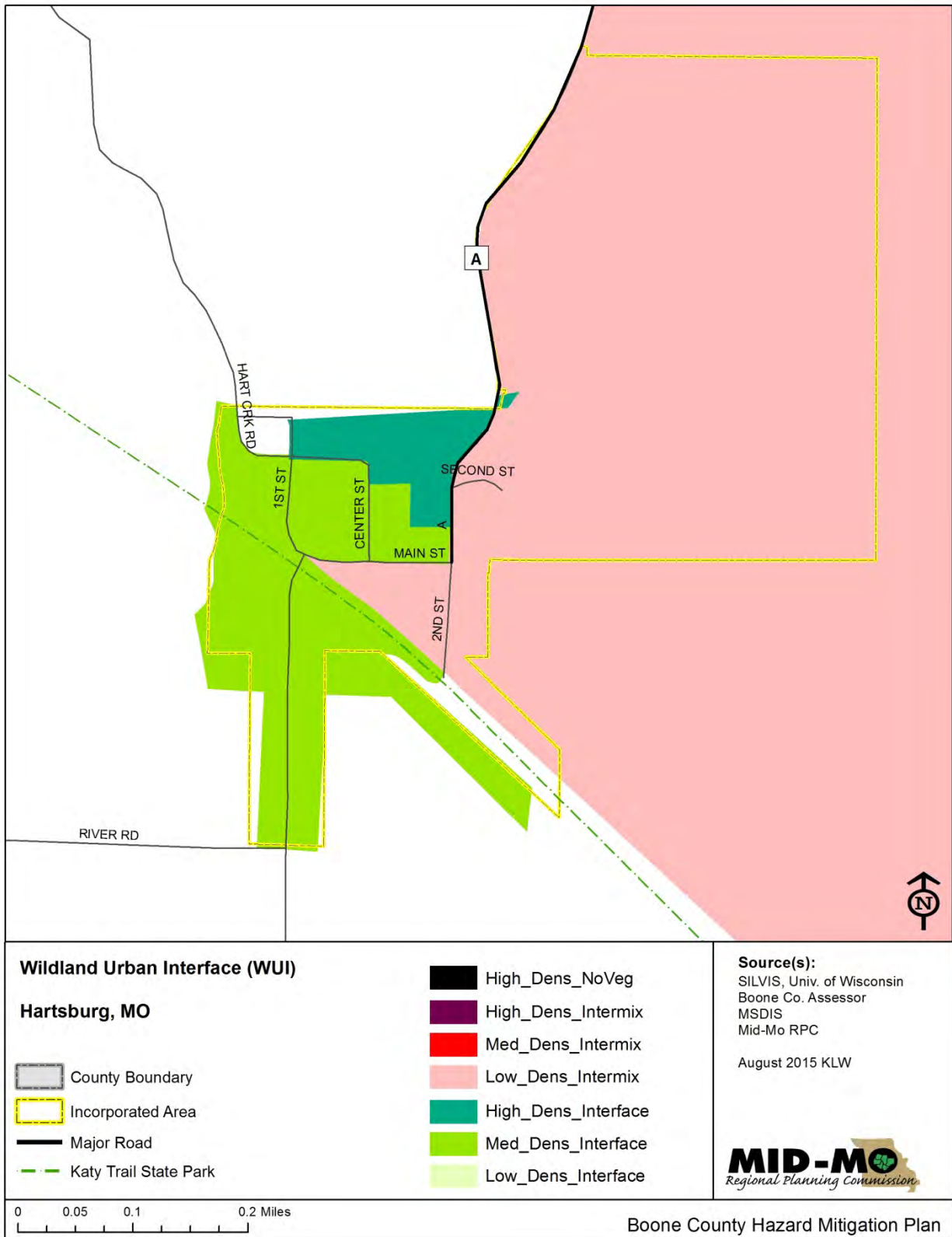


Figure 4.80

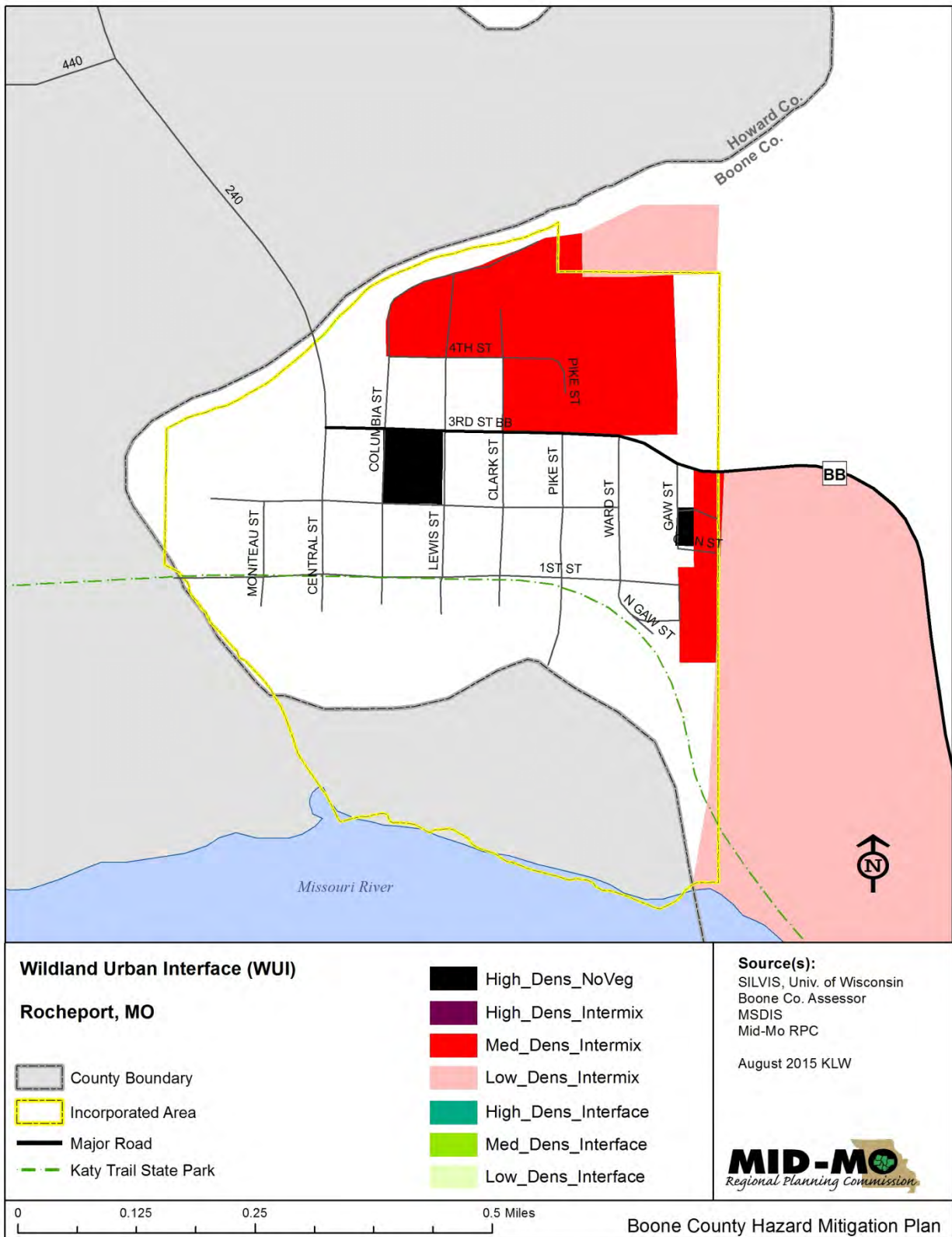
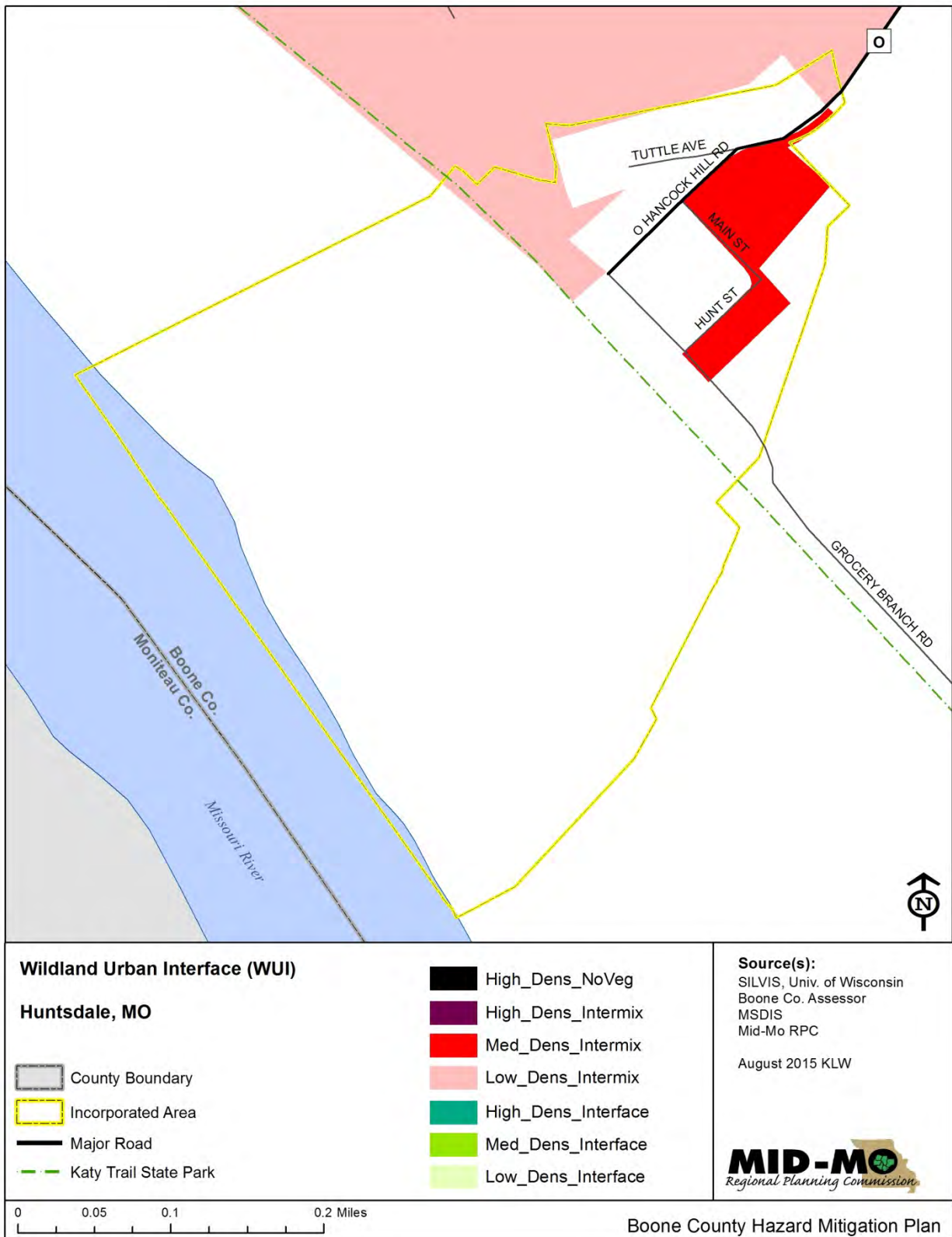


Figure 4.81



Extent

Most wildfires in the planning area are of limited duration due to the quick response of the fire districts.

Previous Occurrences

Wildfires are very common in the planning area. According to information from the Boone County Fire Protection District (BCFPD), there are hundreds every year. Most of these fires only require 50' by 50' fire lines; however, there are perhaps ten fires a year which burn over 10 acres. Fires of this size require a large amount of resources to put out.

Wildfires in the planning area typically destroy crops, hay fields, green space, and woods; there have also been losses of barns, farming equipment and trucks from some fires. During the 2012 drought, a grass fire caused fire damage to a house in the City of Columbia.

Probability of Future Events

Probability: High – Boone County

Moderate - Columbia, Harrisburg, Hartsburg, Rocheport

Low – All other participating jurisdictions

The probability of wildfires increases during conditions of excessive heat, dryness, and drought. The probability is also higher in spring and late fall.

ANALYSIS OF RISK

Severity: Moderate – Boone County, Columbia, Harrisburg, Hartsburg, Rocheport

Low – All other participating jurisdictions

Potential Impact - Existing Structures

While wildfires in the central Missouri area have the potential to destroy buildings, data from the entire Mid-MO RPC region indicates that this is more the exception than the rule. While there has been damage to built structures and vehicles in Boone County, wildfires are usually quickly suppressed and the damage to the built environment is minimal.

Potential Impact - Future Development

As development proceeds in the planning area, there is the potential for the increase in the Wildland Urban Interface (WUI); this interface puts more of the built environment at risk for structural damage from wildfire.

Existing Mitigation Activities

State of Missouri Statutes: Missouri Revised Statute 49.266, adopted in August 2013, confers the right of county commissions to adopt an order or ordinance issuing a burn ban upon a determination made by the state fire marshal:

Upon a determination by the state fire marshal that a burn ban order is appropriate for a county because:

- (1) An actual or impending occurrence of a natural disaster of major proportions within the county jeopardizes the safety and welfare of the inhabitants of such county; and
- (2) The U.S. Drought Monitor has designated the county as an area of severe, extreme, or exceptional drought,

the county commission may adopt an order or ordinance issuing a burn ban, which may carry a penalty of up to a class A misdemeanor. State agencies responsible for fire management or suppression activities and persons conducting agricultural burning using best management practices shall not be subject to the provisions of this subsection. The ability of an individual, organization, or corporation to sell fireworks shall not be affected by the issuance of a burn ban. The county burn ban may prohibit the explosion or ignition of any missile or skyrocket as the terms "missile" and "skyrocket" are defined by the 2012 edition of the American Fireworks Standards Laboratory, but shall not ban the explosion or ignition of any other consumer fireworks as the term "consumer fireworks" is defined under section 320.106.

Emergency response systems, well trained fire departments, and numerous county roads improve response times to fire events, thus decreasing the chances of fire spread.

The Missouri Department of Conservation and the State Fire Marshal have published an informational booklet entitled "Living with Wildfire" which educates homeowners on assessing a property's vulnerability to wildfire and making changes to decrease the risk.

SUMMARY OF VULNERABILITY

Wildfire is not a major threat in the planning area; however, all participating jurisdictions are potentially vulnerable. While wildfires occur on a regular basis, they are usually easily suppressed by a quick response from the fire districts and thus limited in their spread and destruction.

The threat is greatest in unincorporated Boone County, where most of the fires occur, and in Columbia, Harrisburg, Hartsburg, and Rocheport which incorporate significant areas of medium or high density wildland urban interface or intermix.

Section 5: Risk Assessment

TECHNOLOGICAL AND HUMAN-MADE HAZARDS AFFECTING THE PLANNING AREA

A summary of the Probability and Severity ratings for technological/human-made hazards in each of the participating jurisdictions is shown in Figure 5.1.

Figure 5.1

Technological/Human-made Hazard Probability and Severity Ratings by Participating Jurisdiction																				
		Boone Co. (uninc.)	Ashland	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon	Centralia R-VI	Columbia Public	Hallsville R-IV	Harrisburg R-VIII	Southern Boone	Sturgeon R-V	Columbia College	Stephens College	University of MO
Public Health Emergency	P	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	S	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H
Hazardous Materials Release	P	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	S	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Transportation Incident	P	L	na	na	L	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
	S	H			H															
Nuclear Incident	P	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	S	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Utility Service Disruption	P	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H
	S	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Telecommunications Disruption	P	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
	S	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Cyber Attack	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H
Unwanted Intruder/ Active Shooter	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Terrorism	P	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	S	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H	L-H
Civil Disorder	P	na	na	na	L	na	na	na	na	na	na	na	na	na	na	na	na	L	L	L
	S				L-H													L-H	L-H	L-H
Mass Casualty/ Fatality Event	P	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	S	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H	M-H
Key: H = High, M = Moderate, L = Low, ? = unknown, na = not applicable																				

5.1 PUBLIC HEALTH EMERGENCY

DESCRIPTION OF HAZARD

Public health emergencies straddle the divide between natural and human-made hazards. There are any number of potential situations which can give rise to a public health emergency including:

- Communicable disease epidemic
- Radiological, chemical or biological terrorism
- Hazardous material release
- Nuclear incident
- Water or food contamination
- Extended utility disruption
- Wide scale destruction from any natural hazard

The Columbia/Boone County Department of Public Health and Human Services (PHHS) has the lead responsibility for protecting public health in the planning area. In recent years, much of the planning focus has been on preparing for response to communicable disease epidemics and radiological, chemical or biological terrorism. There is a fulltime emergency management planner at PHHS in a position funded by the Center for Communicable Diseases (CDC) through the Public Health Emergency Preparedness Grant contracted by Missouri Department of Health and Senior Services.

Location

The entire planning area is at risk from a Public Health Emergency. Residence halls and student housing associated with the location of the University of Missouri, Columbia College, and Stephens College in Columbia provide the opportunity for a quicker spread of communicable diseases within that city.

Extent

A public health emergency can range from a short duration event in a small population to a longer duration event involving entire states, regions, the nation, or the world.

The PHHS has made the assumption in its planning that an influenza pandemic may occur in waves of 6-8 weeks and last for 12-24 months.

Previous Occurrences

While there have been contained outbreaks of communicable diseases, such as shigella, and food poisoning incidents in the planning area, there has not been a widespread public health emergency within the recall of the planning committee.

In 1918, the planning area was affected by the flu pandemic sweeping the world. Certain movement restrictions were placed on citizens and students at the University of Missouri. The flu pandemic resulted in 9,677 deaths statewide in 1918, according to the *MO State Hazard Mitigation Plan (2013)*; the death rate dropped by half in the subsequent year.

Probability of Future Events – Moderate for all participating jurisdictions

ANALYSIS OF RISK

Measure of Severity – Moderate to High for all participating jurisdictions

The measure of severity is variable due to the varying impact of the wide-range of events which could trigger a public health emergency. For example, a limited hazardous material release or a utility disruption might result in only some injuries and property damage. On the other hand, an influenza pandemic would have the high probability of resulting in major injury and death in the planning area.

In addition to direct impacts on life and existing structures, a public health emergency has the potential for large economic effects. A CDC model suggests that about 20% of the work force will be absent due to illness or caring for family at the height of a pandemic. There is also the possibility of the population being asked or required to “shelter at home” and businesses and schools being shut down.

Potential Impact – Life

Information modeled for the PHHS Pandemic Flu Plan in 2006 gives an indication of the potential impact of varying levels of flu pandemic on the planning area (Figure 5.2). It should be noted that the population of the planning area has increase by over 20,000 since this modeling was done.

Figure 5.2

IMPACT ESTIMATE OF A PANDEMIC ON BOONE COUNTY					
Potential Impact of a 1918-like "major pandemic" Pandemic – U. S. and Boone County					
	Population	Clinically Ill (30%)	Outpatient Care (50% of ill)	Hospitalized (11% of ill)	Deaths (2.1%)
U.S.	297.7 million	90 million	45 million	9.9 million	1.9 million
Missouri	6 million	1.8 million	900,000	198,000	38,610
Boone County	141,367	42,410	21,205	4,665	890
Boone Co. + college students	169,067	50,720	25,360	5,579	1,065
Boone Co. + college students + regional draw to healthcare service ¹	661,107	198,332	99,166	21,817	4,165

FluSurge Estimates of a mild pandemic (similar to 1957 and 1968 pandemics)		
Population	Hospitalized (15-35%)	Deaths (15-35%)
Boone County	358-835	87-203
Boone Co. + college students	425-992	103-241
Boone Co. + college students + regional draw to healthcare service ¹	1833-4278	458-1068

¹ Estimation of regional draw from Boone Hospital Center discharge data to include a 25 county area around Boone County.
 *FluSurge is a Center for Disease Control computer program for estimating pandemic flu impacts on a community. The program utilizes projections based on the 1957 and 1968 pandemics.

Source: *Pandemic Influenza and Highly Infectious Respiratory Disease Response Plan for Boone County Missouri*

Potential Impact - Existing Structures

The organism which causes Legionnaire's Disease can reside in hot water systems; a thorough decontamination of the system must take place in this situation. There is the possibility that other existing or emerging diseases may be found to have a relationship to the built environment which results in costs or economic losses.

Potential Impact - Future Development

The planning area has seen rapid growth and development in the past decades; indications suggest that this growth will continue. Population growth increases the overall risk for communicable diseases, especially in areas where crowding occurs.

In addition, the past decades have witnessed an incredible increase in air travel and global movement. This new "global community" allows for the introduction of diseases not endemic to the area and the reemergence of previously eradicated diseases.

Existing Mitigation Activities

Columbia/Boone County PHHS has a strong base of mitigation and prevention activities in place for public health emergencies.

General:

- *Public Health Emergency Response Plan (2013)* – This plan is updated for maintenance yearly and individual sections are worked on according to a schedule set by the Missouri Department of Health and Senior Services. The plan includes special considerations needed for specific diseases such as *Ebola* and a Mass Fatality Plan.
- *Columbia/Boone County PHHS Business Continuity Plan (2013)*
- *Columbia/Boone County PHHS Hazard Vulnerability Analysis*
- Excellent coordination with other agencies (Federal, State and local) - Local coordination and planning includes governments, educational institutions, businesses, and non-profits. Columbia/Boone County PHHS coordinates a Health and Medical Emergencies Committee which is comprised of public health staff and emergency management from all hospitals; this committee meets monthly.
- Excellent communication systems including MoSWIN (Missouri State Interoperability Network) and ham radio capability
- A Community Health Status Assessment developed in 2013 using the MAPP (Mobilizing for Action through Planning and Partnerships) Process - This baseline assessment allows for more targeted and effective planning.

Communicable Diseases:

- *Pandemic Influenza and Highly Infectious Respiratory Disease Response Plan for Boone County Missouri (2006)* – The focus of this all hazards plan is “to provide guidance and resources for the coordinated public health response to a disaster and/or public health emergency.” The plan covers all facets of a public health emergency including: disease prevention and control; epidemiology; disease containment; mass prophylaxis; community medical resources coordination; environmental health (including food and water safety, water-borne and vector-borne illness, air quality, and an animal disaster plan); command and control; liaison; safety; public information; logistics; finance/administration; planning and operations.
- Prevention /education
 - Education at health fairs, daycares and other sites
 - Mandated food handler classes for those working within the City of Columbia
 - Active flu vaccination program
- Reporting/tracking
 - Suspected food borne illnesses may be reported by phone or online
 - Disease reporting by phone and dedicated secure fax line
 - Reporting of certain diseases as mandated by MO State law
- Preparation in place, via partnership with American Red Cross, to respond to environmental health concerns for mass care providers
- PODs (Points of Dispensation) Go Kits – These kits are ready and available with equipment and supplies to set up a POD. (A POD is where mass prophylaxis (antiviral and antibiotics) may be dispensed.). Agreements are in place with certain businesses and residences for “closed PODs” where distribution will be for employees and residents. “Open POD” exercises are carried out routinely, such as at a PHHS sponsored Flu Clinic.
- Medical Reserve Corps – This is a volunteer group of volunteer of health professionals and lay persons organized for public health preparedness and response. This is now organized through the Show-Me Response registry at SEMA.
- Strategic National Stockpile (SNS) Program – “The mission of Center for Disease Control's Strategic National Stockpile (SNS) Program is to ensure the availability and rapid deployment of life-saving pharmaceuticals, antidotes, other medical supplies, and equipment necessary to counter the effects of nerve agents, biological pathogens, and chemical agents. The SNS Program stands ready for immediate deployment to any U.S. location in the event of a terrorist attack using a biological toxin or chemical agent directed against a civilian population.” (website)

Radiological, chemical or biological terrorism:

- Smallpox Plan
- Biohazard Detection System (BDS) Response Plan – This plan deals primarily with Anthrax detection at the mail facility at the Columbia Regional Airport.

SUMMARY OF VULNERABILITY

A public health emergency can come in many sizes and shapes. The entire planning area is vulnerable; the greatest known threats are an epidemic/pandemic or an emergency arising from radiological, chemical or biological terrorism. There is a high chance that a public health emergency might evolve in the midst of another disaster, complicating both response and recovery.

The planning area is probably better prepared to meet a public health emergency than many locales. The excellent work of the Columbia/Boone County Department of Public Health and Human Services (PHHS) has resulted in extensive planning and provisioning for a wide variety of possible emergencies. There are significant medical and hospital resources in the planning area. Coordination between PHHS and federal, state, and local agencies is excellent.

Nonetheless, a significant risk still exists; the potential sources of a public health emergency are numerous, varied, dangerous, and continually evolving.

5.2 HAZARDOUS MATERIALS RELEASE

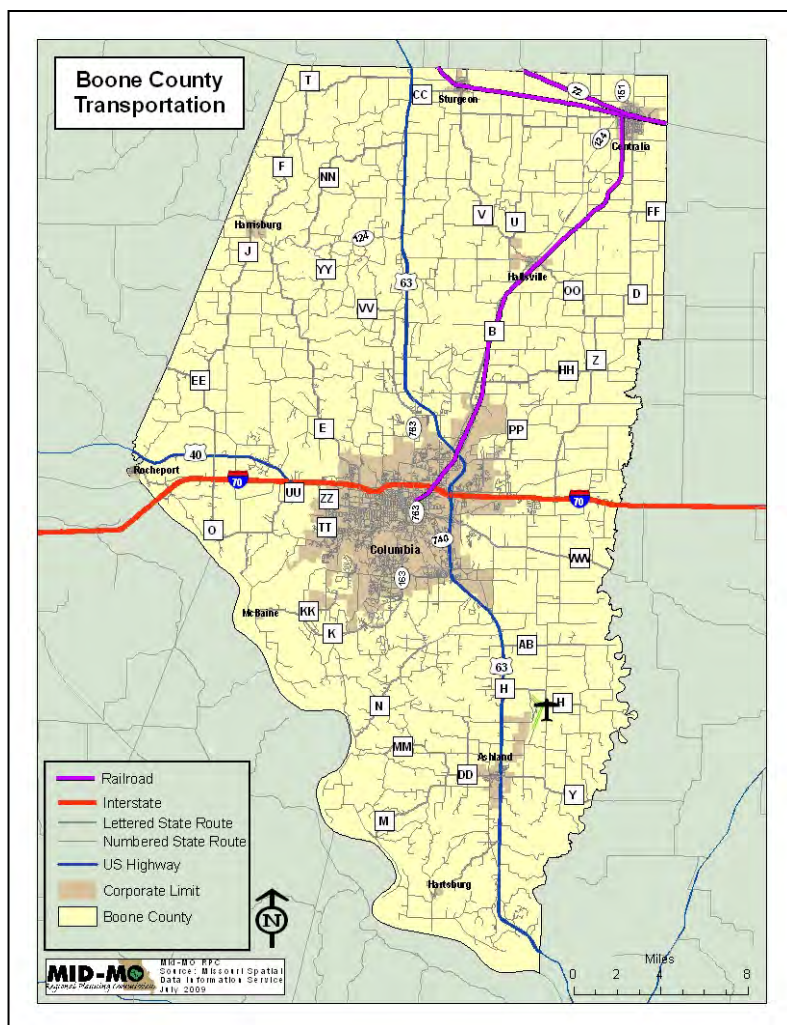
DESCRIPTION OF HAZARD

Location

The entire planning area is at risk from a Hazardous Materials Release. This could originate from a transportation incident along the highway system, railways, or pipelines or at a fixed facility using or generating hazardous materials in its operation. The following information is taken from Annex H of the *Boone County Emergency Operations Plan*.

Transportation Routes There are multiple transportation modes and routes in the planning area which may be used to transport hazardous materials (Figure 5.3).

Figure 5.3



Two major highways, I-70 (east-west) and Highway 63 (north-south), traverse the planning area. These highways intersect each other within the City of Columbia and are common routes for the transportation of hazardous substances, the majority of which are petroleum-based products.

Three railroads, the Columbia Terminal (COLT), Norfolk Southern and Kansas City Southern Railroad, run through the planning area. The two latter railroads serve the northern portion of Boone County and may transport cars containing hazardous or extremely hazardous substances.

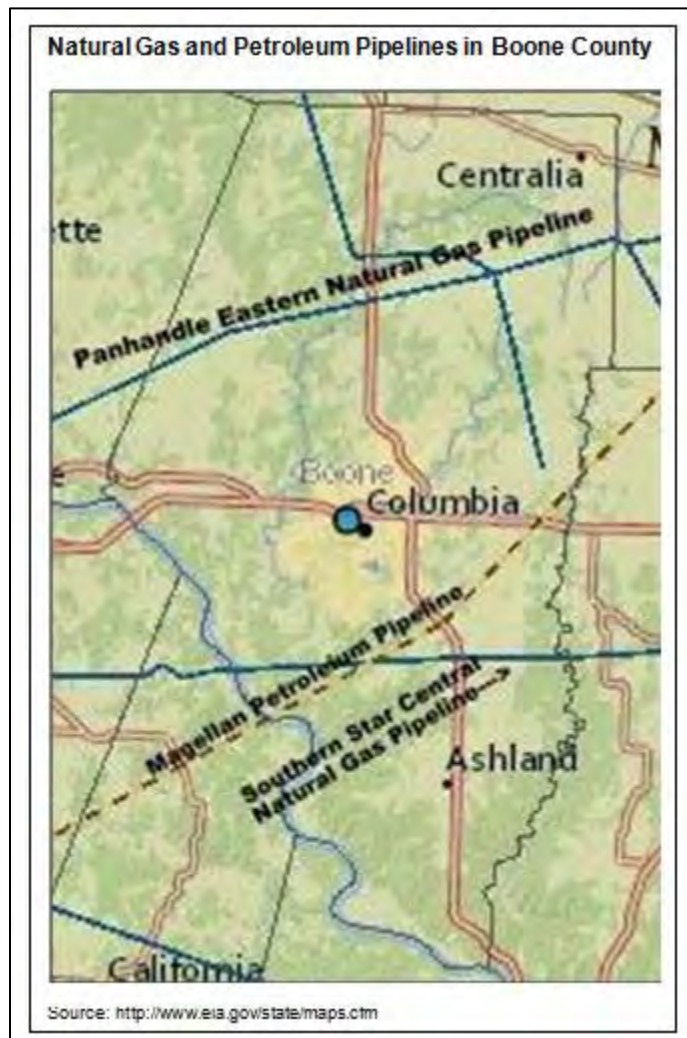
Columbia Regional Airport, located between Columbia and Ashland, serves Boone County and Central Missouri.

The Missouri River, which defines the southwestern

boundary of Boone County, is a commercially navigable river.

Pipelines There are three natural gas lines and a major petroleum pipeline that run through planning area (Figure 5.4).

Figure 5.4



Panhandle Eastern has two natural gas pipelines running through the northern part of Boone County. A Southern Star Central natural gas pipeline crosses the county in the south, between Columbia and Ashland. A Magellan petroleum pipeline also crosses the county south of Columbia.

The two southern pipelines run near the City of Columbia's water source in the alluvial floodplain of McBaine Bottoms, according to the city's *Source Water Protection Plan (2013)*

In addition to the major pipelines, there is a network of pipelines carrying natural gas and other materials throughout the county.

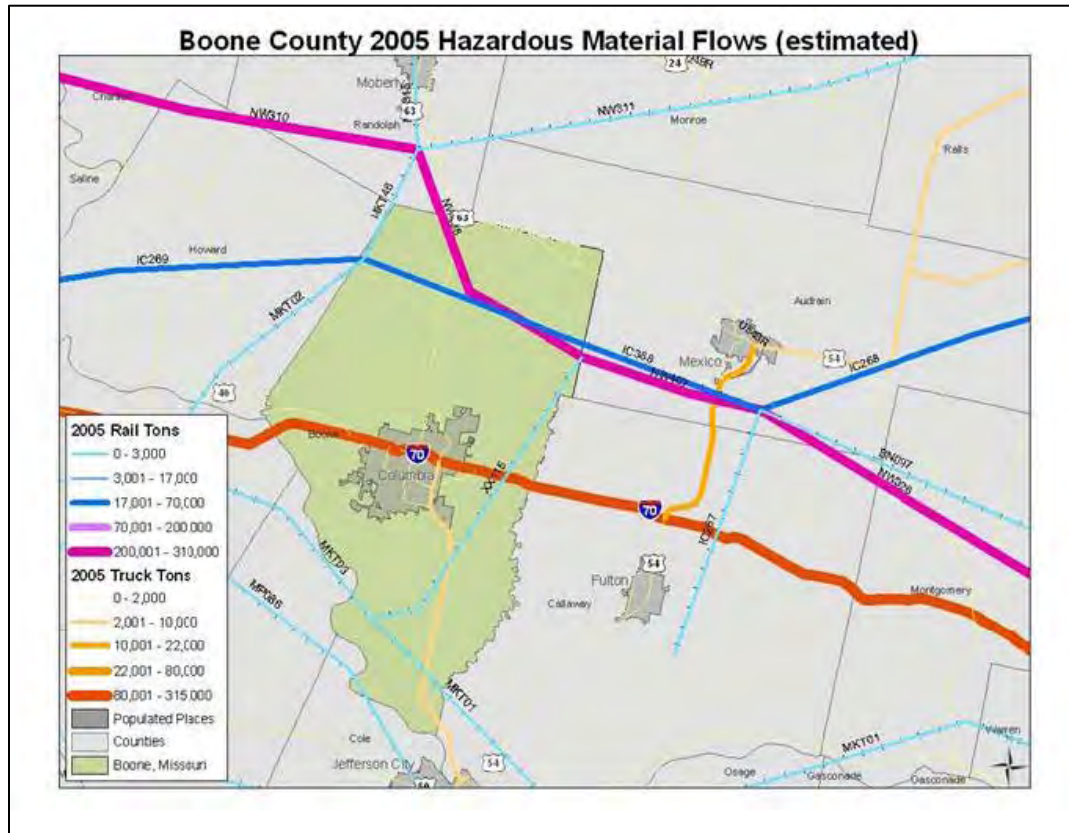
Fixed Facilities: There are a large number of fixed facilities in the planning area that use, produce and/or store hazardous materials. There are a small number of facilities in the planning area that use or store extremely hazardous substances (EHS). The University of Missouri operates the University of Missouri-Columbia Research Reactor (MURR) that produces and stores nuclear waste until it can be shipped off for regulated disposal.

Extent

Hazardous materials emergencies can range from small fuel spills to large-scale releases.

Estimated material flows on transportation routes through the planning area were made in 2005 (Figure 5.6) and give some idea of the potential extent of the issue. However, the LEPC questions the accuracy of these estimates; in addition, the map shows an incorrect placement of the railways in northern Boone County. Understanding the true extent of the potential threat from the transportation sector has been identified as a need by the LEPC.

Figure 5.6



Previous Occurrences

Information from the Missouri Environmental Emergency Response Tracking System (MEERTS) indicates a total of 1,019 reported spills in Boone County between 12/17/1993 and 11/30/2014 (Figure 5.7). It can be seen from the data that incidents along roads and highways are the most frequent.

Figure 5.7 Boone County - Reported Hazardous Materials Incidents 12/17/1993 - 11/30/2014			
Location	Incidents	Location	Incidents
Road/Highway/ROW	233	Healthcare Facility	11
Private Residence	172	Transformer/Substation	11
Conv. Store/Gas Station	75	Power Plant	7
Other Fixed Facility	70	Waterline/Water Treatment Facility	7
Water/Waterway/Marina	69	Agricultural Facility	5
Sewer/Wastewater Treatment Facility	66	Abandoned Property	4
Public Property	57	Bulk Chemical Facility	4
Undeveloped Property	48	Railroad/Railyard	3
Manufacturing Facility	42	Salvage/Junkyard	3
Pipeline/Pump Station	40	Aircraft/Airport	2
Retail Facility	38	Solid Waste Facility	2
Educational Facility	26	Bulk Petroleum Facility	1
Distribution Facility	22	Mining Facility	1
Source: http://dnr.mo.gov/env/esp/meerts.htm			

Probability of Future Events – Low for all participating jurisdictions

The historical MEERTS data indicates 1,019 events in an approximately 21 year period. This averages to ~49 events per year. The Boone County Fire Protection District (BCFPD), Columbia Fire Department and Southern Boone County Fire Protection District respond to about 15,000-16,000 calls per year, according to an estimate from BCFPD personnel. If all of these hazardous material incidents resulted in emergency calls, the calls would still only make up 0.3% of the total calls.

ANALYSIS OF RISK

Measure of Severity – Low for all participating jurisdictions

According to the Boone County LEPC (Local Emergency Planning Committee), injuries/casualties associated with hazardous material spills in the Planning Area are very low.

The greatest areas of concern from an emergency management perspective are: 1) petroleum releases from commercial vehicles on highways and 2) accidents/spills or fires in residential garages that may contain disproportionate amounts of consumer quantities of hazardous materials. The reporting threshold for a petroleum release is 50 gallons; e.g. a typical accident that might require an emergency response would be when saddle tank(s) get ripped open on a commercial vehicle which may contain greater than 50 gallons of petroleum product.

There are no reporting requirements for releases at private residences; these incidents are only reported if responders are called. Emergency response is usually called once someone has already been affected by the release. One of the main dangers posed in the residential incidents is the potential mixing together of various stored, and possibly out-of-date and degraded, chemicals; this random mixing can result in increased toxicity, flammability or reactivity.

Fixed facilities have a vested economic interest in the responsible management of their hazardous materials in order to prevent accidents and releases. While personnel are typically well trained and good stewards of the materials, the levels of hazardous materials at some facilities still present high risks should an earthquake, tornado, or some other hazard damage the facility. These facilities are monitored to mitigate the impact should an unavoidable disaster affect the facilities.

Potential Impact – Life

According to the LEPC, the risk to human life is very low from most hazardous chemical releases. It would only be extreme situations which would pose a great threat. The potential is there, however, and is explained as follows in the Boone County Emergency Operations Plan:

A release or threatened release of hazardous material could result in serious and quickly escalating threats to the public. Determination of the type of hazard involves knowing what hazardous material is involved and its potential impact and containment status. The physical or chemical characteristics of hazardous materials may include toxicity, flammability or reactivity. These factors require technical analysis by qualified and approved specialists in order to determine existing hazards, the anticipated course of the incident and any cascading hazards.

(EOP, Annex H)

Potential Impact - Existing Structures

There is the potential for structures to be impacted by hazardous substance releases. A release involving an explosion could impact the HVAC system and therefore the entire facility. A major release at a fixed facility has the potential to require road closures and restricted access during

environmental assessment and cleanup; in addition to inconvenience, this would result in financial losses.

Potential Impact - Future Development

More development is expected in the future at the University of Missouri's Discovery Ridge Research Park which is located in southeastern Columbia, adjacent to Highway 63 and close to the Columbia Regional Airport.

Plans are currently underway for Northwest Medical Isotopes (NWMI) to locate at the research park; NWMI is intended to be operational by 2017. NWMI will be working closely with the University of Missouri-Columbia Research Reactor (MURR). A central part of NWMI's mission is to provide a domestic, secure, and reliable supply of Mo⁹⁹ for medical diagnostics. This will be done with a reactor fission method using LEU (low-enriched uranium) targets shipped to irradiation facilities (MURR, etc) then transported back to NWMI for processing of target for Mo⁹⁹ for medical use.

The Mo⁹⁹ isotope decays very rapidly and must be continuously produced on a weekly basis and shipped to hospital end users. NWMI will be producing, processing, storing, and shipping volumes of materials; this will result in significant numbers of shipments containing increased radioactivity, above the current level of transits on the local transportation corridors. Additional impacts to the environment and public within future Exposure Planning Zones (EPZ) and Ingestion Pathway Zones (IPZ) may impact current assumptions regarding potential exposure and future needs for responder training; this should all be reassessed when more information is made available and future revisions of this document are due.

As more businesses locate at Discovery Ridge, additional evaluations (and possibly trainings) will be needed to understand the classification of materials involved, transportation routes of materials, and handling by emergency response agencies.

Hazardous materials also affect future development in another significant way; spills on parcels in the past can affect the desire to develop the parcels. The Boone County Fire Protection District regularly receives calls requesting a check of their database for HazMat spills.

Existing Mitigation Activities

- *The Local Emergency Planning Committee:*
 - Develops and maintains the Columbia/Boone County Hazardous Materials Emergency Plan (HMEP) - Annex H of the EOP; this is reviewed annually
 - Compiles the annual Hazardous Materials Inventory for Boone County based on Tier II reporting.
 - Outlines methods and schedules for training and exercises on hazardous materials in coordination with local government officials, schools and available private participants.
- Fixed Facilities are required by the EPA to prepare a risk management plan.
- The Missouri Spill Bill (RSMO 260.500-260.550) requires reporting of all spills to the Environmental Emergency Response (EER) Hotline or to the National Response Center. All reported incidents are tracked on the Missouri Environmental Emergency Response Tracking System (MEERTS). The threshold for reporting is 50 gallons.
- Processing of hazardous materials emergency 911 calls according to Fire Priority Dispatch protocol developed by the National Academies of Emergency Dispatch (NAED)
- Public warning and emergency notification systems; the Boone County outdoor warning siren is now operated on a zone basis as discussed in Section 3.
- The City of Columbia's *Source Water Protection Plan (2013)* includes the following in its action plan: "The Task Force will contact the Southern Star Central Gas Pipe Line Company and the Magellan Pipe Line Company about the importance of source water procedures in the event of a leak in either of their pipelines in the McBaine Bottoms."
- First Responders all required to be trained at the Operations Level.
- Regional assets include the Homeland Security Response Teams (HSRTs) located in Columbia and Cole County. The HSRTs are funded through grant funds from the Missouri Office of Homeland Security via appropriations at the regional level by the RHSOC (Regional Homeland Security Oversight Committee). HSRTs operate at the Technician Level as well as the MoDNR's Emergency Response Team and EPA's response elements.
- The Missouri Department of Natural Resources Emergency Response Team can respond to hazardous materials incidents.
- The Environmental Protection Agency (EPA) oversees the federal hazardous waste program.

SUMMARY OF VULNERABILITY

The entire planning area is vulnerable to a hazardous materials release. However, hazardous materials are highly regulated by federal law; multiple safeguards and emergency response teams are in place to mitigate the potential threat of a hazardous material incident.

The Boone County Local Emergency Planning Committee (LEPC) identifies residential garages as one major concern in hazardous material spills. This is due to the potential toxic, flammable, or reactive mix which may be created where numerous chemicals are stored in close proximity. Petroleum-based spills on the highways are the other major area of concern.

As some of the more rural areas of the county experience a transition from agriculture to urban development, past hazardous material spills may be a roadblock, or at least an added expense, on the way to development.

5.3 TRANSPORTATION INCIDENT

DESCRIPTION OF HAZARD

This section of the plan deals with major accidents involving air or passenger rail travel which result in injury or death. The risks associated with highway transportation accidents involving hazardous materials are covered in Section 5.2.

Columbia Regional Airport is located between Columbia and Ashland, to the east of U.S. Highway 63. The airport is served by American Airline with daily flights to and from Chicago and Dallas/Fort Worth. In addition, there are numerous charter flights associated with athletics and other activities at the University of Missouri. In 2014, there were 53,080 enplanements and 53,379 deplanements at the airport. These figures represent a 52.5% increase in passenger traffic at the airport since 2010. At the present time, there is not a lot of freight activity at the airport.

There is currently no passenger rail operating in the planning area.

Location

Boone County and the City of Columbia are at risk from a transportation incident. The airport is located within the corporate boundaries of Columbia; the city and the surrounding areas in Boone County are flown over during the most likely times for an accident: takeoff, ascent, descent, and landing.

Extent

Extent is defined as an attribute of the hazard alone which does not include its effect on humans or the built environment”; a transportation incident, for the purpose of this plan, is defined as an accident resulting in injury or death. There is not, therefore, a possible way to describe the extent of a transportation incident.

Previous Occurrences

Historically, there have been some deaths resulting from small aircraft crashes in the planning area, but there have been no major crashes.

Probability of Future Events

Low – Boone County and City of Columbia

Not applicable – all other participating jurisdictions

ANALYSIS OF RISK

Potential Impact - Life

By the definition established for this plan, a transportation incident is a passenger rail or air accident which results in injury or death. While airplane accidents are extremely rare given the high volume of traffic, when they do occur they usually result in injuries and at least some loss of life.

Potential Impact - Existing Structures

There is the possibility of an aircraft crashing into a building. This is a rare event which is impossible to predict or assess.

Potential Impact - Future Development

The Columbia Regional Airport is expanding its runways to allow service from larger jets. This will probably increase both passenger service and will also open the door for cargo operations. These developments would statistically increase the risks of a transportation incident; however, the probability of an incident would remain low.

Existing Mitigation Activities

The airline industry is highly regulated to ensure passenger safety. The Columbia Regional Airport complies with all requirements of the Federal Aviation Administration (FAA) and Transportation Safety Administration (TSA). The airport Emergency Plan is regularly updated; a complete exercise of the plan is carried out every three years.

Measure of Severity

High - Boone County and City of Columbia

Not applicable – all other participating jurisdictions

SUMMARY OF VULNERABILITY

While the potential exists for a major air transportation incident in the planning area, the probability of its occurrence is quite low. The jurisdictions at risk, should an accident occur, are the City of Columbia, where the regional airport is located, and the surrounding areas in Boone County which are flown over at lower altitudes during takeoff, ascent, descent, and landing.

A transportation incident involving an airplane is a low probability/high severity event. While an accident involving a large plane would most probably result in injuries and at least some loss of life, the vulnerability to this hazard has been assessed as low due to the extreme rarity of such events.

5.4 NUCLEAR INCIDENT

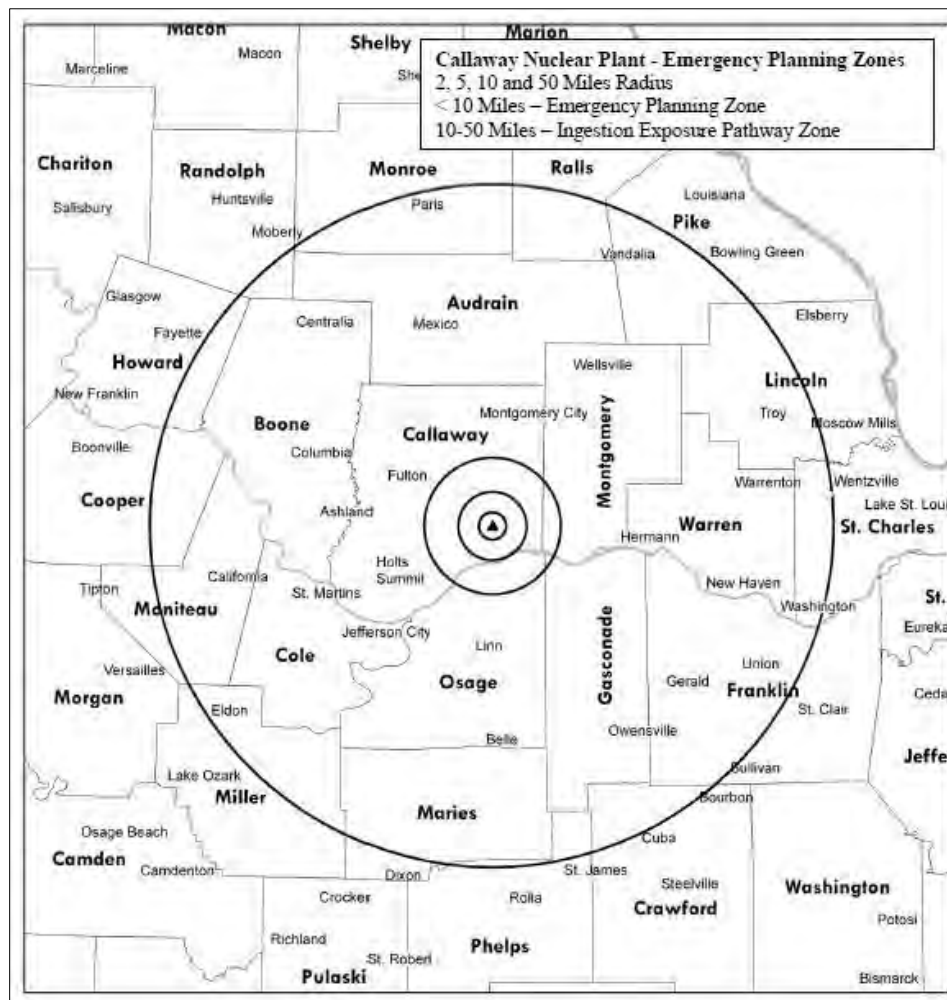
DESCRIPTION OF HAZARD

This section will deal specifically with the risks posed by a nuclear incident at a nuclear reactor.

Location

The entire Planning Area is outside of the 10 mile radius Emergency Planning Zone for the Callaway Nuclear Plant in adjacent Callaway County, but it is within the 10-50 mile radius Ingestion Exposure Pathway Zone (Figure 5.8).

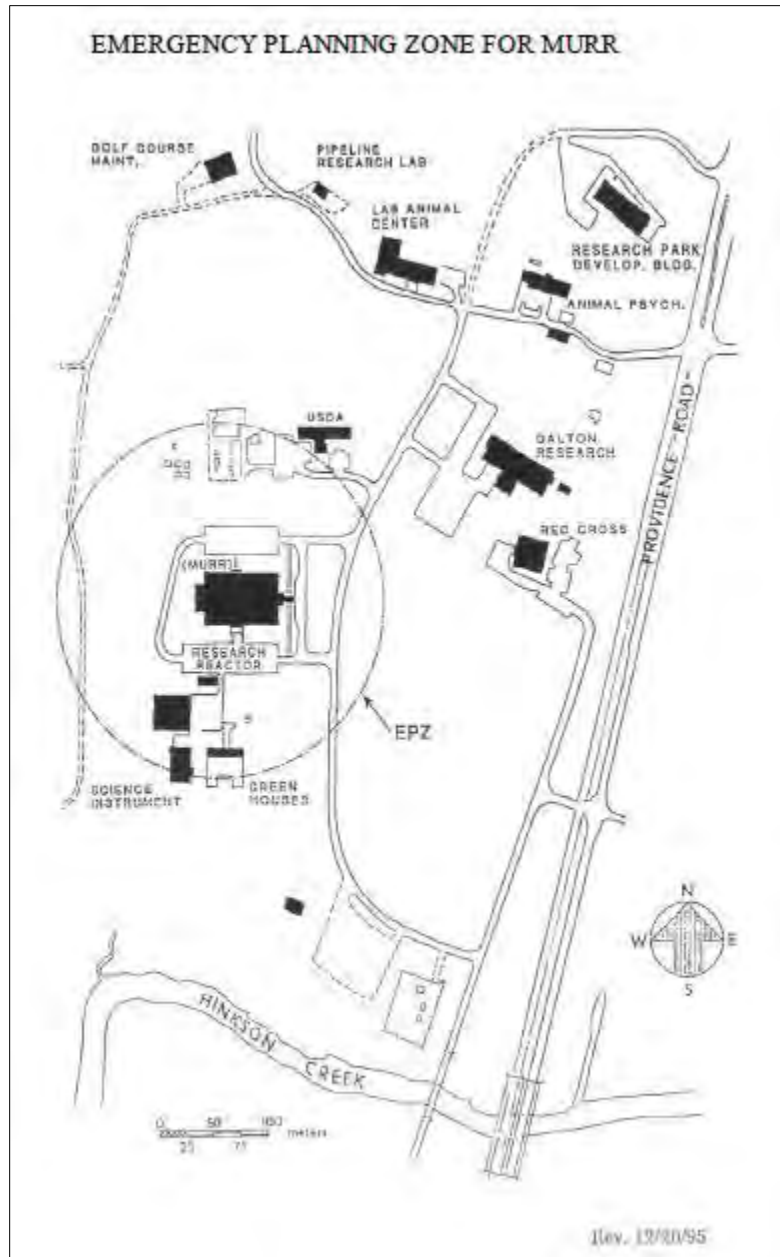
Figure 5.8



Source: *Missouri Hazard Analysis, 2013*

In addition, the University of Missouri-Columbia Research Reactor (MURR) is located within the City of Columbia. The Emergency Planning Zone for the MURR is the area within a 100-meter radius of the reactor's exhaust stack (Figure 5.9).

Figure 5.9



Source: *Missouri Hazard Analysis*, 2013

Extent

There are four classes of Emergency Action Levels used for early notification of incidents at nuclear reactors:

A. Notification of Unusual Event - This indicates a potential degradation of the safety level of the plant; no releases of radioactive material requiring off-site response or monitoring are expected unless safety systems are further degraded.

B. Alert - Unusual events are in process or have occurred and indicate a potential degradation of the level of plant safety; any releases are expected to be limited to small fractions of the Environmental Protection Agency (EPA) Protective Action Guideline (PAG) exposure levels.

C. Site Area Emergency – Events are in process or have occurred that involve actual or likely major failures of the plant functions needed to protect the public; no releases are expected to exceed EPA PAG exposure levels except near the site boundary.

D. General Emergency - An event is in process or has occurred that involves actual or imminent substantial core degradation or melting, with the potential for loss of containment integrity; releases can reasonably be expected to exceed the EPA PAG exposure levels off-site for more than the immediate site area

Callaway Nuclear Plant - Only the most serious incident (General Emergency) has the potential to have a direct effect on the Planning Area. Whether a General Emergency would result in contamination in the Planning Area would depend on the nature of the incident and meteorological conditions during the release.

University of Missouri-Columbia Research Reactor (MURR) - With regard to a potential incident at the MURR, it has been determined that “no credible potential accidents have been identified...that would result in exceeding the classification of Notification of Unusual Events” (*Missouri Hazard Analysis*). The greatest risk posed by activities at the MURR is that resulting from the transport of radiopharmaceuticals produced at the reactor. This issue falls under the purview of the LEPC which deals with hazardous materials (Section 5.2).

Previous Occurrences

The only nuclear incident in the United States equivalent to a General Emergency was the leaking of radioactive materials at Three Mile Island in Pennsylvania in 1979. According to 2013 information from FEMA, there have been five Site Area Emergencies with no release of radioactive materials at commercial nuclear power plants and four at non-commercial reactors.

Callaway Nuclear Reactor - The Callaway Nuclear Reactor has been in operation since 1984 and has had no major safety concerns in that time. It was originally licensed to operate until 2024 and the Nuclear Regulatory Commission (NRC) is currently considering extending its license.

MURR - “The MURR has been in operation since October 1967. The reactor averages 8,060 hours of operation per year (155 hours per week) at peak flux due to the service work that it

performs. During its history of operation, the MURR has never had an incident that would be considered an emergency action level” (*Missouri Hazard Analysis*).

Probability of Future Events – Low

“The Reactor Safety Study conducted by the NRC rated the chances of a major nuclear disaster as very low (a probability of one in one million per plant operating year). The report concluded that the worst accident type that could affect a nuclear power plant would be one resulting in a meltdown, which could be expected to occur once in 20,000 years of reactor operation. The report also stated that a meltdown would likely cause less than one fatality or injury. This low hazard rating is due to all of the added safety engineered instrumentation used to monitor and shut down nuclear plant systems before any severe damage occurs” (*Missouri Hazard Analysis*).

In addition, following the 2011 nuclear accident at Fukushima in Japan, the NRC increased requirements for nuclear plants in the United States. This has resulted in major upgrades to the Callaway Nuclear Reactor site including a new hardened facility sited next to the original facility; the Callaway Plant now has backup systems for its backup systems.

ANALYSIS OF RISK

Measure of Severity – Low

With regard to a potential incident at the MURR, it has been determined that “no credible potential accidents have been identified...that would result in exceeding the classification of Notification of Unusual Events” (*Missouri Hazard Analysis*). The Notification of Unusual Events classification indicates “no releases of radioactive material requiring off-site response or monitoring”.

In the case of a General Emergency at the Callaway Nuclear Reactor, the major impact in the Planning Area (aside from the possible need for some decontamination) would be the sheltering of persons from the exposure zone in Callaway County. The Hearn Center at the University is a designated shelter location for some of the evacuees. Should sheltering and services be required for a lengthy time, this could have an economic effect on the Planning Area.

The Planning Area would be involved in other ways should a General Emergency occur: the Columbia Regional Airport, located in the Planning Area, would be used to fly in equipment and personnel; law enforcement and public works departments in the Planning Area might be called upon for assistance.

Potential Impact - Life

If contamination occurred in the Planning Area, it could pose a threat to the health and safety of humans, animals, and agricultural production.

The nature of the incident and extent of contamination would determine the state or federal resources activated to address contamination concerns as well as methods for decontamination, sheltering in place or evacuation of members of the public, and isolation of contaminated areas. While portions of the planning area may be impacted by wind spread radiological contamination, it is expected that the contamination will be minimal due to the distance travelled from source of

contamination, nature of particle size and mass, and deposition mechanics of the height of plume, including wind speed and direction.

Should contamination of the planning area occur, it is very likely that the Missouri State Emergency Management Agency, along with initial responders from the Missouri Department of Health and Human Services, Missouri Department of Natural Resources and other local offsite organizations such as local fire departments and radiological technical experts from the University, would be the initial group to begin response and assessment of contamination. This initial response would soon be followed up by a mobilization of numerous response teams from federal agencies such as the EPA and U.S. Nuclear Regulatory Commission, U.S. Department of Agriculture, U.S. FDA etc. to determine the nature and extent of the radiological contamination as well as recommend “Early” “Intermediate”, and “Late or Recovery” phase response actions.

The initial assessments would attempt to estimate the levels of internal or external exposure for a member of the public from plume contaminants (radioactive iodines, strontiums, etc.) as well as contamination of drinking water supplies and food stuffs. Once those levels of contamination and projected worst case exposures are estimated then it is likely that the state and federal response agencies will make recommendations to local and state policy makers of impacted areas on action to be taken to protect the public, animals, pets, etc. In most cases the guidelines and protective actions as established in the EPA Manual “Protective Action Guides and Protective Actions for Nuclear Incidents” (PAG 400 Manual) would be used.

The EPA PAG is a valuable aid to state and local authorities making radiation protection decisions during an emergency. Decision-makers compare estimates of projected dose (a dose that can be averted by protective actions) with values in the appropriate PAG to determine what actions to take.

The protection action plan can be broken down into three phases:

- Early Phase - can last from hours to days until the release has stopped
- Intermediate Phase - can last from a week to months
- Late Phase - can last from months to years

Early Phase The “Early Phase” of the protection action recommendations would focus on physical action which can be taken to avoid exposure, based upon projected dose to members of the public.

Two primary pathways exist for radiation exposure to the public in the Early Phase. As the radioactive plume moves from the incident site across surrounding areas, members of the public may receive direct exposure to radioactive materials. These materials may be deposited on the skin and clothing. The extent of direct exposure will depend on the radiation source and the particular conditions of the incident.

A second important pathway is inhalation. This can occur when members of the public are directly immersed in the plume. In most cases, the dose from inhalation of radioactive particles is of greater concern than skin or clothing contamination.

Currently the recommendations would be to Evacuate or Shelter in place. As an example, should a projected dose from exposures from a plume approach 1 to 5 rem (REM=Roentgen Equivalent Man) then either an evacuation or shelter in place (depending on individual locations of constituents) would be one of several recommended actions for policy holders to consider. The recommendations would also specifically focus on methods to limit dose and exposures to adults and children's thyroids (based up FDA age-specific guides) such as the issuance of KI (stable potassium iodine) to first responders and/or members of the public.

Early Phase process:

- Notification of state and/or local authorities
- Immediate evacuation/sheltering (if necessary) based on preliminary information or measurements indicating severity or inability prevent accident from getting worse
- Monitoring of releases and exposure rate measurements
- Estimation of dose consequences
- Implementation of protective actions in other areas, if necessary

Intermediate Phase Activities in the "Intermediate Phase" are intended to reduce or avoid dose to the public, control worker exposures, control the spread of radioactive contamination, and prepare for long-term cleanup operations. This phase covers doses received in the first year and up to 50 years. These would include food and drinking water PAGs to limit uptake or intake of contaminated waters or foods stuffs to avoid a dose of either the 0.5 rem projected dose limit for the whole body or the 5 rem limit to the most exposed organ or tissue.

In addition, recommendations would be provided to local decision-makers on how to protect an area's local food sources. Such action might be covering exposed food products, moving animals to shelter, and providing protected feed and water to animals. It may also be necessary to place temporary embargoes on food and agricultural products to prevent public consumption of potentially contaminated food.

It is important to remember that these dose limits are based on projected dose for the first year of exposure. Actions are taken to avoid this dose.

The recommended PAG for drinking water is 0.5 rem committed effective dose equivalent in the first year of exposure. A committed effective dose equivalent is used because only one pathway, ingestion, is involved. The drinking water PAG does not apply to all potable water sources. The Intermediate Phase PAG covers other water uses like swimming and bathing.

If the projected dose is expected to exceed this threshold, then alternate sources of drinking water may be necessary. It is also possible that water treatment or other actions may help to reduce the radiation doses received from drinking contaminated water.

A key aspect of the drinking water PAG is that it is not intended to set an acceptable level of contamination of water, nor is it intended to serve as a remediation level in water. This PAG dose is in addition to the primary Intermediate Phase PAG and applies only in an emergency situation.

The “Intermediate Phase” objectives would focus on the need to relocate. The Protective Action Recommendation based on PAG is shown in Figure 5.10.

Figure 5.10

Protective Action Recommendation	PAG (projected dose)	Comments
Relocate the general population	≥ 2 rem (20 mSv) First year	Beta dose to skin may be up to 50 times higher
Apply simple dose reduction techniques	< 2 rem (20 mSv) First year	Reduce doses to as low as practical levels
Longer term objectives	0.5 rem (5 mSv)	In any single year after the first
	≤ 5 rem (50 mSv)	Cumulative dose over 50 years

Additional Objectives:

- Identify high dose rate areas
- Relocate population from high dose rate areas
- Allow return of evacuees to non-contaminated areas
- Establish relocation areas
- Establish procedures for reducing exposure of non-relocated population
- Perform detailed environmental monitoring
- Decontaminate essential facilities and routes
- Begin recovery activities

Surface Contamination Control General Guidance (applies to both Early and Intermediate Phases):

- Do not allow monitoring and decontamination to delay evacuation
- If necessary, establish emergency contamination screening stations
- Establish monitoring and personnel decontamination facilities at evacuation centers
- Set up monitoring and decontamination stations at exits from the relocation area
- Establish auxiliary monitoring in low background areas
- Do not waste effort trying to contain contaminated wash water

Decontamination:

- Decontamination of persons, vehicles, facilities, crops, soils, pets and animals, and water sources will be performed during the intermediate phase. Contaminated individuals will be provided assistance at mass decontamination staging areas such as the University of Missouri’s Hearne’s Center which will be used during a Nuclear Incident as a Reception and Care Facility. The staging area will also be set up to address pets and vehicles driven to the mass decontamination area.

- Decontamination guidelines will be set up initially by local and state agencies. The early and intermediate phases will be based upon gross decontamination of persons to avoid exposures to values indicated above.
- Local and state agencies will make modifications to the decontamination guidelines if necessary during the intermediate, late and recovery phases.

Drinking Water PAG:

- Drinking water— limit to 0.5 rem (5 mSv) first year committed effective dose equivalent
- Applicable to drinking water from any source
- EPA Safe Drinking Water Standards after first year

Some additional protective actions for water:

- Wait for flow-by
- Ration clean water supplies
- Treat contaminated water
- Activate existing connections to neighboring systems
- Establish pipeline connections to closest sources/systems
- Import water in tanker trucks and import bottled water

Late Phase The late phase cleanup process begins sometime after the commencement of the intermediate phase and proceeds independently of intermediate phase protective action activities. The transition is characterized by a change in approach, from strategies predominantly driven by urgency, to strategies aimed at both reducing longer-term exposures and improving living conditions.

The late phase involves the final cleanup of areas and property at which contamination directly attributable to the incident is present. It is in the late phase that final cleanup decisions are made and final recovery efforts are implemented. Unlike the early and intermediate phases of a radiological incident, decision makers will have more time and information during the late phase to allow for better data collection, stakeholder involvement and options analysis. There will be opportunities to involve key stakeholders in providing sound, cost-effective cleanup recommendations.

Generally, emergency phase decisions will be made directly by elected public officials, or their designees, with limited stakeholder involvement due to the need to act within a short timeframe. Longer-term decisions should be made with stakeholder involvement and can also include incident-specific technical working groups to provide expert advice to decision makers on impacts, costs and alternatives. Community members will influence decisions such as if and when to allow people to return home to contaminated areas. There will be people living in contaminated areas, outside the evacuation and relocation zones, where efforts to reduce exposures will be ongoing.

Late Phase Goals:

- The types of contamination; the technical feasibility, cost, timeliness and effectiveness of decontamination measures; and the availability and cost of options for the disposal of wastes.

- The size and character of the areas that are contaminated; past and projected future uses for these areas; and the preservation or destruction of places of historical, national, or regional significance.
- Site-specific natural and anthropogenic background levels of radioactivity.
- Estimates of the impacts of both contamination and options for decontamination, on human health, communities, the economy, ecosystems and ecosystem services.
- Public acceptability and intergenerational equity.

Factors to consider in determining cleanup actions include evaluating:

- areas impacted (e.g., size, location relative to population);
- actions already taken during the early and intermediate phases;
- the ability of a remedy to maintain reliable protection of overall human health and the environment over time;
- assessing the relative performance of treatment technologies on the toxicity, mobility or volume of contaminants;
- the success or effectiveness of the cleanup or remediation as the cleanup progresses (contaminant removal);
- the adverse impacts on human health and the environment that may be posed in the time it takes to implement the remedy and achieve the community-based remediation goals;
- the impacts of alternative levels of clean up on the local and regional economy (e.g., job loss due to closed businesses, job creation due to decontamination and waste handling operations) and on residents' sense of place (e.g., continued limited access to one's home and community until clean up levels have been reached);
- preservation or destruction of places of historical, national, or regional significance;
- the technical and administrative feasibility of the remedy, including the availability of materials and services needed to implement each component of the option in question;
- the cost of each alternative, including the estimated capital and operation and maintenance costs and net present value of capital and operation and maintenance costs;
- state concurrence with the remedy;
- community support for the remedy.

This may be an iterative process. As experience is gained, adjustments may be required to achieve long-term goals.

The goals of late or recovery phase decontamination efforts are:

- Restoration of incident site to conditions as near as possible to pre-existing—creation of a “new normal”
- Remove contamination
- Eliminate access restrictions
- End food and water controls
- Return population to homes and jobs

Potential Impact - Existing Structures

There would be no physical damage to existing structures in the Planning Area from a nuclear incident. However, buildings would need to be assessed for external and internal contamination and remediated, if needed. This would be supported on the local, state, and federal levels.

Potential Impact - Future Development

Theoretically, the expected population growth in the Planning Area will put more people at risk from contaminated food and water should there be a General Emergency level incident at the Callaway Nuclear Reactor which results in contamination in the Planning Area. However, this needs to be viewed in the context of the likelihood of the occurrence of such an event; the likelihood is extremely low.

Existing Mitigation Activities

The nuclear industry is heavily regulated with many safeguards in place. The MURR and Callaway Nuclear Plant are in compliance with all regulations. Missouri SEMA and the Callaway Nuclear Plant run exercises/drills throughout the year.

SUMMARY OF VULNERABILITY

While there is one research nuclear located in the planning area, and a large commercial reactor in an adjacent county, all jurisdictions in the planning area have a very low vulnerability to adverse effects from a nuclear incident.

The location of the University of Missouri-Columbia Research Reactor (MURR) within the City of Columbia poses virtually no threat due to the type of reactor and radioactive materials being used.

There is an extremely low probability of an incident occurring at the Callaway Nuclear Plant in adjacent Callaway County due to extensive industry regulations industry and the numerous safeguards in place. Should a major incident occur, there is the possibility of contamination of food and water in the planning area but this would be dependent on the nature of the incident and meteorological conditions at the time of release. There are extensive guidelines in place at the state and federal level to deal with such a possibility.

In the case of a major incident occurring at the Callaway Plant, some personnel and facilities in the planning area would potentially function in a supportive role for the emergency response.

5.5 UTILITY SERVICE DISRUPTION

DESCRIPTION OF HAZARD

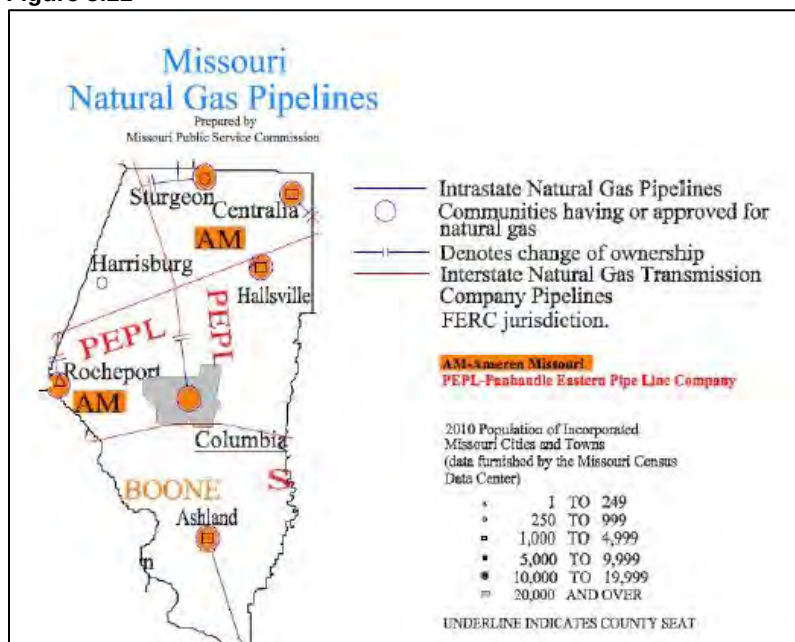
A utility service disruption may involve electrical power, natural gas, public water, wastewater treatment, or telecommunications systems. Telecommunications disruptions will be covered separately in Section 5.6.

Electrical: A number of the natural hazards profiled in this plan, especially severe winter weather (heavy snow and ice), thunderstorms (wind, hail, lightning), and tornadoes, pose threats to above ground electric utilities. Solar flares are increasingly being recognized as a threat to the power grid. Motor vehicle accidents and animals can cause outages. Digging and construction are a potential threat to buried utilities of all type. In 2008, the Mid-America Earthquake Center mapped the expected probability of at least moderate damage to electric power facilities from a 7.7 magnitude earthquake in the NMSZ; such damage was considered “highly unlikely” in the planning area.

Natural Gas: Natural gas disruption is a very serious concern; it can lead to explosions and fires. Since it is carried in underground pipelines, natural gas is protected from some of the threats to aboveground electrical utilities. However, according to the U.S. Energy Department, “Severe storms, flooding, and earthquakes can expose and break pipes....When disruptions do occur, it can take weeks or even months to restore.” In addition to damage from major events, natural gas pipelines can be damaged from digging or excavation activities,

Ameren Missouri is the local natural gas provider for the planning area. In addition to these delivery pipelines, there are three interstate gas pipelines, owned by Panhandle Eastern Pipe Line Company, which pass through Boone County (Figure 5.11).

Figure 5.11



Public Water: There are many hazards (both natural and technological/human-made) which can cause problems for the public water supply.

Drought, earthquakes, and flooding can result in broken pipes and/or other equipment failure. Many parts of the planning area have clay soils which often cause pipe breakage as they expand and contract.

Electrical power outages will cause problems for most water delivery systems if the power is not restored in a timely fashion. The water supply can also face contamination as a result of internal system failures or hazardous material spills or as a direct target of domestic or foreign terrorism.

The water supply districts in the planning area are CPWSD #1, WD #4, WD #9, WD #10, and the City of Columbia WD (Figure 3.4). In northern Boone County, extensive use of water for fire suppression could severely limit the public water available in the area served by Water District #10.

Wastewater: Wastewater treatment can be crippled by extended power outages and by flooding; significant ground displacement from a strong earthquake could break wastewater lines.

Location

The entire planning area is at risk from all types of utility service disruptions.

Extent

Electrical:

There was a power outage in Columbia on July 7, 2014 due to damaging thunderstorm winds which resulted in some outages which lasted a little over 100 hours (4.5 days).

Some data exists on the recent maximum duration of electrical outages due to ice storms in some parts of Missouri. The *Missouri State Hazard Mitigation Plan (2013)* gives the following information:

- December 1994 – ice storm – power outages, rural areas (northern MO) - 7 days
- December 2007 – ice storm - power outages (northern MO) - almost 2 weeks
- February 2008 – ice storm –power outages (southern MO) - almost 2 weeks
- January 2009 – ice storm – power outages (southern MO) - over 3 weeks

These are worst case scenarios; power is usually restored in a matter of hours, rather than days or weeks. However, a widespread outage with a lot of damage to infrastructure can cause lengthy restore times. This is especially true if large geographical areas are affected at the same time and mutual aid must travel from long distances.

Natural Gas: Major disruptions of natural gas are fairly rare events. When one does occur, it can take weeks or even months to restore service, according to the U.S. Department of Energy.

Public Water: The duration of a water supply disruption will vary according to the cause of the disruption.

Boil orders in Missouri are issued by the MO DNR when there is a question of the safety of the drinking water; these are typically issued due to a major pipe break or other event resulting in low pressure and possible contamination in the system. The duration of these orders vary, but typically last a day or two.

A major disruption of the system due to a natural disaster or terrorism might last many days or even weeks. The CDC recommends that citizens store at least a 72-hour supply of water (1 gallon/person or pet/day) and up to a two week supply, if possible.

Wastewater: Smaller wastewater disruption problems are usually resolved quickly. When wastewater utilities suffer a major infrastructure damage, such as during Hurricane Katrina, full restoration of service can stretch into months.

Previous Occurrences

There is not a definitive reporting system for utility outages in the State of Missouri, so limited data on disruptions is available.

Electrical: Some information on electrical outages is available from SEMA Situation Reports filed at the time of events. In December 2007, ice storms caused approximately 200 power outages in the Ashland area. The City of Hartsburg was without power. Shelters were opened in both Ashland and Hartsburg.

Heavy snow falls in February 2013 resulted in widespread power outages throughout the planning area. Some outages lasted 3-4 days. Data from Boone Electric Coop (BEC) for this period indicates that almost 2,800 of their customers lost power. The average outage for BEC lasted about 36 hours with some power being restored within 24 hours and the longest outage lasting almost 65 hours.

Storms on July 7, 2014 in Columbia resulted in 14,000 residents (most in the vicinity of West Broadway) losing power. The longest without power went a little over 100 hours/4.5 days. Six 80-foot transmission line poles were snapped in half and trees were uprooted over a widespread area.

Natural Gas: Natural gas distribution can be disrupted by pipeline failures and accidents. The Pipeline and Hazardous Materials Safety Administration (PHMSA) of the U.S. Department of Transportation has data going back to 1994 on significant and serious accidents involving the nation's natural gas gathering, transmission, and distribution pipelines. The data shows 13 transmission pipeline incidents and 46 distribution pipeline incidents in the State of Missouri during that 20-year period (Figures 5.13-5.14).

The Planning Committee recalled some natural gas fires in the County:

- In 2009, there was a rupture and explosion in a Panhandle Eastern pipeline in Howard County, about 15 miles northeast of Columbia and near the border with Boone County.

- There have been two natural gas incidents in or near Centralia; one gas explosion in the late 1970s (?) burned down significant structures in the city. There was also a natural gas incident ignited by static electricity sometime in the past few decades.

According to information from the *Columbia Daily Tribune* newspaper, “In 1997, Centralia was rocked by a similar explosion from a Panhandle Eastern pipeline. The blast occurred in a farmer’s field near Cline Road and threw a fireball so high it was reportedly visible as far away as Quincy, Ill.”

Public Water: Data is not available but boil advisories/orders are not uncommon in the planning area.

Wastewater: Data is not available.

Probability of Future Events:

Electrical outage – High for all participating jurisdictions

Natural gas disruption – Moderate for all participating jurisdictions

Public Water disruption– Moderate/High for all participating jurisdictions

Wastewater disruption – Moderate for all participating jurisdictions

Public Water: Water utility disruption can run the gamut from contamination requiring boil orders to full disruption of service. If all such possible disruptions are considered, then a high probability rating is appropriate. For more widespread disruptions, a moderate probability rating is more appropriate.

A widespread disruption of the water utility is tied to the availability of electrical power. The city of Columbia has a dual electrical feed to both its water and wastewater plants. This allows for continuity if only one of the electrical substations is compromised.

For most of the planning area, an electrical power outage of 8-10 hours would require the assistance of backup generators to avoid larger problems with water. Some backup generators are available but more are needed.

Wastewater: The wastewater utility is also tied to availability of electrical power. Most municipal wastewater systems in the planning area would begin having problems within 1-1½ days of loss of electrical power. There is a need for more generators and transfer switches in the planning area.

The Boone County Regional Sewer District indicated that their system would begin to experience problems within 4-24 hours of loss of power. With a countywide power outage, pump stations would start to overflow around 4 hours. If an outage persisted for over 24 hours, the treatment process at some of the smaller treatment plants without backup generators or wiring for portable generators would begin to degrade. The BCRSD did indicate that they have a lot of generators and a few portable generators but not all of the wiring/transfer switches needed.

ANALYSIS OF RISK

Measure of Severity: Moderate for all participating jurisdictions

Potential Impact – Life

Utility service disruption can have widespread and cascading effects on many segments of society. Extended loss of electrical power will affect the ability of the water and wastewater utilities to function at full capacity. Even short-term loss of electrical power is a threat to the home and commercial food supply. Loss of electrical power in the winter months is a threat to life and safety, especially that of the most vulnerable populations.

Natural gas disruption is a very real threat to human and animal life. Disruption of the public water utility poses a risk for fire protection and for health. Disruption of the wastewater utility poses threats to health and the environment.

Potential Impact on Existing Structures

Electrical: Boone Electric Cooperative: BEC began keeping records on outages in 2006. During planning for the *Multi-Jurisdictional Hazard Mitigation Plan for Missouri's Electric Cooperative (May 2012)*, an analysis was conducted of outages between January 2006 and April 2011 and the cost to BEC infrastructure (Figure 5.12).

Figure 5.12

Cause of Outage	# of Events	Average Cost to BEC/event
Thunderstorm/high wind	22	\$3,236
Hail	18	\$1,452
Severe Winter Weather	2	\$ 115

BEC personnel stressed that, during the time period for which outage data is available, there were no major ice storms. Ice storms are not uncommon in the BEC service area and are one of the most damaging natural hazards which can impact the cooperative.

Natural Gas: The PHMSA data for Missouri indicates that the average property damage cost (in current year dollars) was \$782,660 for a transmission pipeline incident and \$650,526 for a distribution pipeline incident (Figures 5.13-5.14).

Figure 5.13

Transmission Lines:

PHMSA Pipeline Incidents: (1994-2013)				
Incident Type: Significant System Type: GAS TRANSMISSION State: MISSOURI Offshore Flag : ALL				
Calendar Year	Number	Fatalities	Injuries	Property Damage Current Year Dollars
1994				
1995				
1996	1	0	0	\$252,479
1997	1	0	0	\$689,298
1998				
1999				
2000				
2001	1	0	0	\$469,907
2002				
2003	1	0	0	\$4,040,197
2004				
2005	1	0	0	\$110,866
2006	3	0	0	\$523,390
2007				
2008	2	0	0	\$1,096,446
2009	1	0	0	\$745,234
2010				
2011				
2012	1	0	0	\$240,986
2013	1	0	0	\$2,005,775
Grand Total	13	0	0	\$10,174,577

Figure 5.14

Distribution Lines:

PHMSA Pipeline Incidents: (1994-2013)				
Incident Type: Significant System Type: GAS DISTRIBUTION State: MISSOURI				
Calendar Year	Number	Fatalities	Injuries	Property Damage Current Year Dollars
1994	2	0	0	\$437,904
1995	1	0	0	\$114,368
1996	5	2	3	\$1,837,486
1997	5	0	4	\$372,221
1998	4	0	2	\$786,786
1999	4	1	4	\$116,365
2000	3	1	3	\$250,382
2001	2	0	0	\$1,223,046
2002	1	0	1	\$31,554
2003	2	1	2	\$352,883
2004	2	0	0	\$276,117
2005	2	0	0	\$877,575
2006	3	0	0	\$763,967
2007	1	0	2	\$85,911
2008				
2009	3	0	1	\$230,719
2010	2	0	0	\$338,417
2011	2	0	0	\$267,360
2012	1	0	0	\$93,782
2013	1	1	4	\$0
Grand Total	46	6	26	\$8,456,843

Loss of Use Estimates – Electric Power, Drinking Water, Wastewater Treatment: *The Missouri State Hazard Mitigation Plan (2013)* estimated the cost of loss of use of electrical power, drinking water, and wastewater treatment for 10% of the population for one day in each county in Missouri; these estimates for Boone County are shown in Figure 5.15. The value assigned to loss of use for each utility was taken from *What is a Benefit? Guidance on Benefit-Cost Analysis of Hazard Mitigation Projects* (FEMA, June 2009).

Figure 5.15 Boone County Utility Service Disruption Loss of Use Estimates for One Day Disruption	
Total population (2010 Census)	162,642
Scenario population (10%)	16,264
Electric power (\$126 per person/day)	\$2,049,264
Drinking water (\$93 per person/day)	\$1,512,552
Wastewater treatment (\$41 per person/day)	\$666,824
Source: <i>Missouri State Hazard Mitigation Plan (2013)</i>	

Potential Impact - Future Development

Utility outages can be more problematic in higher population areas; a higher population means more people impacted by a major outage and more people competing for limited local supplies of generators, food, bottled water, blankets, etc. This is just one of the reasons that reliable infrastructure and services must keep pace with development.

Some areas of new development in the planning area are required by law to have underground utilities. Underground utilities are required in both Ashland and Centralia subdivisions. The City of Columbia Water and Light Department continues its policies of undergrounding electric in new developments as well as actively undergrounding approximately one mile of existing overhead electric each year.

Existing Mitigation Activities

Multiple Utilities:

The purchase of generators has been a major focus of the Region F RHSOC (Regional Homeland Security Oversight Committee) for a number of years. Boone County is one of 13 counties in Region F.

Region F RHSOC has purchased the following for each county in the region:

- 1 towable 65kW generator
- 2 portable 13kW generators

In addition, Region F RHSOC has purchased three 178kW towable generators which are housed in Audrain, Cole, and Cooper Counties and three 100kW towable generators which are housed in Camden, Howard, and Osage Counties. Plans are underway to purchase cabling to accompany these six larger towable generators.

Electrical:

- Burying electric lines
- Tree trimming
- Shelter system

Boone Electric Cooperative (BEC) has been part of a collaborative effort of eight electric coops in central Missouri in developing a website called BeStormSmart.coop. The site serves to educate the public on differentiating between a storm watch and storm warning, building a storm kit, and safely using a portable generator among other topics. BEC promotes the website in its monthly newsletter.

Natural Gas:

- “Call before you Dig” campaigns and requirements
- In October 2014, Ameren Missouri held training for the Boone County Fire Protection District on natural gas safety. The training was part of a collaboration to coordinate responses to natural gas emergencies and help educate the public about natural gas safety.

Public Water:

- Distribution of notices and boil orders when there is a problem or potential problem with drinking water
- City of Columbia – dual feed for power at water plant

Wastewater:

- City of Columbia – dual feed for power at wastewater plant

SUMMARY OF VULNERABILITY

All participating jurisdictions in the planning area are vulnerable to a utility service disruption. Electrical power is the most commonly disrupted utility; this is usually due to severe winter weather or damaging winds. The duration of these outages can last from hours to days.

Water utilities are periodically disrupted in the planning area to the level of “boil orders” being issued for drinking water. The expansion and contraction of the clay soils which predominate in many areas can cause pipe breakage; this in turn lowers pressure and opens a gateway to possible contamination in the system. This is especially a problem in times of severe drought.

Natural gas and wastewater are also vulnerable to disruption although these are less common occurrences.

The numerous backup systems, other mitigation activities, and strong working relationships in the planning area help to lessen the risks associated with all utility disruptions.

5.6 TELECOMMUNICATIONS DISRUPTION

DESCRIPTION OF HAZARD

Modern telecommunications is a complex system which is both sophisticated and fragile. The sector has undergone massive transformation in the past few decades and each year brings greater expansion and complexity. Almost all aspects of modern life are highly dependent on telecommunications and disruptions of these networks can have large and widespread impacts. This is especially troublesome as the most likely time for a telecommunications disruption is at the time of an emergency or disaster.

New York University conducted an analysis of the interaction of disasters and telecommunications infrastructure through studying large urban disasters of the 1990s and early 2000s. The findings were published in *Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications (April 2005)* which has been used to frame and inform much of the discussion in this section.

There were three primary causes of telecommunications disruptions identified. They are:

1. Physical destruction of network components: This can cause severe and lengthy disruptions due to the time and funds needed to repair the infrastructure. In the planning area, aboveground infrastructure is vulnerable to ice storms, damaging winds, tornadoes; underground components are vulnerable to flooding and earthquakes.
2. Disruption in supporting network infrastructure: Telecommunication networks rely on many other systems which are often older and lack resiliency. The primary supporting infrastructure is the electrical distribution system; this can fail as can needed cooling systems. In addition, disruption of transportation routes can have a cascading effect whereby fuel is not available for electrical generation and electricity is not available for telecommunications.

While telecommunications disruption from failure of supporting infrastructure is less common it can be more widespread and pose greater challenges for response and recovery.

3. Network congestion: Most networks are designed to support peak loads far below those which occur during a crisis or emergency. In times of disaster, there are almost always problems caused by network congestion as people try to make contact either into or out of the affected area. In addition, network congestion can be a deliberate tactic employed as part of a terrorist attack.

One newer and developing issue regarding telecommunications disruption is the interference posed by some LED and fluorescent lighting system ballasts to radio and wireless communications. An incident of this interference was identified in the planning area when some emergency responders were unreachable by radio while eating lunch at a newly opened restaurant. According to an October 2014 posting on the website of the National Public Safety

Telecommunications Council (NPSTC), the NPSTC is “working with the American Radio Relay League (ARRL) to learn more about the extent of this problem. ARRL has been doing extensive research and testing into different problems and scenarios. In 2013, the FCC issued an order directing General Electric (GE) to make some changes to their LED lighting transformers after complaints were received about interference.”

This issue with LED interference highlights the continuing nature of potential emergent problems in telecommunications disruptions. Technological innovation is taking place at an incredible speed and there is always the potential for new interferences and problems. Within the telecommunications industry itself there has been an increased focus on redundancy and interoperability which will help mitigate the potential for breakdown; however, as systems get more complex, and the number of interactions multiply, there is always the potential for new interferences and problems to emerge.

Location

The entire planning area is at risk from a telecommunications disruption.

Extent

A telecommunications disruption can range in length from a short disruption lasting only minutes to one which may take days, weeks, or even months to fully resolve. Many disruptions can be restored rapidly due to the multiple redundancies built into the systems; however, in the case of major disasters where telecommunications infrastructure and supporting infrastructure are damaged or destroyed, it can take much longer.

Previous Occurrences

Telecommunications systems have been vulnerable to disruption since their inception. Within a few decades of its invention in 1844, the telegraph system was a target for destruction in the Civil War; attempted disruption of communication tools is often one of the first actions in a war.

Some level of telecommunications disruption accompanies most major disasters. There was serious telecommunications disruptions associated with the September 11 attacks in 2001. Much of lower Manhattan was disconnected from the telephone landline grid when a routing hub near the World Trade Center was damaged. In addition, the cellular telephone network in New York City suffered severe disruption; Washington D.C.’s cellular network was also congested but to a lesser degree.

All the major cell phone networks in the Northeastern U.S. failed during Hurricane Sandy (2012). In Hoboken, NJ, officials relied on whiteboards outside City Hall to keep citizens informed. Cellular telephone networks were also overloaded after the bombing at the Boston Marathon (2013).

Probability of Future Events – Moderate

ANALYSIS OF RISK

Measure of Severity - Moderate

The greatest threat for a serious telecommunications problem in the planning area is a disruption of the commercial telecommunications systems. In general, the commercial providers are co-located on towers; damage to one tower can often affect two or three providers.

Potential Impact - Life

Telecommunications disruptions can have a serious impact on life through the delay or disruption of emergency services. In addition, a serious lack of symmetry can develop between information coming out of the affected area and that which can reach those within the area. This is a recipe for the spreading of false rumors and panic which may interfere with response and relief efforts. Telecommunications breakdown can also delay the mobilization of broader relief efforts and thus contribute to greater suffering and loss of life.

Telecommunications disruptions can also put emergency personnel at greater risk due to the lack of accurate and current situational information. A 2013 United Nations Report indicates that at least 300 firefighters in New York City lost their lives due to communication failures.

Potential Impact - Existing Structures

The delay or disruption of emergency response because of telecommunications disruptions can also result in greater than necessary damage to the built environment and infrastructure.

Potential Impact - Future Development

There has been a rapid growth in population and housing in the planning area in recent years. A larger population and more extensive built environment increase the risk of injury, loss of life, and damage should a serious and widespread telecommunications disruption occur.

In addition, development requires that vigilance is maintained in assuring that new areas of development are fully operational in terms of telecommunications. This issue has been highlighted in the planning area with the discovery of communication issues within the new Battle High School, opened in Columbia in 2013.

It is estimated that approximately 95% of Battle High lacks a radio signal. In an emergency requiring backup, the school safety officer must contact the front desk in order for a landline call to be placed to Joint Communications. (The school also has poor cellular reception.) Boone County and the Columbia Public School System have reached an agreement whereby the County will build and own a 170 foot radio transmission tower at the school; the school district will pay the County a onetime fee. The new tower will also provide a signal for an elementary school scheduled to open in the area in the fall of 2015.

Existing Mitigation Activities

There are many industry developments, government programs, and local abilities which help to mitigate the hazards posed by telecommunication disruptions. Some of these are:

- Increased redundancy in newer networks (e.g. “packet switched” networks)
- “Self-healing” networks where repair begins almost immediately after links are broken
- Increased number of wireless networks
- VoIP (Voice over Internet Protocol) in some jurisdictions
- Public Safety Networks
- GETS (Government Emergency Telecommunications Service) – This federal service provides emergency personnel priority access and processing in the landline networks during an emergency or crisis. The Boone County EMA has four GETS cards internally.
- WPS (Wireless Priority Service) – This federal program authorizes cellular providers to prioritize calls over their networks during emergencies. The service is available to federal, state, tribal and local emergency service providers and essential healthcare providers. Participation by cellular providers is voluntary.
- Cooperative relationships and mutual aid among emergency service providers within the planning area:
- Emergency radio interoperability within the planning area – There are two issues surrounding radio interoperability between the jurisdictions in Boone County:
 1. Frequency – This has been resolved in the planning area; most agencies have the full range of channels used by all the agencies.
 2. Hardware – This is a more difficult issue to resolve as there is an incompatibility between the hardware used by most community agencies and that used by the University of Missouri. Once a Unified Command (UC) has been set up this is no longer an issue because every agency has somebody at UC who can communicate with its officers.
- Amateur (“ham”) radio – This is the only communications infrastructure which has repeatedly demonstrated its ability to operate when electrical power supplies fail. It is the “last to be destroyed, first to be restored”. There is an active Amateur Radio Emergency Service (ARES®) in Boone County. According to their website: “The Amateur Radio Emergency Service (ARES®) in Missouri provides emergency communications to “Served Agencies” such as the Office of Emergency Management, the American Red Cross, the Salvation Army, the National Weather Service, hospitals, and others as agreed in each county.”
- The Missouri – Region F Regional Communication Interoperability Plan (R-CIP)(2015) outlines a three to five year plan to “enhance interoperable and emergency communications” within Region F which is composed of 13 counties in central Missouri.

SUMMARY OF VULNERABILITY

All participating jurisdictions in the planning area are vulnerable to telecommunications disruption. The greatest threat for a serious telecommunications disruption is damage to the commercial telecommunications systems. Telecommunications towers are vulnerable to ice storms, damaging winds, tornadoes and terrorism. Commercial providers are often co-located on these towers so damage to one tower can affect two or three providers. Underground telecommunication components are vulnerable to flooding and earthquakes.

Various federal programs and services, mutual aid agreements, and an active amateur radio organization in Boone County all help to ensure that communications for emergency services stay intact.

A current telecommunications problem being mitigated in the planning area is the lack of an available radio signal at Battle High School in Columbia. To remedy this situation, the County is building a new radio transmission tower at the school in a cooperative agreement with Columbia Public Schools.

5.7 CYBER ATTACK

DESCRIPTION OF HAZARD

Cyber attack is the targeting of computer systems and networks for malicious purposes. The rapid development and reliance on computers networks and the internet makes this threat a serious concern for government, business, and individuals.

Cyber attacks are carried out for a variety of reasons: cyber crime, espionage, political activism (“hacktivism”), and “just for fun”. Local governments are probably most vulnerable to hacktivists seeking to make a statement or individuals just set on disruption.

Location

The entire planning area is at risk from a cyber attack. While some of the smaller local governments may not use their own networks to carry out local government functions, they still rely on other networked systems to support the health and safety of their citizens.

The website hackmaggedon.com collects data on disclosed cyber attacks from the news. As the website states repeatedly, its data represents an overview of “the tip of the iceberg”.

With that caveat in mind, the hackmaggedon.com data for 2014 indicates that governments faced the largest number of attacks (27.1%) followed by industry (25.2%) and finance (15.7%) In addition, the 2014 statistics indicate the motivation behind the attacks as follows: cyber crime (62.3%), hacktivism (24.9%), cyber espionage (10.2%), and cyber warfare (2.5%).

Extent

There is a broad range of methods used for cyber attacks. Some of the methods include:

- Phishing
- Malware
- Distributed Denial of Service (DDoS) – this attack floods an internet domain with large amounts of data thus either slowing its service for legitimate use or blocking it all together; often used to make a political statement to or about the owner of the domain
- Advanced Persistent Threat (APT) – this is a high level, coordinated attack which seeks to infiltrate and remain undetected on the target system; often used for corporate and intelligence espionage

Previous Occurrences

Cyber attacks have been occurring since the very early days of the internet; one of the first known attacks, the Morris worm, took place in 1988. Since that time the number of attacks has increased exponentially and become a very serious concern for government, business, and individuals.

In 2014 alone, there were numerous major attacks on Target, J.P. Morgan, Home Depot, Staples, Healthcare.gov. The year 2015 began with the hacking of two social media accounts run by the U.S. military's Central Command; this was followed by the discovery of a huge breach at Anthem/Blue Cross-Blue Shield with the potential to affect an estimated 80 million customers and employees.

Locally, in December 2014, the City of Columbia's website became a target for cyber attack. The site was hit with a DDoS attack; the website of KOMU, the University of Missouri's commercial television station, was struck a few days later in what was claimed to be a related attack. The attempted disruption to the city's website has continued into 2015 with a wave of DDoS attacks; due to security measures put into place, disruption has been minimal

Probability of Future Events: High

ANALYSIS OF RISK

Measure of Severity: Low to High

The severity of a cyber attack varies depending upon the type of attack and the target. Some damage would be expected from any attack, as staff time and resources are required to deal with an attack and implement higher levels of security for the future.

Successful attacks targeting utilities or hospitals could potentially put public safety at risk, depending upon the type of attack(s) and the backup systems in place. The cascading effects from a serious attack could have wide-ranging impacts.

Potential Impact - Life

There is the potential for a threat to health and safety from a well-planned attack, or series of attacks, on a utility or hospital system.

Potential Impact - Existing Structures

At this point in time, most cyber attacks have been focused on stealing information, damaging files or shutting down networks. However, there have been two confirmed cases of cyber attacks which caused actual physical damage:

- Stuxnet, a computer worm discovered in 2010, is thought to be responsible for ruining about one-fifth of all the nuclear centrifuges in Iran.
- In 2014, hackers gained control of a blast furnace at a German steel plant and caused massive damage at the plant.

While these were high level attacks aimed at strategic targets, the developing capability to cause actual physical destruction is of great concern for the future.

Potential Impact - Future Development

As reliance on computer networks increases throughout the planning area, so does the threat of greater disruption of daily life and operations from cyber attack. Continually updating security measures is vital but cyber criminals' methods and strategies continually evolve to meet new challenges. For this reason, it is extremely important to have backup systems and continuity of operations plans in place for all essential functions potentially disrupted by cyber attack.

Existing Mitigation Activities:

- The Office of Emergency Management has access to CBs and ham radios for backup communications.
- The City of Columbia's Information Technology (IT) Department has a Disaster Recovery Plan in place.
- Stephens College tracks devices being used on the college network; devices must be registered before they can be used.
- Columbia Public Schools uses VoIP (Voice over Internet Protocol) for their phone service. There are hardwired landline phones in each building which could be used in case of a cyber attack on the network.

SUMMARY OF VULNERABILITY

The entire planning area is vulnerable to cyber attack in some fashion; it is an increasingly serious threat in the planning area, as it is throughout the developed world. It is important that local governments have both backup systems and continuity of operations plans in place to help mitigate the risk associated with this hazard.

5.8 UNWANTED INTRUDER/ACTIVE SHOOTER

DESCRIPTION OF HAZARD

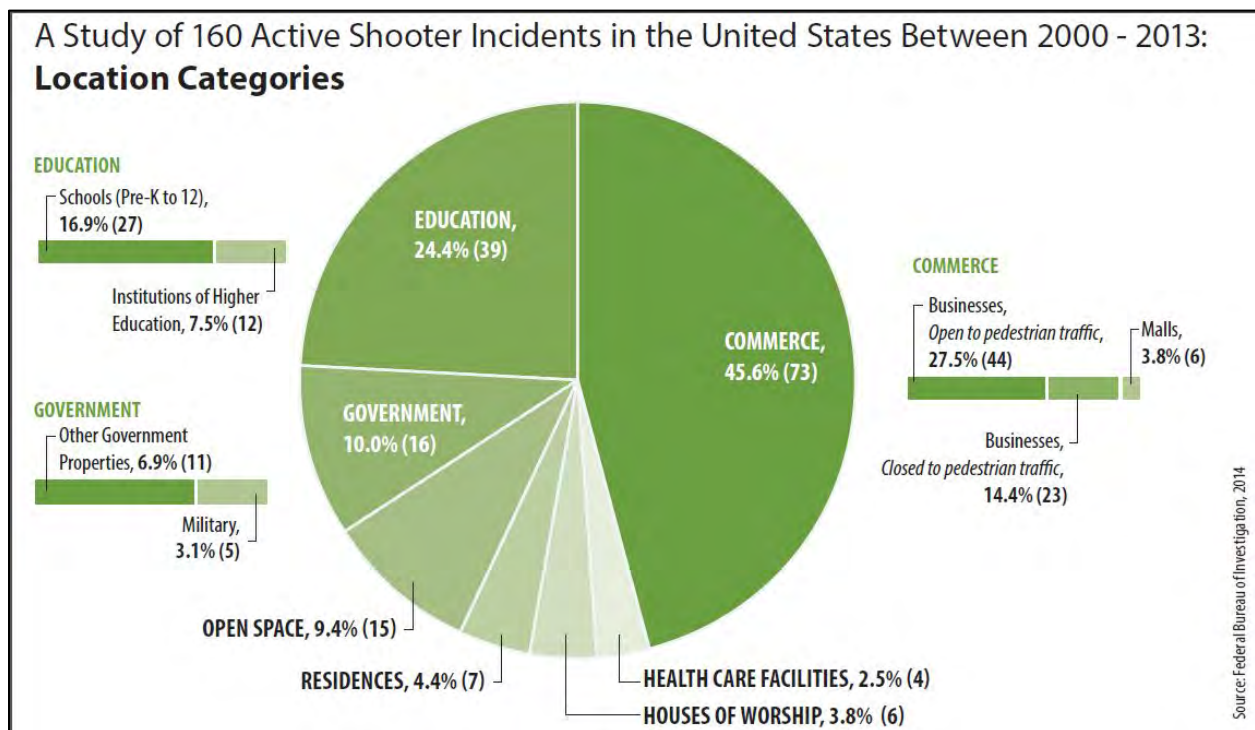
The United States government defines an active shooter as “an individual actively engaged in killing or attempting to kill people in a confined and populated area.” Some government agencies, such as the FBI, now reject the “confined” term in the definition as recent events show that active shooter events can take place in open areas and move between buildings.

Mitigating for active shooter events is essentially mitigating for unwanted intruders; the intention of intruders cannot always be known at the outset.

Location

The entire planning area is at risk from an Unwanted Intruder/Active Shooter event. This is of particular concern for the school districts, colleges, and University who are responsible for large numbers of students and staff. However, an active shooter event can take place in any location. In 2013, the FBI published a study of all known active shooter events in a 14 year period in the U.S. (“A Study of Active Shooter Incidents in the United States Between 2000 and 2013”). The data showed more incidents in businesses open to pedestrian traffic than in educational institutions during the period studied (Figure 5.16).

Figure 5.16



Extent

The 2013 FBI report had the following key findings regarding the nature of the active shooter events studied:

Evolution of the event -

- Active shooter incidents develop very rapidly. In 64 of the incidents where the duration could be determined, 69% of the incidents ended in 5 minutes or less with 36% of the incidents ending in 2 minutes or less.
- 67% of the events ended before police arrived and could engage the shooter
- In 28% of the incidents, law enforcement and the shooter exchanged gunfire
- In 13% of the incidents, unarmed individuals successfully and safely restrained the shooter.
- In 40% of the incidents, the shooters committed suicide

Characteristics of the shooter -

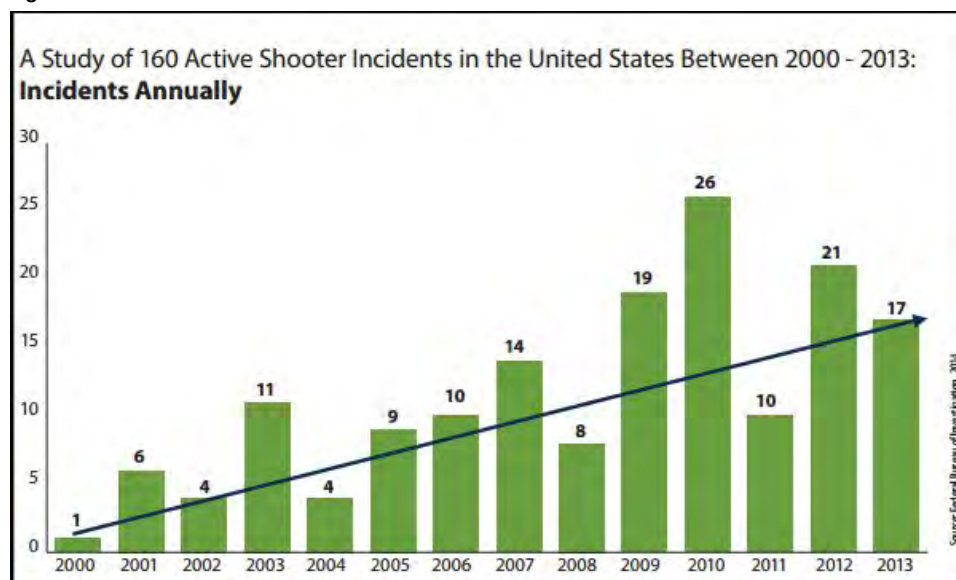
- 99% of the events involved a single shooter
- 96% of the events were carried out by men
- In incidents occurring in businesses closed to pedestrian traffic (23 incidents), all but one of the incidents were carried out by current or previous employees.
- In incidents in businesses open to pedestrian traffic and malls, the shooters generally had no relationship to the businesses.
- In high school and middle school incidents, the shooter was usually a student; the elementary school incidents did not involve a student at the school.

Previous Occurrences

According to information from the Boone County Office of Emergency Management, unwanted intruders occur regularly in the planning area; however, there have been no active shooter events.

Nationwide, the FBI study identified 160 active shooter events in the nation in the period 2000-2013. This was an average of 11.4 events per year with the trend of incidents increasing between 2000 and 2013 (Figure 5.17).

Figure 5.17



Probability of Future Events - High

A unwanted intruder is a common event in the planning area and intention cannot be known at the outset. For this reason, the probability of an unwanted intruder/active shooter event has been rated high. Mitigation for active shooters is, first and foremost, mitigation for unwanted intruders.

ANALYSIS OF RISK

Measure of Severity: High

During the period 2000-2013, 160 active shooter events in the U.S. resulted in 486 deaths and 557 injuries, according to the 2014 FBI study. (Shooter deaths were not included in these statistics.)

Potential Impact – Life

The main impact of active shooter events is the loss of and/or injury to human life. In addition, there is the psychological trauma experienced by all those directly involved in an event, by the families of those involved, and by the wider community.

Potential Impact - Existing Structures

Active shooter events often involve some damage to buildings from the gunfire involved. In addition, a decision is often made after an event to either renovate areas where most of the incident took place or to totally demolish a building.

Potential Impact - Future Development

Educational institutions must take the possibility of active shooter events into account in all future development. One issue brought up in the Planning Committee meetings is that schools must be designed differently than they were in the past. This has caused a problem for at least one school district in the planning area which struggled to get architects to understand the imperative need to prioritize safety over aesthetics.

Existing Mitigation Activities

Extensive work has been done and is ongoing in the planning area to mitigate unwanted/active shooter events and prepare for response. During the hazard mitigation planning process, the representatives from the educational institutions completed a survey of the mitigation and preparedness activities in their jurisdictions (Figure 5.18). Not every one of these measures is being used in each jurisdiction but each educational institution has significant measures in place.

Figure 5.18 Unwanted Intruder/ Active Shooter Mitigation and Preparedness in Boone County Educational Facilities	
PLANNING	Established and enforced anti-bullying policies
	Established point of contact for report of concerns/perceived threats
	Districtwide emergency and crisis plan
	Quick reference guide to crisis plan in every room
	Multiple evacuation routes identified
	Posted emergency exit plans
	Designated shelter locations
	Designated point of contact with police and emergency services
	Limited access to floorplans and blueprints
	Police access to floorplans and blueprints
INFRASTRUCTURE AND STAFF	Locked buildings
	Access control system
	Cameras
	Facility-wide, real-time communication system
	Emergency call boxes
	Window numbering
	Emergency notification system
	Social media
	Emergency escape windows
	Resource officer
	Armed resource officer
TRAINING AND EXERCISES	Ongoing training for staff
	Ongoing training for students
	Ongoing training for parents
	Drills - shelter in place
	Drills - spontaneous evacuation
	Involvement of wider community in training

Boone County Schools Mental Health Coalition: Prior identification of, and assistance for, students struggling with issues which might lead to an active shooter event is critical. (The 2013 FBI study found that students were usually the shooters at middle schools or high schools incidents.) With this in mind, the Boone County Schools Mental Health Coalition will be training all certified staff in Boone County schools in Mental Health First Aid in order to be able to “recognize and respond appropriately to students with signs and symptoms of mental health concerns.” All staff in districts outside of Columbia, in addition to the majority of administrators in Columbia Public Schools, will have gone through this training by the end of 2015. The logistics of training all certified staff in Columbia Public School are still being worked out.

The Boone County Schools Mental Health Coalition is a cooperative agreement between all school districts in the county and the psychology, school counseling, and social work departments at the University of Missouri. The Coalition meets approximately once per month and is funded through the Boone County Children’s Services Board. In addition to the Director, the Coalition will be funding six positions for individuals who will be working in the schools to help those with a variety of needs connect with support systems.

Other mitigation and preparedness activities include:

- A protocol has been established through the Boone County Emergency Management Agency to be used countywide for active shooter events. Several training sessions were held in 2014 with all police/fire/medical personnel.
- Annual drills are carried out in every public school, police department, fire department, and EMS location in Boone County.
- There have been active shooter drills at one large church and a number of workplaces.
- The Columbia Police Department has conducted trainings at some commercial malls.
- Centralia R-VI School District has involved the banks, the City Council, and the A.B. Chance Company in their active shooter trainings.
- Stephens College partnered with the U.S. Department of Homeland Security to host a one-day Security Workshop to enhance awareness of, and response to, an active shooter event (March 2015).

SUMMARY OF VULNERABILITY

The entire planning area is vulnerable to an unwanted intruder/active shooter event. There has been an intensive focus in the planning area on preventing, mitigating, and preparing to respond to this type of event. Programs have been put in place which will continue to expand on the current capabilities.

While the risk of an unwanted intruder/active shooter event is of special concern to the educational institutions with their responsibility for large numbers of students, the data indicates that over 75% of incidents actually occur outside of school settings. The prevention, mitigation, and preparedness activities in the planning area are addressing this reality through the widespread training of all emergency personnel and a widening focus beyond the schools.

5.9 TERRORISM

DESCRIPTION OF HAZARD

The Federal Bureau of Investigation (FBI) defines terrorism as “the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.”

The RAND Corporation, which has been compiling data on terrorism since 1968, provides the following definition for the acts included in its Database of Worldwide Terrorism Incidents (RDWTI):

Terrorism is defined by the nature of the act, not by the identity of the perpetrators or the nature of the cause; key elements include:

- Violence or the threat of violence
- Calculated to create fear and alarm
- Intended to coerce certain actions
- Motive must include a political objective
- Generally directed against civilian targets
- Can be a group or an individual

Terrorism can be perpetrated by either domestic or international/internationally-directed individuals or groups. International terrorism is an evolving threat which, due to recent events, has come into greater focus for local communities.

Location

The entire planning area is vulnerable to terrorism. The City of Columbia is the largest population center and hosts many large-scale events; there are also large festivals and gatherings in numerous other places throughout Boone County. Major pipelines, a potential target, also run through the planning area and major highway systems, allowing easy access, intersect in Columbia.

Extent

Terrorist acts can take many forms. Many of the methods of terrorism have been addressed separately in other sections of this plan: active shooter incident, hazardous materials release causing a public health emergency, transportation incident, utility service disruption, telecommunications disruption, cyber attack, and bombing causing a mass casualty/fatality event; civil unrest may generate terrorist acts. In addition, terrorist acts may take the form of arson, kidnapping, and assassination.

Previous Occurrences

There is a long history of terrorist acts, both domestic and international, in the United States. Domestic terrorist incidents have been perpetrated from both sides of the political spectrum and by religious groups, white supremacist groups, and disaffected individuals.

While not the first international terrorist incidents in the U.S., the 1993 bombing of the World Trade Center in New York City and subsequent Sept. 11, 2001 attacks brought international terrorism into the spotlight for the general public. Events following the 9/11 attacks ushered in a dramatic increase in global terrorism.

There have been no known terrorist attacks in the planning area.

Probability of Future Events - Low

While terrorism has been increasing dramatically worldwide since about 2004 (Figure 5.19), incidents in the U.S. have actually declined since the 1990s (Figure 5.20), according to data from the Global Terrorism Database. The database, which was created by the Center for Terrorism and Intelligence Studies in collaboration with academic institutions and government agencies, currently has data available for the years 1970-2013 (Figure 5.21).

Figure 5.21				
Terrorist Attacks (1970-2013)				
	Successful	Unsuccessful	% Unsuccessful	Total
U.S.	1,668	350	17.3%	2,018
Worldwide	96,800	9,907	9.3%	106,707
Source: Global Terrorism Database				

ANALYSIS OF RISK

Measure of Severity – Low to High

Potential Impact – Life

Terrorism is a serious threat to life. Even if a terrorist event is thwarted and does not result in injury or death, it is still a great psychological trauma for a population.

Potential Impact - Existing Structures

Terrorism is a serious threat to existing structures. Bombs have been and continue to be a frequent tactic of both domestic and international terrorists.

Potential Impact - Future Development

Future development could provide new structural targets for terrorism but, overall, does not really impact the threat.

Existing Mitigation Activities

Information gathering and surveillance of suspected terrorists are major mitigation actions for this hazard. However, due to the nature of the hazard, information on this type of mitigation is not publicly available. All mitigation activities in place in the planning area for hazards which might be used as tools by terrorists also serve as mitigation for this hazard.

SUMMARY OF VULNERABILITY

Terrorism within the U.S. is a fairly rare event when looked at from the perspective of the size of the country. While terrorism has been dramatically increasing worldwide since about 2004, it has been declining in the U.S. since the 1990s. But terrorism is, by its nature and continual evolution, unpredictable. It can take many forms and all jurisdictions in the planning area are vulnerable.

Given the rarity of a terrorist event in the U.S., the planning area would be considered to have a low vulnerability to this hazard; however, that is not zero vulnerability. It is important to be aware of and monitor any potential threats on the local level.

5.10 CIVIL DISORDER

DESCRIPTION OF HAZARD

The rights of free assembly and free speech are protected under the U.S. Constitution. However, at times throughout history, such assemblies have turned destructive and violent; such behavior conflicts with the government's role, outlined in the Preamble of the Constitution, to "promote domestic tranquility". This transformation of a peaceful gathering to a violent crowd or mob is almost always preceded by some actual or perceived triggering event.

The Revised Statutes of MO, Section 574.070, define civil disorder as "any public disturbance involving acts of violence by assemblages of three or more persons, which causes an immediate danger of or results in damage or injury to the property or person of any other individual".

Location

If a civil disorder event were to occur in the planning area, it would most probably take place in the major population center, the City of Columbia, or at the institutes of higher education in Columbia (Columbia College, Stephens College, or the University of Missouri).

Extent

Civil disorder can range from minor infractions of law to large scale rioting.

Previous Occurrences

There were two notable historic instances of civil disorder in the planning area. They both resulted in lynching:

- In 1853, a slave who had been accused of attempting to rape a 15-year old white girl was dragged from the Boone County jail and lynched on the outskirts of Columbia. The lynching occurred after another lynching mob had been persuaded from their action the day before (*Missouri's Black Heritage*, Lorenzo J. Green, Gary R. Kremer, Antonio F. Holland, University of Missouri Press, 1993).
- On April 29, 1923, a black janitor at the University of Missouri was lynched by a crowd for the alleged rape of a 15-year old white girl. The man had been forcibly removed from the Boone County jail by the mob. The lynching on the Stewart Street Bridge in Columbia occurred despite the pleas of the girl's father who said he believed the man was innocent ("Legacy of a Lynching", *Columbia Missourian*, May 3-8, 2003).

In May 1960, large anti-war rallies were held at the University of Missouri (MU) in Columbia after four students were shot and killed by National Guardsmen at Kent State in Ohio. Some arrests of MU students and faculty were made but the protests were largely non-violent ("Panelists recount Vietnam War-era protests on MU campus", *Columbia Tribune*, April 22, 2014).

In 1986, there was civil unrest for a few days which involved rock throwing along Providence Road in Columbia. Also in the mid-1980s, there were rallies at the University of Missouri

promoting the University's divestiture in South African investments; shanties were set up on campus but the demonstrations remained peaceful.

In 2014, there was prolonged civil unrest resulting in deaths, injuries, and destroyed property in Ferguson, Missouri, in the wake of the shooting death of a black teenager by a police officer. Protests took place in Columbia after the Ferguson shooting but they remained peaceful.

Probability of Future Events - Low

The *Missouri Hazard Analysis* concluded that there will continue to be protests and demonstrations in the state which could erupt into civil disorder. "However, based on the state's general history of civil disturbance...the probability that such incidents will develop into full-scale riots is considered low."

ANALYSIS OF RISK

Measure of Severity – Low to High

There is a large range of impacts which could occur with civil disorder based on many variable factors. Some disturbances might result in minor infractions/property damage while large disturbances can result in major injuries, death, extensive property damage, high economic losses and high emergency management costs.

Potential Impact - Life

Civil disorder poses a risk of injury and possibly even death in large scale rioting.

Potential Impact - Existing Structures

There is the potential for significant damage to buildings and property from civil disorder which becomes violent.

Potential Impact - Future Development

Development, in and of itself, should not impact civil unrest. However, it is very important that citizens feel they have a voice in any development which will impact their lives and homes. Unfair treatment, real or perceived, could become a triggering event for civil unrest.

Existing Mitigation Activities

The planning area is well prepared for a multi-agency response should civil unrest pose a threat.

The University of Missouri encourages marches on campus to avoid greater problems which might occur if students felt they had not been allowed to express their ideas. The University works with the leaders of marches and clearly outlines the boundaries of acceptable/unacceptable behavior and uses social media to communicate with students.

SUMMARY OF VULNERABILITY

Civil disorder is not a major concern for the planning area; the historical record would indicate a mostly peaceful history of protests and demonstrations through some very challenging times. The last major incident of civil unrest, a lynching, took place almost 100 years ago.

While there is a low probability of civil disorder, the City of Columbia, Columbia College, Stephens College, and the University of Missouri are vulnerable to this hazard. The University of Missouri has adopted a proactive approach to civil disorder by working with demonstration leaders to assure freedom of speech rights while clearly delineating the boundaries of appropriate conduct.

5.11 MASS CASUALTY/FATALITY EVENT

DESCRIPTION OF HAZARD

Mass casualty/fatality is a potential cascading effect from many of the hazards profiled in this plan. Notably, an earthquake, damaging winds, tornado, public health emergency, transportation incident, active shooter, terrorism, and civil disorder have the potential to cause mass casualties/fatalities in the planning area. In addition, the planning area includes major transportation corridors running both east/west and north/south. Vehicle accidents are another potential cause of a mass casualty/fatality event.

Mass casualty/fatality is being profiled as its own event to allow for specific analysis of potential effects of multiple injury/loss of life in the planning area.

Location

The entire planning area is vulnerable to a mass casualty/fatality event.

Extent

The term “extent” is meaningless for a mass casualty/fatality event by the definition used in this plan which is “an attribute of the hazard alone ... (which) does not include its effect on humans”. By definition, a mass casualty/fatality event has affected humans.

Previous Occurrences

There have been numerous incidents of mass casualty/fatality in the planning area. The rate of school bus accidents averages approximately one every other year, according to an estimate from the Boone County Fire Protection District.

In 2005, there was a van accident on I-70 to the west of Columbia which involved 17 people; there were numerous injuries and some fatalities.

In 2013, there were over 100 medical emergency incidents at University of MO football game. Most of the incidents were related to dehydration which was exacerbated by alcohol.

Probability of Future Events – High

ANALYSIS OF RISK

Measure of Severity – Moderate - High

Potential Impact – Life

By definition, a mass casualty/fatality event has caused injury and/or loss of life. In analyzing further effects of mass casualties/fatalities, the psychological effect is paramount. In addition to traumatic shock to the population as a whole, those who have lost loved ones will be dealing with grief and potential loss of income for life maintenance. There will be a great need for a variety of types of support for those directly affected.

Potential Impact - Existing Structures

Mass casualty/fatality events are not a threat to infrastructure although there may have been structural damage from the precipitating incidents. However, mass casualty/fatality events do put a strain on emergency and medical personnel/facilities.

Potential Impact - Future Development

As populations grow and increase in density, it is important that supporting infrastructure and services increase accordingly; this is important at all times but lack of appropriate balance will be highlighted in times of extreme duress such as mass casualty/fatality events.

Existing Mitigation Activities

All of the mitigation activities for the other hazards in this plan help to mitigate mass casualty/fatality events. The following mitigation action has been included in the plan specifically to address the risks associated with multiple injury/loss of life in the planning area:

- Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.

SUMMARY OF VULNERABILITY

Mass casualty/fatality events are a fairly common occurrence in the planning area; all participating jurisdictions are vulnerable to such events.

Historically, the majority of mass casualty/fatality events have been related to vehicular accidents on roads and highways. However, many of the hazards profiled in this plan could cause mass casualties or fatalities; mitigation for those hazards also helps to mitigate for these events.

Section 6: Mitigation Strategy

6.1 GOALS, OBJECTIVES AND ACTIONS

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

The hazard mitigation goals first developed during the 2004 planning process were updated in 2015 to reflect the inclusion of technological and human-made disasters in the mitigation plan.

The five goals for the Boone County Hazard Mitigation Plan (2015) are:

- Goal 1: Mitigation Planning - Mitigate the effects of future natural, technological, and human-made hazards throughout the County through public and private action.
- Goal 2: Mitigation Policy - Develop policies that limit the impact of natural, technological, and human-made hazards on lives and property.
- Goal 3: Mitigation Programs - Implement cost effective and feasible mitigation programs to protect lives and property of Boone County jurisdictions.
- Goal 4: Public Awareness - Increase public awareness of natural, technological, and human-made hazards in order to make the public a greater partner in hazard mitigation planning.
- Goal 5: Future Development - Promote hazard-proof development in the jurisdictions of Boone County.

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

The original Project Steering Committee (2004-2005) was charged with developing a comprehensive range of mitigation actions to promote the agreed upon mitigation goals. Objectives were defined under each goal and the mitigation actions were then developed to promote each objective. The following six categories of mitigation were considered in developing the mitigation actions:

- **Prevention tools** - regulatory methods such as planning and zoning, building regulations, open space planning, land development regulations, and storm water management.
- **Property protection measures** - acquisition of land, relocation of buildings, modifying at-risk structures, and flood proofing at-risk structures.
- **Natural resource protection** - erosion and sediment control or wetlands protection.
- **Emergency services measures** – warning systems, response capacity, critical facilities protection, and health and safety maintenance.
- **Structural mitigation** - reservoirs, levees, diversions, channel modifications and storm sewers.
- **Public information** - providing hazard maps and information, outreach programs, real estate disclosure, technical assistance and education.

UPDATE OF MITIGATION ACTIONS

The Planning Committee for the 2010 update reviewed and evaluated the status of the mitigation actions from the original plan. In order to ensure that there was a comprehensive mitigation approach to each hazard, there was a discussion of each hazard and the existing actions focused on its mitigation. Most actions were retained for the 2010 update; some were deleted as unrealistic or inappropriate and some new actions were added.

For the 2015 update, the actions in the plan were again reviewed by the planning committee and categorized as follows:

- Completed actions (Figure 6.1) are now discussed in the plan as “existing mitigation strategies” in the hazard sections and were removed from the 5-year mitigation strategy action plan
- Some uncompleted actions were removed from the strategy action plan for various reasons (Figure 6.2)
- Many of the 2010 actions were kept in the 2015 strategy action plan either because they have not yet been completed or because they are ongoing actions which the committee wanted to highlight in the overall plan (Figure 6.3).

In addition, the planning committee added new actions to the 2015 update in order to have a comprehensive mitigation strategy for all hazards (Figure 6.4).

Figure 6.1			
2010 Plan Mitigation Actions			
Completed and Removed from 2015 Mitigation Strategy Action Plan			
2010 #	Mitigation Action	Jurisdiction	Description of Implementation
1.1.2	Adopt Flood Insurance Rate Maps (FIRM) when updated.	County and all participating communities	The new FEMA D-FIRM maps were adopted in 2011. Action has been removed because FIRM maps will not be updated again in near future.
1.1.3	Become a participant in the NFIP.	Harrisburg and Huntsdale	Harrisburg joined the NFIP in 2012 and Huntsdale joined in 2015.
1.1.4	Encourage development of Storm Water Master Plan.	County	The Boone County Storm Water Master Plan was completed in 2010.
2.1.2	Review and update flood damage prevention/floodplain management ordinances, in compliance with NFIP requirements, when current and correct D-FIRMs are available.	County and all participating communities	Floodplain regulations were updated either when the new maps were adopted and/or during the NFIP review. Update of regulations is part of NFIP compliance action.
2.1.3	Develop building codes or ordinances to ensure post-development flow mimics pre-development flow in regard to storm water.	County, Ashland, Centralia, Columbia, Hallsville, Hartsburg, Sturgeon	This is now addressed in the Boone County Stormwater regulations and the subdivision regulations. Columbia covers this in the stream buffer ordinance and Stormwater Manual. In Centralia, this is part of the subdivision code. The other communities for which this action was written in 2010 did not see the need for this action at this time.
2.1.4	Limit construction and development in known subsidence/sinkhole areas.	County	This is now covered in the Boone County Stormwater regulations and the subdivision regulations; engineering plans are required for proposed development in these areas.
2.2.2	Encourage adoption of building codes in every incorporated community.	Huntsdale	The County and all participating incorporated communities have building regulations or codes. This action should have been deleted in the 2010 update.
2.2.5	Adopt the prevailing County regulations concerning storm water once they are formalized by the County.	Hartsburg	This is not needed as Hartsburg's policy is to follow all the County codes and regulations.
5.0.1	Adopt procedures for review of subdivision plans to minimize flood problems.	County, Ashland, Centralia, Columbia, Hallsville, Hartsburg, Sturgeon	This is in place in all jurisdictions which had it as an action in the 2010 plan.

Figure 6.2

2010 Plan Mitigation Actions Removed during 2015 Plan Update		
2010 #	Mitigation Action	Reason for Removal
1.1.5	Update Public Safety Joint Communications staff knowledge of earthquake safety.	This action is no longer relevant as Public Safety/Joint Communication is no longer in charge of Emergency Management for the Planning Area. The Emergency Management Agency staff are regularly involved in training and exercises.
1.1.6	Have alternate power sources readily available for the electric needs of emergency vehicles and the buildings where they are located.	The evaluation was made that various measures are in place throughout the Planning Area which ensure the operability of emergency vehicles when needed. This action was removed because it is not needed and suffers from confusing and arbitrary language.
1.1.10	Encourage cooperative agreements between municipalities and water supply districts to ensure adequate supply for fire flow.	This action was removed because, for the most part, this is under the jurisdiction of the fire districts/departments. The only jurisdiction with its own fire department is the City of Columbia and it has mutual water agreements in place.
1.2.1	Encourage electric utilities to maintain right of ways.	This is being moved to the "existing mitigation/operating assumptions" section of the plan as the right of ways are being well maintained.
2.2.4	Adopt regulation stating that any newly built dam must have a maintenance plan approved before construction.	This was an action for the County but the County does not have the legal authority to require this.
3.1.3	Evaluate and implement effective strategies to mitigate flooding at the wastewater treatment plant in Rocheport.	This was an action for the City of Rocheport. The City no longer owns or operates the wastewater treatment plant; it is now owned and operated by the Boone County Regional Sewer District.
4.0.2	Maintain and distribute materials for public regarding earthquakes in Missouri and the benefits and availability of earthquake insurance.	This is not needed as it is included in the Action #4.0.1 ("Continue to education the public on all hazards.")

Figure 6.3

2010 Plan Mitigation Actions Retained for 2015 Mitigation Strategy			
2010 #	2015 #	Mitigation Action	Implementation/Current Status
1.1.1	1.1.1	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.	Boone County has a new LiDAR flight (even higher quality elevation data) scheduled for spring of 2015 and will be sharing that info with the National Elevation Data program that FEMA uses for the D-FIRM maps.; in addition, aerial photography is scheduled for late 2015.
1.1.7	1.1.3	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.	This is being done. The OEM is moving to a targeted polygon area of warning so that the particular area of the county impacted by the threat can be warned instead of always warning the entire county. A public education campaign will take place when this is instituted.
1.1.8	1.1.4	The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.	This is a Boone County action; a schedule is being adhered and this will continue.
1.1.9	1.1.5	Encourage the local water district to have adequate fire flow.	This action is for Sturgeon and is still needed as the issue has not been satisfactorily resolved.
1.2.2	1.2.1	Encourage underground utilities in improvements and new development.	Underground utilities are required in both Ashland and Centralia subdivisions; Hallsville has a policy, working in conjunction with Boone Electric Coop and Ameren, of undergrounding utilities in all new subdivisions; Columbia Water & Light Department continues its policies of undergrounding in new developments as well as actively undergrounding approximately one mile of existing overhead electric each year. The language of this action has been changed for the update to read: "Encourage underground utilities where feasible."
1.2.3	1.2.2	Review and formalize relationships with cooling centers in each community.	Some work still needs to be done in formalizing these relationships with written agreements so that the capacity is not lost with changes in staffing on either the public or private sector.
2.1.1	2.1.1	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	This is taking place. Two additional communities (Harrisburg and Huntsdale) now have floodplain ordinances since they have joined the NFIP.

Figure 6.3 (cont.)

2010 Plan Mitigation Actions Retained for 2015 Mitigation Strategy			
2010 #	2015 #	Mitigation Action	Implementation/Current Status
2.1.5	2.1.2	Add sinkhole regulations to stream buffer/storm water ordinance.	This has not been addressed due to more pressing political issues in the City. The Stormwater Utility staff is aware of this as an issue of increasing importance as Columbia develops to the south and west.
2.1.6	2.1.3	Develop policy and enforcement regulations concerning burning and/or encourage development of burn permit procedure.	Ashland has burning restrictions; Columbia requires a permit for open burning; Hallsville has a burning ordinance in place; Sturgeon passed Ordinance #724 regarding burning in 2010.
2.2.1	2.2.1	Review building codes every two years for possible update.	This is being done.
2.2.3	2.2.2	Develop regulations for roads on dams.	This is an action for Columbia and work still needs to be done around this.
3.1.1	3.1.1	Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).	This is still needed as new facilities are built.
3.1.2	3.1.2	Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.	There has not been any replacement of water lines in Sturgeon due to the current lack of funding availability.
3.1.4	3.1.3	Mitigate the effects of flooding on public infrastructure.	In Columbia, the Scott Blvd. bridge over Hinkson Creek was rebuilt at a higher elevation in 2014; this will mitigate flooding which has incapacitated the bridge 6-7 times since it was originally constructed. A detention basin in south Columbia is being retrofitted to mitigate flooding on the Hinkson. In addition, pipe sizes are being increased in various locations. This is no longer an action for Rocheport as they sold their wastewater plant to BCRSD and don't have any city property vulnerable to flooding.
3.2.1	3.2.1	Ensure evacuation plans are adequate for nursing homes and special needs populations.	This is an ongoing action.
3.2.2	3.2.2	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.	This is being done in all the schools.
3.2.3	3.2.3	Evaluate and maintain emergency preparedness plans.	This is being done in all the schools.
3.2.4	3.2.4	Conduct emergency preparedness exercises periodically throughout the year.	This is being done in all the schools; this is also now mandated by law in Missouri.

Figure 6.3 (cont.)

2010 Plan Mitigation Actions Retained for 2015 Mitigation Strategy			
2010 #	2015 #	Mitigation Action	Implementation/Current Status
3.2.5	3.2.5	Build tornado safe rooms.	Most jurisdictions are in need of safe rooms but lack the funding at this time. Personnel from Centralia R-VI School District are exploring possibilities for a tornado safe room and have visited other districts to discuss their safe rooms and project funding. Wording of action amended to include hardening of existing structures to FEMA 361 standards.
3.2.6	3.2.6	Encourage shelters to have alternative heating sources.	This is an ongoing discussion with selected and approved shelter through the American Red Cross. The availability and expense of generators is a huge issue for communities. The loosening of FEMA rules for mitigation funding of generators is a positive step.
4.0.1	4.0.1	Continue to educate the public on natural hazards.	In 2011, the EMD assisted with nearly 200 media contacts, citizen presentations and ongoing education initiatives in the County. Social media accounts have been created for the Office of Emergency Management to assist in public education. Staff continue to meet with the public to raise disaster awareness. The wording of this action has been edited to reflect the "all hazards" nature of the 2015 updated plan.
4.0.3	1.2.4	Continue to help the public realize the liability and responsibility for maintaining dams on private property.	This action was majorly rewritten to read, "Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs)" in order to (hopefully) make it more effective.
5.0.2	5.01	Target Repetitive Loss Properties for flood buyout.	The City of Columbia has completed two residential buyouts in recent years; the homes were both located in Zone X. However, there are still some properties which are repeatedly flooded.
5.0.3	5.0.2	Acquire properties susceptible to flood damage when buyout grants are available.	This is an action for Rocheport which has a number of properties in the floodplain, but not repetitive loss properties. Some of these properties owners might be amenable to leaving the floodplain at some point.

Figure 6.4

New Actions for 2015 Mitigation Strategy	
2015 #	Mitigation Action
1.1.2	Continue to participate as a partner in FEMA's RISKMap process.
1.1.6	Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.
1.1.7	Conduct a survey of generator needs of critical infrastructure in Planning Area; include information on sizing, hookup, and fuel storage.
1.1.8	Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.
1.1.9	Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.
1.1.10	Develop Continuity of Operations Plans (COOPs).
1.1.11	Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.
1.2.3	Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.
1.2.4	Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).
3.1.4	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.
3.2.7	Acquire generators and power transfer hookup equipment.
3.2.8	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.
3.2.9	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
3.2.10	Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.
3.2.11	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.
3.2.12	Enhance alert and warning capabilities.
4.0.2	Promote the purchase and use of NOAA radios.
4.0.3	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.

2015 MITIGATION GOALS, OBJECTIVES, AND ACTIONS

A comprehensive list of the goals, objectives, and mitigation actions for the 2015 Boone County Hazard Mitigation Plan follows. The mitigation actions listed are for the entire planning area; participating jurisdictions will differ in the specific actions undertaken in their jurisdictions. The mitigation actions for each participating jurisdiction are included in Section 6.3: Implementation, Administration, and Integration in Participating Jurisdictions.

Actions which address reducing the effects of hazards on new and/or existing buildings and infrastructure are indicated as such in parentheses following the actions (i.e. New, Existing, Both).

Goal 1: Mitigation Planning - Mitigate effects of future natural hazards throughout the County through public and private action.

Objective 1.1 Incorporate mitigation planning and procedures into the community.

- 1.1.1 Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data. (Both)
- 1.1.2 Continue to participate as a partner in FEMA's RISKMap process. (Both)
- 1.1.3 Continue with monthly testing of warning systems in compliance with procedures set out by the Office of Emergency Management.
- 1.1.4 The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads. (Both)
- 1.1.5 Encourage the local water district to have adequate fire flow. (Both)
- 1.1.6 Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.
- 1.1.7 Conduct a survey of generator needs of critical infrastructure in planning area; include information on sizing, hookup, and fuel storage.
- 1.1.8 Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities. (Both)
- 1.1.9 Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.
- 1.1.10 Develop a Continuity of Operations Plan (COOP).
- 1.1.11 Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants. (Both)

Objective 1.2 Encourage private involvement in mitigation activities.

- 1.2.1 Encourage underground utilities where feasible. (Both)
- 1.2.2 Review and formalize relationships with cooling and warming centers in each community.
- 1.2.3 Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.
- 1.2.4 Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).

Goal 2: Mitigation Policy - Develop policies that limit the impact of natural hazards on lives and property.

Objective 2.1 Pass appropriate ordinances for mitigation efforts.

- 2.1.1 Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements. (Both)
- 2.1.2 Add sinkhole regulations to stream buffer/storm water ordinance. (New)
- 2.1.3 Develop policy and enforcement regulations concerning burning permits. (Both)

Objective 2.2 Adopt new codes and standards.

- 2.2.1 Review building codes every two/three years for possible update. (Both)
- 2.2.2 Develop regulations for roads on dams. (Both)

Goal 3: Mitigation Programs - Implement cost effective and feasible mitigation programs to protect lives and property of Boone County jurisdictions.

Objective 3.1 Protect buildings and valuable assets.

- 3.1.1 Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment). (Both)
- 3.1.2 Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow. (Both)
- 3.1.3 Mitigate the effects of flooding on public infrastructure. (Both)
- 3.1.4 Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.

Objective 3.2 Protect vulnerable populations.

- 3.2.1 Ensure evacuation plans are adequate for nursing homes and special needs populations.
- 3.2.2 Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
- 3.2.3 Evaluate and maintain emergency preparedness plans.
- 3.2.4 Conduct emergency preparedness exercises periodically throughout the year.
- 3.2.5 Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
- 3.2.6 Encourage shelters to have alternative heating sources.
- 3.2.7 Acquire generators and power transfer hookup equipment.
- 3.2.8 Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.
- 3.2.9 Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events. (Both)
- 3.2.10 Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.
- 3.2.11 Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.
- 3.2.12 Enhance alert and warning capabilities.

Goal 4: Public Awareness - Increase public awareness of natural hazards in order to make the public a greater partner in hazard mitigation planning.

- 4.0.1 Continue to educate the public on all hazards.
- 4.0.2 Promote the purchase and use of NOAA radios.
- 4.0.3 Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.

Goal 5: Future Development - Promote hazard-proof development in the jurisdictions of Boone County.

- 5.0.1 Target Repetitive Loss Properties for flood buyout. (Existing)
- 5.0.2 Acquire properties susceptible to flood damage when buyout grants are available. (Existing)

OVERVIEW OF MITIGATION ACTIONS BY HAZARDS ADDRESSED AND PARTICIPATING JURISDICTIONS

An overview of the mitigation actions for the 2015 update is shown by the hazards addressed (Figure 6.5) and by the participating jurisdictions to which they apply (Figure 6.6).

The Boone County Office of Emergency Management carries out many mitigation actions which benefit the entire planning area. The jurisdictions benefiting from such actions are indicated in Figure 6.6 with the use of asterisks (*).

Figure 6.5

Overview of Mitigation Actions by Hazards Addressed																					
Action #	Mitigation Action	Natural												Technological/Human-made							
		Flood	Levee Failure	Dam Failure	Earthquake	Land Subsidence/Sinkhole	Damaging Winds	Hail	Lightning	Tornado	Severe Winter Weather	Drought	Extreme Heat	Wildfire	Public Health Emergency	Hazardous Materials Release	Transportation Incident	Nuclear Incident	Utility Service Disruption	Telecommunications Disruption	Cyber Attack
1.1.1	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.	✓																			
1.1.2	Continue to participate as a partner in FEMA's RISKMap process.	✓	✓																		
1.1.3	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.						✓			✓											
1.1.4	The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.						✓			✓	✓			✓					✓	✓	
1.1.5	Encourage the local water district to have adequate fire flow.				✓									✓							
1.1.6	Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.														✓	✓					
1.1.7	Conduct a survey of generator needs of critical infrastructure in Planning Area; include information on sizing, hookup, and fuel storage.	✓			✓		✓		✓	✓	✓		✓		✓		✓		✓	✓	✓

Figure 6.5 (cont.)

Figure 6.5 (cont.)																										
Overview of Mitigation Actions by Hazards Addressed																										
		Natural													Technological/Human-made											
Action #	Mitigation Action	Flood	Levee Failure	Dam Failure	Earthquake	Land Subsidence/ Sinkhole	Damaging Winds	Hail	Lightning	Tornado	Severe Winter Weather	Drought	Extreme Heat	Wildfire	Public Health Emergency	Hazardous Materials Release	Transportation Incident	Nuclear Incident	Utility Service Disruption	Telecommunications Disruption	Cyber Attack	Active Shooter	Terrorism	Civil Disorder	Mass Casualty/Fatality Event	
1.1.8	Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.																			✓	✓		✓			
1.1.9	Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
1.1.10	Develop a Continuity of Operations Plan (COOP).	✓			✓		✓		✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
1.1.11	Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
1.2.1	Encourage underground utilities where feasible.						✓		✓	✓	✓			✓					✓	✓			✓			
1.2.2	Review and formalize relationships with cooling and warming centers in each community.												✓		✓											
1.2.3	Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.																			✓						
1.2.4	Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).			✓																						

Figure 6.5 (cont.)

Overview of Mitigation Actions by Hazards Addressed																										
		Natural														Technological/Human-made										
Action #	Mitigation Action	Flood	Levee Failure	Dam Failure	Earthquake	Land Subsidence/ Sinkhole	Damaging Winds	Hail	Lightning	Tornado	Severe Winter Weather	Drought	Extreme Heat	Wildfire	Public Health Emergency	Hazardous Materials Release	Transportation Incident	Nuclear Incident	Utility Service Disruption	Telecommunications Disruption	Cyber Attack	Active Shooter	Terrorism	Civil Disorder	Mass Casualty/Fatality Event	
2.1.1	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	✓																								
2.1.2	Add sinkhole regulations to stream buffer/storm water ordinance.					✓																				
2.1.3	Develop policy and enforcement regulations concerning burning permits.													✓												
2.2.1	Review building codes every two/three years for possible update.				✓				✓	✓	✓			✓												
2.2.2	Develop regulations for roads on dams.			✓																						
3.1.1	Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).				✓		✓			✓																
3.1.2	Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.													✓												
3.1.3	Mitigate the effects of flooding on public infrastructure.	✓																								
3.1.4	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tomadoes.															✓										

Figure 6.5 (cont.)

Overview of Mitigation Actions by Hazards Addressed																									
		Natural											Technological/Human-made												
Action #	Mitigation Action	Flood	Levee Failure	Dam Failure	Earthquake	Land Subsidence/ Sinkhole	Damaging Winds	Hail	Lightning	Tornado	Severe Winter Weather	Drought	Extreme Heat	Wildfire	Public Health Emergency	Hazardous Materials Release	Transportation Incident	Nuclear Incident	Utility Service Disruption	Telecommunications Disruption	Cyber Attack	Active Shooter	Terrorism	Civil Disorder	Mass Casualty/Fatality Event
3.2.1	Ensure evacuation plans are adequate for nursing homes and special needs populations.				✓				✓	✓	✓					✓			✓						
3.2.2	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.				✓																				
3.2.3	Evaluate and maintain emergency preparedness plans.				✓		✓			✓	✓				✓							✓	✓	✓	
3.2.4	Conduct emergency preparedness exercises periodically throughout the year.				✓		✓			✓												✓			
3.2.5	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.						✓			✓															
3.2.6	Encourage shelters to have alternative heating sources.	✓			✓		✓			✓	✓					✓			✓						
3.2.7	Acquire generators and power transfer hookup equipment.	✓			✓		✓	✓	✓	✓	✓								✓			✓			
3.2.8	Develop strategy for provision of 72-hour kits for most vulnerable populations; include food, water, hygiene, and medical supplies.														✓										
3.2.9	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.																					✓			

Figure 6.5 (cont.)

Overview of Mitigation Actions by Hazards Addressed																			
Action #	Mitigation Action	Natural												Technological/Human-made					
		Flood	Levee Failure	Dam Failure	Earthquake	Land Subsidence/ Sinkhole	Damaging Winds	Hail	Lightning	Tornado	Severe Winter Weather	Drought	Extreme Heat	Wildfire	Public Health Emergency	Hazardous Materials Release	Transportation Incident	Nuclear Incident	Utility Service Disruption
3.2.10	Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.	✓			✓		✓			✓					✓	✓	✓	✓	
3.2.11	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.																✓		
3.2.12	Enhance alert and warning capabilities.				✓		✓	✓	✓	✓	✓		✓		✓	✓		✓	
4.0.1	Continue to educate the public on all hazards.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4.0.2	Promote the purchase and use of NOAA radios.	✓	✓		✓		✓	✓	✓	✓	✓								
4.0.3	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.	✓	✓	✓	✓	✓	✓			✓	✓				✓	✓		✓	✓
5.0.1	Target Repetitive Loss Properties for flood buyout.	✓																	
5.0.2	Acquire properties susceptible to flood damage when buyout grants are available.	✓	✓																

Figure 6.6

Figure 6.6

Overview of Mitigation Actions by Jurisdiction																				
Action #	Mitigation Action	County	Ashland	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon	Centralia R-VI	Columbia P.S.	Hallsville R-IV	Harrisburg R-VIII	Southern Boone	Sturgeon R-V	Columbia College	Stephens College	University of MO
1.1.1	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.	L	*	*	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1.1.2	Continue to participate as a partner in FEMA's RISKMap process.	L	*	*	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1.1.3	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.	L	*	L	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*
1.1.4	The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.	L																		
1.1.5	Encourage the local water district to have adequate fire flow.										L									
1.1.6	Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1.1.7	Conduct a survey of generator needs of critical infrastructure in Planning Area; include information on sizing, hookup, and fuel storage.	L	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
1.1.8	Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.	L	P	P	P	P	P	P	P	P	P									
1.1.9	Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.	L	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
1.1.10	Develop a Continuity of Operations Plan (COOP).	L	L	L	L	L	L				L	L	L	L	L	L	L			
1.1.11	Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.	L	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Key: L = lead jurisdiction for action; P = partnering jurisdiction; * = serves as mitigation action for this jurisdiction also																				

Figure 6.6 (cont.)

Figure 6.6 (cont.)																				
Overview of Mitigation Actions by Jurisdiction																				
Action #	Mitigation Action	County	Ashland	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon	Centralia R-VI	Columbia P.S.	Hallsville R-IV	Harrisburg R-VIII	Southern Boone	Sturgeon R-V	Columbia College	Stephens College	University of MO
1.2.1	Encourage underground utilities where feasible.	L		L			L		L	L	L									
1.2.2	Review and formalize relationships with cooling and warming centers in each community.	L	P	P	P	P	P	P	P	P	P									
1.2.3	Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1.2.4	Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).	L		*	*	*	*													
2.1.1	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	L	L	L	L	L	L	L	L	L	L									
2.1.2	Add sinkhole regulations to stream buffer/storm water ordinance.				L															
2.1.3	Develop policy and enforcement regulations concerning burning permits.			L																
2.2.1	Review building codes every two/three years for possible update.	L			L															
2.2.2	Develop regulations for roads on dams.				L															
3.1.1	Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).	L			L															
3.1.2	Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.										L									
3.1.3	Mitigate the effects of flooding on public infrastructure.	L			L															
3.1.4	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.	*			*															L
3.2.1	Ensure evacuation plans are adequate for nursing homes and special needs populations.	L	*	*	*	*	*	*		*	*									
3.2.2	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.											L	L	L	L	L	L	L	L	L
Key: L = lead jurisdiction for action; P = partnering jurisdiction; * = serves as mitigation action for this jurisdiction also																				

Figure 6.6 (cont.)

Figure 6.6 (cont.)																				
Overview of Mitigation Actions by Jurisdiction																				
Action #	Mitigation Action	County	Ashland	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon	Centralia R-VI	Columbia P.S.	Hallsville R-IV	Harrisburg R-VIII	Southern Boone	Sturgeon R-V	Columbia College	Stephens College	University of MO
3.2.3	Evaluate and maintain emergency preparedness plans.											L	L	L	L	L	L	L	L	L
3.2.4	Conduct emergency preparedness exercises periodically throughout the year.											L	L	L	L	L	L	L	L	L
3.2.5	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.		L				L				L	L	L	L	L	L	L	L		L
3.2.6	Encourage shelters to have alternative heating sources.	L	*	*	*	*	*	*		*	*									
3.2.7	Acquire generators and power transfer hookup equipment.	L	*	*	*	*	*	*	*	*	*									
3.2.8	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.	L			L															
3.2.9	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.											L	L	L	L	L	L	L	L	L
3.2.10	Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3.2.11	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.	*	*		L															
3.2.12	Enhance alert and warning capabilities.																			L
4.0.1	Continue to educate the public on all hazards.	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4.0.2	Promote the purchase and use of NOAA radios.	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
4.0.3	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.	L	*	*	L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
5.0.1	Target Repetitive Loss Properties for flood buyout.				L															
5.0.2	Acquire properties susceptible to flood damage when buyout grants are available.									L										
Key: L = lead jurisdiction for action; P = partnering jurisdiction; * = serves as mitigation action for this jurisdiction also																				

Requirement §201.6(c)(3)(ii):	<i>[The mitigation strategy] must also address the jurisdiction’s participation in the National Flood Insurance program (NFIP), and continued compliance with NFIP requirements, as appropriate.</i>

All eligible participating jurisdictions in this plan are now members of the NFIP. The following action relates to NFIP compliance for each of these jurisdictions:

2.1.1 Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.

Accurate flood maps are the basis of the NFIP. The jurisdictions of Boone County and the City of Columbia both have extensive GIS, engineering, and planning capabilities. These jurisdictions have the following mitigation actions which support accurate flood mapping (and NFIP compliance) for the entire planning area:

1.1.1 Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.

1.1.2 Continue to participate as a partner in FEMA’s RISKMap process.

6.2 PRIORITIZATION OF MITIGATION ACTIONS

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

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

STAPLEE AND BENEFIT/COST REVIEWS

STAPLEE Review – The Planning Committee conducted a STAPLEE review of the ongoing and proposed new mitigation actions using key questions for each of the STAPLEE categories:

S	Social	Community Acceptance	Is the action generally acceptable to the community?
		Effect on Segment	Will this action have an adverse effect on any one segment of the community?
T	Technical	Technically Feasible	Is the action technically feasible?
		Long-term Solution	Does the action represent a long-term solution or is it more of a band-aid?
		Secondary Impacts	Are there any negative secondary impacts to the action?
A	Administrative	Staffing	Is there staffing available to lead and carry out the action?
		Maintenance	Can the jurisdiction provide any maintenance required?
P	Political	Political Support	If the action requires political action, is the political support there?
		Local Champion	Is there a local champion to promote the action?
		Public Support	Will the public support the political action needed to accomplish the mitigation?
L	Legal	Existing Local Authority	Does the local jurisdiction have authority to carry out the action?
		Potential Legal Challenge	Does the action run the risk of potential legal challenge?
E	Economic	Contribute to Economic Goals	Does the action contribute to other economic goals, such as capital improvements or economic development?
		Project Funding	Is funding already allocated or is outside funding required?
E	Environmental	Effects - Land/Water	How will this action affect land and water resources?
		Effects- Endangered Species	How will this action affect endangered species?

Each action was scored for each criterion according to the following scale:

-1	0	1	na
Less Favorable	Mixed	Favorable	(not applicable)

After the actions were evaluated, the following formula was used to calculate the percentage of points scored out of points available for each individual action: % score = (total points/total of applicable criteria) * 100

Benefit/Cost Review

The benefit of each action was evaluated by awarding two (2) points for each of the following *avoided* damages (8 points maximum = highest benefit):

- Injuries and/or casualties (IC)
- Property damages (PD)
- Loss-of-function (LF) – includes loss of utility services, impact of road/bridge closures, loss of income, cost of displacement
- Emergency management costs/community costs (EM)

The cost of each action was according to the following scale (-4 points maximum = highest cost):

- Already in place or easily put into work program (-1)
- Low/moderate cost – could be worked into operating budget (-2)
- Moderate/high cost –help with funding possibly needed depending on specifics of project (-3)
- High cost – outside help with funding definitely needed (-4)

Note: For the Benefit/Cost Review, the benefit and cost of actions which used the word “Encourage” were evaluated *as if* the action or strategy being encouraged was actually to be carried out.

Prioritization

The Planning Committee reviewed the % STAPLEE score and benefit/cost review for all of the actions and prioritized them according to the following scale:

- High – Work should begin as soon as possible; action should be accomplished in the next 5 years
- Medium – Work could begin within the next 5 years, if time and resources allow
- Low – Long-range goal, if time and resources allow; work within the next 5 years is possible but not probable

It was understood that some of these priorities might be changed by the individual jurisdictions due to funding or staffing constraints as they developed their plans for action implementation.

It should be noted that a number of high priority actions scored somewhat low on both the STAPLEE review and the benefit/cost review due to their high cost which figures into both reviews. These actions remain a high priority with the hope that funding will become available.

Figure 6.7

Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis

		STAPLEE ANALYSIS																		BENERT/COST				Priority
		Social	Technical				Admin		Political		Legal		Econ	Env		Total								
Action #	Mitigation Action	Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
1.1.1	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.	1	na	1	0	1	1	1	1	1	1	1	na	na	1	na	na	11	90.9%	IC,PD,LF,EM	8	-1	7	H
1.1.2	Continue to participate as a partner in FEMA's RISKMap process.	1	na	1	1	1	1	1	1	1	na	1	na	1	1	na	na	11	100.0%	IC,PD,LF,EM	8	-1	7	H
1.1.3	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.	1	na	1	1	1	1	1	1	1	1	1	na	na	1	na	na	11	100.0%	IC,EM	4	-1	3	H
1.1.4	The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.	0	na	1	1	1	1	1	1	1	0	1	na	na	1	na	na	11	81.8%	IC,PD,LF,EM	8	-1	7	H
1.1.5	Encourage the local water district to have adequate fire flow.	1	na	1	1	1	1	na	1	1	1	na	na	na	0	1	1	11	90.9%	IC,PD,LF,EM	8	-3	5	M
1.1.6	Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.	1	na	1	1	1	1	na	na	na	na	1	na	1	0	na	na	8	87.5%	IC,PD,LF,EM	8	-2	6	H

Figure 6.7 (cont.)

Figure 6.7 (cont.)																								
Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis																								
		STAPLEE ANALYSIS																BENEFIT/COST				Priority		
		Social	Technical			Admin		Political			Legal		Econ		Env		Total							
Action #	Mitigation Action	Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
1.1.7	Conduct a survey of generator needs of critical infrastructure in Planning Area; include information on sizing, hookup, and fuel storage.	1	na	1	1	1	0	0	na	na	na	1	na	1	1	na	na	9	77.8%	IC,PD,LF,EM	8	-2	6	M-H
1.1.8	Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.	1	na	1	1	1	0	0	na	na	na	1	na	1	1	na	na	9	77.8%	IC,PD,LF,EM	8	-1	7	M-H
1.1.9	Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.	1	na	1	1	1	1	1	na	na	na	1	na	1	0	na	na	9	88.9%	IC,PD,LF,EM	8	-2	6	M
1.1.10	Develop a Continuity of Operations Plans (COOP).	1	na	1	1	1	0	0	1	1	1	1	na	1	0	na	na	12	75.0%	IC,PD,LF,EM	8	-2	6	H
1.1.11	Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.	0	na	1	1	1	1	na	1	1	0	1	na	1	na	1	na	11	81.8%	IC,PD,LF,EM	8	-2	6	H

Figure 6.7 (cont.)

Figure 6.7 (cont.)																								
Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis																								
		STAPLEE ANALYSIS																BENEFIT/COST				Priority		
		Social	Technical			Admin		Political			Legal		Econ		Env		Total							
Action #	Mitigation Action	Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
1.2.1	Encourage underground utilities where feasible.	1	na	1	1	0	1	na	na	na	na	na	na	1	1	-1	na	8	62.5%	IC,PD,LF,EM	8	-2	6	H
1.2.2	Review and formalize relationships with cooling and warming centers in each community.	1	1	na	na	1	0	0	na	na	na	1	na	na	1	na	na	7	71.4%	IC,EM	4	-1	3	H
1.2.3	Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.	1	na	1	1	1	1	1	na	na	na	1	na	1	1	na	na	9	100.0%	IC,PD,LF,EM	8	-1	7	H
1.2.4	Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).	0	na	1	1	1	0	0	1	1	1	1	na	1	1	1	na	13	76.9%	IC,PD,LF,EM	8	-1	7	L-M
2.1.1	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	0	na	1	1	1	1	1	1	1	0	1	na	na	1	1	na	12	83.3%	IC,PD,LF,EM	8	-1	7	H
2.1.2	Add sinkhole regulations to stream buffer/storm water ordinance.	0	na	1	1	1	1	na	1	1	0	1	na	na	1	1	na	11	81.8%	IC,PD,LF,EM	8	-2	6	M

Figure 6.7 (cont.)

Figure 6.7 (cont.)																								
Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis																								
		STAPLEE ANALYSIS																	BENEFIT/COST				Priority	
		Social	Technical				Admin		Political			Legal		Econ		Env		Total						
Action #	Mitigation Action	Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
2.1.3	Develop policy and enforcement regulations concerning burning and/or encourage development of burn permit procedure.	0	na	1	1	1	0	na	1	1	0	1	na	na	1	1	1	12	75.0%	IC,PD,LF,EM	8	-2	6	M
2.2.1	Review building codes every two/three years for possible update.	0	na	1	1	1	1	1	na	na	na	1	na	na	1	na	na	8	87.5%	IC,PD,LF,EM	8	-1	7	H
2.2.2	Develop regulations for roads on dams.	-1	na	1	1	1	1	na	1	1	0	1	na	na	1	1	na	11	72.7%	IC,PD,LF,EM	8	-2	6	H
3.1.1	Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).	1	na	1	1	1	0	1	na	na	na	1	na	na	1	na	na	8	87.5%	IC,PD,LF,EM	8	-2	6	H
3.1.2	Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.	1	na	1	1	1	1	1	1	1	1	1	na	na	-1	1	na	12	83.3%	IC,PD,LF,EM	8	-4	4	M
3.1.3	Mitigate the effects of flooding on public infrastructure.	1	na	1	1	1	1	1	na	na	na	1	na	na	0	na	na	8	87.5%	IC,PD,LF,EM	8	-3	5	H
3.1.4	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.	1	na	1	1	1	1	na	1	1	na	1	na	1	-1	1	1	12	83.3%	IC,PD	4	-4	0	H

Figure 6.7 (cont.)

Figure 6.7 (cont.)																								
Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis																								
		STAPLEE ANALYSIS																BENEFIT/COST				Priority		
Action #	Mitigation Action	Social	Technical	Admin	Political	Legal	Econ	Env	Total															
		Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
3.2.1	Ensure evacuation plans are adequate for nursing homes and special needs populations.	1	na	1	1	1	1	1	na	na	na	1	na	na	1	na	na	8	100.0%	IC,EM	4	-1	3	H
3.2.2	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.	1	na	1	1	1	1	1	na	na	na	1	na	na	1	na	na	8	100.0%	IC,EM	4	-1	3	H
3.2.3	Evaluate and maintain emergency preparedness plans.	1	na	1	1	1	1	1	na	na	na	1	na	na	1	na	na	8	100.0%	IC,EM	4	-1	3	H
3.2.4	Conduct emergency preparedness exercises periodically throughout the year.	1	na	1	1	1	1	1	na	na	na	1	na	na	1	na	na	8	100.0%	IC,EM	4	-1	3	H
3.2.5	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	1	na	1	1	1	1	1	1	1	1	na	na	na	-1	na	na	10	80.0%	IC,EM	4	-4	0	M
3.2.6	Encourage shelters to have alternative heating sources.	1	na	1	1	1	1	na	na	na	na	na	na	na	-1	na	na	6	66.7%	IC,EM	4	-4	0	L
3.2.7	Acquire generators and power transfer hookup equipment.	1	na	1	1	1	1	1	na	na	na	1	na	na	-1	na	na	8	75.0%	IC,PD,LF,EM	8	-4	4	M

Figure 6.7 (cont.)

Figure 6.7 (cont.)																								
Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis																								
		STAPLEE ANALYSIS																BENEFIT/COST				Priority		
		Social		Technical			Admin		Political			Legal		Econ		Env							Total	
Action #	Mitigation Action	Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
3.2.8	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.	0	1	1	1	1	1	0	na	na	na	1	na	na	na	na	na	8	75.0%	IC,EM	4	-2	2	L-M
3.2.9	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.	1	na	1	1	1	1	1	na	na	na	1	na	1	1	na	na	9	100.0%	IC,PD,LF,EM	8	-1	7	H
3.2.10	Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.	1	na	1	1	1	1	na	na	na	na	1	na	1	1	na	na	8	100.0%	IC,LF	8	-1	7	H
3.2.11	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.	1	na	1	1	1	1	1	na	na	na	1	na	1	na	na	na	8	100.0%	IC,PD,LF,EM	8	-1	7	H
3.2.12	Enhance alert and warning capabilities.	1	na	1	1	1	1	1	na	na	na	1	na	1	0	na	na	9	88.9%	IC,PD,LF,EM	8	-4	4	H

Figure 6.7 (cont.)

Figure 6.7 (cont.)																								
Prioritization of Mitigation Actions using STAPLEE and Benefit/Cost Analysis																								
		STAPLEE ANALYSIS																BENEFIT/COST				Priority		
		Social		Technical			Admin		Political		Legal		Econ		Env		Total							
Action #	Mitigation Action	Community Acceptance	Effect on Segment	Technically Feasible	Long-term Solution	Secondary Impacts	Staffing	Maintenance	Political Support	Local Champion	Public Support	Existing Local Authority	Potential Legal Challenge	Contribute to Economic Goals	Outside Funding Required	Effects - Land/Water	Effects- Endangered Species	Total Applicable	STAPLEE % Score	Losses Avoided (2 pts. Each)	Benefit	Cost	B/C Total	2015 Plan
4.0.1	Continue to educate the public on natural hazards.	1	na	1	1	1	1	1	na	na	na	1	na	na	1	1	na	9	100.0%	IC,PD,LF,EM	8	-1	7	H
4.0.2	Promote the purchase and use of NOAA radios.	1	na	1	0	1	1	na	na	na	na	1	na	na	1	na	na	7	85.7%	IC,EM	4	-1	3	H
4.0.3	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.	1	na	1	1	1	1	1	na	na	na	1	na	1	1	na	na	9	100.0%	IC,EM	4	-1	3	M
5.0.1	Target Repetitive Loss Properties for flood buyout.	0	na	1	1	0	1	1	1	1	na	1	na	na	1	na	na	10	80.0%	IC,PD,LF,EM	8	-1	7	L-M
5.0.2	Acquire properties susceptible to flood damage when buyout grants are available.	1	na	1	1	0	1	1	1	1	0	1	na	1	-1	1	1	14	71.4%	IC,PD,LF,EM	8	-4	4	L-M

6.3 IMPLEMENTATION, ADMINISTRATION, AND INTEGRATION IN PARTICIPATING JURISDICTIONS

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

Requirement §201.6(c)(3)(iv): *For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.*

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

After the Planning Committee had finished the STAPLEE and Benefit/Cost Reviews and prioritization of the mitigation actions, the mitigation actions suggested for the specific participating jurisdictions were handed over to the representatives or governing bodies of those jurisdictions for implementation and administration decisions.

It was recognized that participating jurisdictions might choose to either change the prioritization of or exclude some suggested mitigation actions based on current specifics of time, resources, and capabilities. In addition, new mitigation actions might be added based on specific issues.

The mitigation actions for which each participating jurisdiction is the lead are shown in the following pages. The Boone County Office of Emergency Management is the lead on many actions which mitigate hazards for the entire planning area; these actions are indicated in Figure 6.6 by the use of an asterisk (*) for jurisdictions benefiting from such actions.

A description of the method for integrating the hazard mitigation actions into other planning processes in the jurisdiction is included after the actions.

BOONE COUNTY

Action #	1.1.1
Mitigation Action	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.
Priority	High
Lead Department or Agency	County Commission
Partners, if any	City of Columbia, GIS Departments
Plan for Implementation and Administration	The County will be meeting with FEMA staff to work on the next step of their digitization project.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	GIS information supplied

Action #	1.1.2
Mitigation Action	Continue to participate as a partner in FEMA's RISKMap process.
Priority	High
Lead Department or Agency	Boone County Resource Management Dept
Partners, if any	FEMA
Plan for Implementation and Administration	This is an ongoing activity with the Boone County Resource Management Dept
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal funds/grants
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	1.1.3
Mitigation Action	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	BCJC
Plan for Implementation and Administration	BCJC conducts monthly tests of the outdoor warning sirens on the first Wednesday of the month (barring inclement weather); a check system is in place to ensure that the sirens went off. An annual maintenance agreement is in place to resolve any mechanical issues that should arise throughout the year.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Moderate
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Regular testing

Action #	1.1.4
Mitigation Action	The Public Works Department will adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	
Plan for Implementation and Administration	This is an ongoing activity within the Public Works Department.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Brush and trees are trimmed.

Action #	1.1.6
Mitigation Action	Conduct a phased flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.
Priority	High
Lead Department or Agency	Local Emergency Planning Committee (LEPC)
Partners, if any	University of MO Civil Engineering Dept.
Plan for Implementation and Administration	Develop a proof of concept for a 24 hr. flow study along I-70 using high speed cameras (Phase I); if proof of concept and cost is approved by LEPC, proceed with study; follow up with study on Highway 63 (Phase II).
Benefits (Losses Avoided)	IC,EM
Projected Cost	\$16,000 (Phase I); hopefully, <\$16,000 (Phase II)
Potential Funding Sources	LEPC; possibly grant \$ from State of MO
Projected Completion Date	Proof of concept - July1, 2015; if accepted, Phase I completion in 2016; Phase II in 2017 (?)
Criterion for Completion	Flow study has been completed and deliverables received.

Action #	1.1.7
Mitigation Action	Conduct a survey of generator needs of critical infrastructure in planning area; include information on sizing, hookup, and fuel storage.
Priority	Medium to High
Lead Department or Agency	Office of Emergency Management
Partners, if any	All jurisdictions
Plan for Implementation and Administration	Create and disseminate a survey to all critical partners, critical infrastructure, and key resources. Survey objective to determine the electrical demands of the facility and the availability of any pre-existing generators or generator hookups.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2016
Criterion for Completion	Survey feedback received

Action #	1.1.8
Mitigation Action	Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.
Priority	Medium to High
Lead Department or Agency	Office of Emergency Management
Partners, if any	All incorporated communities
Plan for Implementation and Administration	Conduct workshop with IT leaders to identify issues and trends in network and telecommunication continuity. Identify potential strategies and secure training on selected topics for local leaders.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2017
Criterion for Completion	Risk assessment completed

Action #	1.1.9
Mitigation Action	Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.
Priority	Medium
Lead Department or Agency	Office of Emergency Management
Partners, if any	All stakeholders
Plan for Implementation and Administration	Network with community stakeholders to determine needs for notification systems. Research and demo vendor products to determine the feasibility of a centralized notification system.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Medium
Potential Funding Sources	Internal
Projected Completion Date	06/31/2016
Criterion for Completion	Notification system selected for OEM
Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).

Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	All stakeholders
Plan for Implementation and Administration	Provide training on benefits of COOP plans for local agencies. Assign OEM Planner to work with local disaster stakeholders to develop individual continuity of operations plans.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2020
Criterion for Completion	COOP plans developed

Action #	1.1.11
Mitigation Action	Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	All participating jurisdictions in Boone County Hazard Mitigation Plan; economic development groups; insurance companies and other business stakeholders; Mid-MO RPC
Plan for Implementation and Administration	Meet with officials and stakeholder groups to: 1. Educate regarding mitigation needs in Boone County, economic benefits of mitigation, and challenges of funding. 2. Strategize possible avenues of funding. 3. Develop method for funding applications.
Benefits (Losses Avoided)	IC, PD, LF, EM
Projected Cost	Low-moderate
Potential Funding Sources	Internal
Projected Completion Date	2016
Criterion for Completion	Local source(s) of sustainable funding for mitigation is established.
Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	High
Lead Department or Agency	Resource Management Dept.
Partners, if any	
Plan for Implementation and Administration	The County and developers work together to encourage underground utilities for new development.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	
Potential Funding Sources	No Funds Necessary
Projected Completion Date	Ongoing
Criterion for Completion	Utilities are underground in new developments

Action #	1.2.2
Mitigation Action	Review and formalize relationships with cooling and warming centers in each community.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	All incorporated communities
Plan for Implementation and Administration	Review listing of current warming/cooling centers and identify gaps within community. Work with stakeholders to fill gaps.
Benefits (Losses Avoided)	IC,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2017
Criterion for Completion	Agreements in place

Action #	1.2.3
Mitigation Action	Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	
Plan for Implementation and Administration	Work with vendors to establish agreements and request procedures to ensure quick deployment of cellular networks.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2016
Criterion for Completion	Agreements in place and request procedures established.

Action #	1.2.4
Mitigation Action	Work with owners of dams not regulated by the State who are willing to develop Emergency Action Plans (EAPs).
Priority	Low - Medium
Lead Department or Agency	Office of Emergency Management
Partners, if any	Dam and Reservoir Safety Program (MO DNR, Rolla)
Plan for Implementation and Administration	Use GIS to identify potential unregulated dams throughout the county. Contact landowners and provide an overview of the dam risks and benefits of EAP's. Assign Planner to work with dam owners to develop EAP concurrent with the hazard posed by the dam.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2020
Criterion for Completion	Dams identified, mapped, and plans established

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead Department or Agency	Resource Management Dept.
Partners, if any	
Plan for Implementation and Administration	This is an ongoing activity within the Planning and Building Department.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced
Hazards Addressed	FL

Action #	2.2.1
Mitigation Action	Review building codes every three years for possible update.
Priority	High
Lead Department or Agency	County Planning & Building Inspections
Partners, if any	County Commission
Plan for Implementation and Administration	The County is currently in the process of reviewing the most recent code.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Codes are reviewed and updated (if update is appropriate)
Hazards Addressed	EQ, WW, T, WF

Action #	3.1.1
Mitigation Action	Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	
Plan for Implementation and Administration	Office of Emergency Management will make recommendations on this.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Equipment is secured
Hazards Addressed	EQ, T

Action #	3.1.3
Mitigation Action	Mitigate the effects of flooding on public infrastructure.
Priority	High
Lead Department or Agency	Depts. of Public Works and Planning
Partners, if any	County Commission
Plan for Implementation and Administration	Departments of Public Works and Planning will make recommendations on this.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Moderate to High
Potential Funding Sources	Internal Funds and Grants
Projected Completion Date	Ongoing
Criterion for Completion	Public infrastructure is protected
Hazards Addressed	FL
Action #	3.2.1
Mitigation Action	Ensure evacuation plans are adequate for nursing homes and special needs populations.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	Red Cross
Plan for Implementation and Administration	This is part of the overall Emergency Operations Plan which covers the entire Planning Area.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Evacuation plans are in place
Hazards Addressed	EQ, WW, T
Action #	3.2.6
Mitigation Action	Encourage shelters to have alternative heating sources.
Priority	Low
Lead Department or Agency	Office of Emergency Management
Partners, if any	Red Cross
Plan for Implementation and Administration	This is part of the overall Emergency Operations Plan which covers the entire Planning Area.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Alternative heating is available
Hazards Addressed	EQ, T, WW

Action #	3.2.7
Mitigation Action	Acquire generators and power transfer hookup equipment.
Priority	Medium
Lead Department or Agency	Office of Emergency Management
Partners, if any	RHSOC, Regional EMD's
Plan for Implementation and Administration	Use generator survey to identify generator needs and hookup equipment. Develop long range plan to secure generators and equipment to match the gaps identified in the survey.
Benefits (Losses Avoided)	LF, EM
Projected Cost	Medium - High
Potential Funding Sources	RHSOC, grants, regional collaboration
Projected Completion Date	12/31/2020
Criterion for Completion	Sufficient logistical resources available to provide electrical service to critical infrastructure and key resources.

Action #	3.2.8
Mitigation Action	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.
Priority	Medium-Low
Lead Department or Agency	Columbia/Boone County Dept. of Public Health and Human Services
Partners, if any	Office of Emergency Management; community-based organizations; faith-based organizations
Plan for Implementation and Administration	Survey for preparedness levels and obstacles to preparedness; analyze obstacles and develop strategy to overcome.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Moderate
Potential Funding Sources	Grants; the Medical Reserve Corps (MRC) Capacity Building Grant is one potential funding source
Projected Completion Date	2020
Criterion for Completion	Strategy is in place.

Action #	3.2.10
Mitigation Action	Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	All stakeholders
Plan for Implementation and Administration	Work with State Department of Health and Senior Services to deliver Psychological First Aid courses to local stakeholders and volunteers. Establish a trained cadre of community members to be utilized during disaster response.
Benefits (Losses Avoided)	IC, LF, EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	12/31/2017
Criterion for Completion	Classes delivered

Action #	4.0.1
Mitigation Action	Continue to educate the public on all hazards.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	Local Media
Plan for Implementation and Administration	This is an ongoing activity of the Office of Emergency Management and is carried out through press releases and available literature.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Program Funds
Projected Completion Date	Ongoing
Criterion for Completion	Natural hazard education for public occurs.

Action #	4.0.2
Mitigation Action	Promote the purchase and use of NOAA radios.
Priority	High
Lead Department or Agency	Office of Emergency Management
Partners, if any	
Plan for Implementation and Administration	Develop marketing plan to promote use of NOAA radios. Secure outside funding to allow provision of radios to community members at risk.
Benefits (Losses Avoided)	IC, PD, LF, EM
Projected Cost	Low - Medium
Potential Funding Sources	Grants, Internal
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	4.0.3
Mitigation Action	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.
Priority	Medium
Lead Department or Agency	Columbia/Boone County Dept. of Public Health and Human Services
Partners, if any	OEM, community-based organizations, MO DHSS
Plan for Implementation and Administration	Ensure material is available and on display at the Columbia/Boone County Dept. of Public Health and Human Services. Identify community events for distribution; explore Medical Reserve Corps potential role in distribution; make plan for distribution and distribute at events.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Low
Potential Funding Sources	In budget
Projected Completion Date	Ongoing
Criterion for Completion	Materials are available, on display, and being distributed.

Integration into Other Planning Mechanisms

The mitigation actions will be reviewed annually as part of the budget and priority setting process. During the EOP review, the additional hazards identified in the mitigation plan will be reviewed to ensure they are dealt with in the EOP.

With regards to permitting and codes/regulations: Prior to issuing any permit it is reviewed to determine proximity to designated flood areas. Critical sites are rejected and permits are not issued until an acceptable site is approved. Codes and regulations are annually scrutinized for currency and compliance with regulatory directions. Permitting staff receive periodic training on site location requirements and are trained to recognize potential conflicts during intake of permits.

ASHLAND

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	City Hall
Partners, if any	RPC
Plan for Implementation and Administration	Internal, ongoing, meet with departments
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	LOW
Potential Funding Sources	N/A
Projected Completion Date	12/31/2015
Criterion for Completion	Plan to be adopted by Board of Aldermen

Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	High
Lead	Utilities
Partners	Local Government
Plan for Implementation and Administration	Encourage through development approval
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	No Funds Necessary
Projected Completion Date	Ongoing
Criterion for Completion	Utilities are underground in new developments
Hazards Addressed	WW, T, WF

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead	Code Official
Partners	Boone County
Plan for Implementation and Administration	This is an ongoing activity
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	Medium
Lead	Board of Aldermen
Partners	School/Community Groups
Plan for Implementation and Administration	Work with other organizations to create a site for the community
Benefits (Losses Avoided)	IC,EM
Projected Cost	\$1.5 million
Potential Funding Sources	FEMA Pre-disaster Mitigation Grant Program, Local Match
Projected Completion Date	Ongoing
Criterion for Completion	Safe room is built.

Integration into Other Planning Mechanisms

The Hazard Mitigation Plan will be reviewed annually when the Board of Aldermen sets priorities through the budgetary process; it will be reviewed during discussion of the 3-5 year Capital Improvement Program; it will be reviewed annually along with the Comprehensive Plan.

CENTRALIA

Action #	1.1.3
Mitigation Action	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.
Priority	High
Lead Department or Agency	Centralia PD and Centralia Electric Department
Partners, if any	Boone County Joint Dispatch
Plan for Implementation and Administration	Ongoing
Benefits (Losses Avoided)	IC,EM
Projected Cost	No additional cost
Potential Funding Sources	na
Projected Completion Date	Ongoing
Criterion for Completion	Sirens are being tested monthly

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	City Administrator
Partners, if any	All departments
Plan for Implementation and Administration	This is currently in development.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	City funds
Projected Completion Date	4/1/2017
Criterion for Completion	Plan is written and approved by the Board of Aldermen

Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	Medium to High
Lead	City Administrator
Partners	-
Plan for Implementation and Administration	This is being done and will continue.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Electric Fund
Projected Completion Date	Ongoing
Criterion for Completion	Utilities are underground in new developments

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead	City Administrator
Partners	-
Plan for Implementation and Administration	This is an ongoing process when issuing building permits and reviewing subdivision plans.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Action #	2.1.3
Mitigation Action	Develop policy and enforcement regulations concerning burning permits.
Priority	Low
Lead	City Administrator
Partners	Volunteer Fire Department
Plan for Implementation and Administration	Regulations are in place concerning when and how burning can take place.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Policy is in place and enforced

Integration into Other Planning Mechanisms

In Centralia, recognition of the flood plain hazard is part of the comprehensive plan and current subdivision regulations. Studies have been performed for expansion of and improvements to the electric and water supply utilities. The recommendations of these studies are being incorporated into drafts of an updated comprehensive plan and capital improvement plans and budgets.

COLUMBIA

Action #	1.1.1
Mitigation Action	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	County Commission GIS Departments
Plan for Implementation and Administration	Public Works staff will provide flood plain modeling info and Letter of Map Review (LOMR) applications to SEMA as they come available.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	GIS information supplied

Action #	1.1.2
Mitigation Action	Continue to participate as a partner in FEMA's RISKMap process.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	County Commission GIS Departments
Plan for Implementation and Administration	Attend meetings and contribute as possible.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Committee; City Manager's Office; Enterprise Departments
Partners, if any	
Plan for Implementation and Administration	Business continuity plans have been developed at the departmental level in 12 of 19 departments; these are considered the "mission critical" departments; some of the plans have not been tested yet.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Committee adoption with regular updates

Action #	1.2.2
Mitigation Action	Review and formalize relationships with cooling and warming centers in each community.
Priority	High
Lead Department or Agency	Columbia/Boone County Department of Health & Human Services
Partners, if any	Local non-profits and service organizations
Plan for Implementation and Administration	Ongoing
Benefits (Losses Avoided)	IC,EM
Projected Cost	Minimal
Potential Funding Sources	Internal; Grants
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing with feedback and adjustments as needed

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	
Plan for Implementation and Administration	Public Works staff reviews all development plans to ensure ordinances are followed.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Action #	2.1.2
Mitigation Action	Add sinkhole regulations to stream buffer/storm water ordinance.
Priority	Medium
Lead Department or Agency	Public Works Department
Partners, if any	
Plan for Implementation and Administration	Staff will draft sinkhole regulations for City Council consideration.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	2020
Criterion for Completion	Regulations are added

Action #	2.2.1
Mitigation Action	Review building codes every two years for possible update.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	
Plan for Implementation and Administration	Staff will review codes along with Building Code Commission and adopt current regulations as directed.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Codes are reviewed and updated (if update is appropriate)

Action #	2.2.2
Mitigation Action	Develop regulations for roads on dams.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	
Plan for Implementation and Administration	Staff will develop ordinance for City Council consideration that addresses the placement of public roadways on non-regulated dams.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	2015
Criterion for Completion	Regulations are adopted
Hazards Addressed	DF

Action #	3.1.1
Mitigation Action	Secure high value equipment located outside county and municipal buildings (e.g. HVAC, generators, communication equipment).
Priority	High
Lead Department or Agency	Public Works
Partners, if any	
Plan for Implementation and Administration	Facilities Planning as new facilities are built
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Part of project costs; Enterprise funds; Bonds
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	3.1.3
Mitigation Action	Mitigate the effects of flooding on public infrastructure.
Priority	High
Lead Department or Agency	Depts. of Public Works and Planning
Partners, if any	City Council
Plan for Implementation and Administration	Departments of Public Works and Planning will make recommendations on this.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Moderate to High
Potential Funding Sources	Internal Funds and Grants
Projected Completion Date	Ongoing
Criterion for Completion	Public infrastructure is protected

Action #	3.2.8
Mitigation Action	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies
Priority	Medium-Low
Lead Department or Agency	Columbia/Boone County Dept. of Public Health and Human Services
Partners, if any	Office of Emergency Management; community-based organizations; faith-based organizations
Plan for Implementation and Administration	Survey for preparedness levels and obstacles to preparedness; analyze obstacles and develop strategy to overcome.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Moderate
Potential Funding Sources	Grants; the Medical Reserve Corps (MRC) Capacity Building Grant is one potential funding source
Projected Completion Date	2020
Criterion for Completion	Strategy is in place.

Action #	3.2.11
Mitigation Action	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.
Priority	High
Lead Department or Agency	Columbia Regional Airport
Partners, if any	
Plan for Implementation and Administration	This is part of the normal operating procedures of the airport.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal - normal operating expenses
Potential Funding Sources	na
Projected Completion Date	Ongoing action
Criterion for Completion	All activities are in compliance with requirements.

Action #	4.0.3
Mitigation Action	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.
Priority	Medium
Lead Department or Agency	Columbia/Boone County Dept. of Public Health and Human Services
Partners, if any	OEM, community-based organizations, MO DHSS
Plan for Implementation and Administration	Ensure material is available and on display at the Columbia/Boone County Dept. of Public Health and Human Services. Identify community events for distribution; explore Medical Reserve Corps potential role in distribution; make plan for distribution and distribute at events.
Benefits (Losses Avoided)	IC, EM
Projected Cost	Low
Potential Funding Sources	In budget
Projected Completion Date	Ongoing
Criterion for Completion	Materials are available, on display, and being distributed.
Action #	5.0.1
Mitigation Action	Target Repetitive Loss Properties for flood buyout.
Priority	High
Lead Department or Agency	Public Works Department
Partners, if any	
Plan for Implementation and Administration	Columbia Storm Water Utility will evaluate properties that are repeatedly flooded and make decision whether to buy out or improve drainage systems.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Program Funds
Projected Completion Date	Ongoing
Criterion for Completion	Properties are targeted.

Integration into Other Planning Mechanisms

The mitigation actions will be implemented by each department as part of the city's annual Capital Improvement Project (CIP) budgeting process.

HALLSVILLE

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Board of Aldermen
Partners, if any	Mid-MO RPC
Plan for Implementation and Administration	This is will be discussed at a Board of Aldermen meeting; if the BOA approves development of a plan, a work session of the BOA will be held along with the appropriate commissions to determine the process for developing the COOP.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	COOP is in place

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead Department or Agency	City Clerk and/or Mayor
Partners, if any	Local Government
Plan for Implementation and Administration	In place
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Integration into Other Planning Mechanisms

Mitigation actions in the plan will be integrated into the City's work program by forming a work session of the Board of Aldermen and relevant commissions; plans for proceeding with the actions will be developed at the work session. (Enforcement of NFIP floodplain regulations is already in the work program.)

HARRISBURG

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	City Clerk and Board of Trustees
Partners, if any	Boone County Emergency Management
Plan for Implementation and Administration	The city clerk and the trustees will coordinate the salvage of city records, recovery of accounts payable and receivable, and restoration of sewer and water. OEM will coordinate any emergency response actions.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Cost to develop the COOP is LOW. Cost to implement actual continuity would be Med/High and is currently unknown and will be determined by the event itself.
Potential Funding Sources	General Fund , Grants and Loans
Projected Completion Date	2017
Criterion for Completion	The original document can show completion but annual maintenance is required to a COOP so it will be ongoing.

Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	High
Lead Department or Agency	Board of Trustees/City Clerk
Partners, if any	
Plan for Implementation and Administration	Pursue possibility of ordinance requiring underground utilities in new development.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	City Budget
Projected Completion Date	2017
Criterion for Completion	Utilities are underground in new developments
Hazards Addressed	WW, T, WF, UTIL

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead Department or Agency	City Clerk
Partners, if any	MO SEMA
Plan for Implementation and Administration	
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	City Budget
Projected Completion Date	Ongoing
Criterion for Completion	Floodplain management ordinance is enforced.

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	High
Lead Department or Agency	Board of Trustees/City Clerk
Partners, if any	
Plan for Implementation and Administration	Discuss at Strategic Planning Meeting
Benefits (Losses Avoided)	IC,EM
Projected Cost	Significant
Potential Funding Sources	FEMA Pre-disaster Mitigation Grant Program, Local Match
Projected Completion Date	2017
Criterion for Completion	Safe room is built.

Integration into Other Planning Mechanisms

The Village of Harrisburg is undergoing a Strategic Planning process and will be including discussion of the mitigation actions from this plan in that process.

HARTSBURG

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead	City Council
Partners	Boone County
Plan for Implementation and Administration	Be available to town residents when building or remodeling; permits are issued through the County.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Integration into Other Planning Mechanisms

Hartsburg is required to place FEMA/SEMA laws and regulations onto our books so we comply with their requirements. We have and will continue to put any relevant plans into our code and regulations and would enforce them as we do all others.

HUNTSDALE

Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	High
Lead	Board of Aldermen
Partners	Boone Electric Coop
Plan for Implementation and Administration	If the opportunity arises, the city would like to work with Boone Electric COOP to put utilities underground.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	High
Potential Funding Sources	FEMA mitigation grants (HMGP)
Projected Completion Date	Ongoing
Criterion for Completion	Utilities are underground.
Hazards Addressed	WW, T, WF

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead Department or Agency	Floodplain Manager
Partners, if any	SEMA
Plan for Implementation and Administration	Review any proposed development to ensure compliance with the floodplain ordinance.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	na
Projected Completion Date	Ongoing
Criterion for Completion	Total compliance with floodplain ordinance in Huntsdale

Integration into Other Planning Mechanisms

The Town Council is kept well informed of any activities involving the city; implementing the hazard mitigation actions will be included in the discussion of village concerns.

ROCHEPORT

Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	Medium
Lead Department or Agency	Mayor
Partners, if any	Aldermen
Plan for Implementation and Administration	This is something the city has talked about and would be interested in pursuing if some additional sources of funding could be found. Undergrounding has been discussed with the electric provider (Boone Electric Coop).
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	High
Potential Funding Sources	Grants, internal funds
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Plan for Implementation and Administration	Enforcement is an ongoing process
Lead Department or Agency	Mayor and City Aldermen
Partners, if any	Planning and Zoning Commission
Potential Funding Sources	Internal Funds
Projected Cost	Minimal
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Action #	5.0.3
Mitigation Action	Acquire properties susceptible to flood damage when buyout grants are available.
Priority	Medium to Low
Lead Department or Agency	City Aldermen
Partners, if any	Planning and Zoning Commission
Plan for Implementation and Administration	This will be done if, and when, grant money becomes available.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	FEMA Grant Funds
Projected Completion Date	Ongoing
Criterion for Completion	Properties are acquired.
Hazards Addressed	FL

Integration into Other Planning Mechanisms

The City annually reviews its capital improvement program and future planning needs; hazard mitigation actions will be reviewed during this process.

STURGEON

Action #	1.1.5
Mitigation Action	Encourage the local water district to have adequate fire flow.
Priority	Medium
Lead Department or Agency	Mayor
Partners, if any	Board of Aldermen
Plan for Implementation and Administration	Water District #10 has passed a \$2.5 Million bond issue and will be putting in bigger lines; talk with the water district to ensure that fire flow is considered in decisions re: location of line upgrades.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	None
Potential Funding Sources	No funds necessary
Projected Completion Date	Ongoing
Criterion for Completion	Water district has adequate fire flow
Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Mayor
Partners, if any	City Staff
Plan for Implementation and Administration	This is in progress; most city documents are now backed up on the Cloud; City will continue to put other parts of a COOP in place.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	City budget
Projected Completion Date	2016
Criterion for Completion	All areas of Continuity of Operations have been addressed by the City.

Action #	1.2.1
Mitigation Action	Encourage underground utilities where feasible.
Priority	High
Lead Department or Agency	Mayor/Board of Aldermen
Partners, if any	AmerenUE
Plan for Implementation and Administration	Ameren UE will be encouraged to go underground when possible.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	No Funds Necessary
Projected Completion Date	Ongoing
Criterion for Completion	All utilities are underground.

Action #	2.1.1
Mitigation Action	Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Priority	High
Lead Department or Agency	Mayor/Board of Aldermen
Partners, if any	
Plan for Implementation and Administration	Will continue the floodplain program the city has in place.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Minimal
Potential Funding Sources	Internal Funds
Projected Completion Date	Ongoing
Criterion for Completion	Ordinances are enforced

Action #	3.1.2
Mitigation Action	Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.
Priority	Medium
Lead Department or Agency	Mayor/Board of Aldermen
Partners, if any	WD #10
Plan for Implementation and Administration	Plan to have additional meetings with WD #10 to insure we have adequate water. Working with Mid-MO RPC on water grants.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	High
Potential Funding Sources	Federal grants/local match
Projected Completion Date	Unknown due to high cost and financing issues
Criterion for Completion	Water lines replaced

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	High
Lead Department or Agency	Public Safety Committee
Partners, if any	Mayor/Board of Aldermen
Plan for Implementation and Administration	Being discussed with Mid-MO RPC.
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	FEMA Pre-disaster Mitigation Grant Program, Local Match
Projected Completion Date	Unknown due to high cost and financing issues
Criterion for Completion	Safe room is built.

Integration into Other Planning Mechanisms

Sturgeon keeps a priority list of things being worked on along with names of people responsible for the work and expected completion dates; the hazard mitigation actions will be added to this list as priority dictates.

CENTRALIA R-VI SCHOOL DISTRICT

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Safety Committee
Partners, if any	Administration, School Board
Plan for Implementation and Administration	The Safety Committee will determine a procedure for developing the COOP and oversee its completion.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal funds
Projected Completion Date	2016
Criterion for Completion	A Continuity of Operations Plan is in place.

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Safety Coordinator
Partners, if any	Centralia Police Department
Plan for Implementation and Administration	Continue to instruct and train the students and staff of Centralia R-6
Benefits (Losses Avoided)	IC,EM
Projected Cost	None
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Actions outlined in RSMO are carried out

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Safety Coordinator
Partners, if any	District Safety Committee
Plan for Implementation and Administration	Centralia R-6 safety committee will continue to evaluate plans and drills
Benefits (Losses Avoided)	IC,EM
Projected Cost	None
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Plans are evaluated and maintained

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Safety Committee
Partners, if any	Local emergency agencies
Plan for Implementation and Administration	Centralia R-6 safety committee will continue to conduct drills and include local emergency agencies
Benefits (Losses Avoided)	IC,EM
Projected Cost	None
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Plans and drills are conducted

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards. Consideration of Fine Arts/Storm Shelter
Priority	Medium
Lead Department or Agency	Safety Committee
Partners, if any	Administration
Plan for Implementation and Administration	Increase the safeness of our tornado refuge areas
Benefits (Losses Avoided)	IC,EM
Projected Cost	Significant
Potential Funding Sources	Grants
Projected Completion Date	Unknown
Criterion for Completion	Building project completed

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Safety Committee
Partners, if any	Centralia Police Department
Plan for Implementation and Administration	Increase Safety Features and Communication
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	\$10,000 yearly
Potential Funding Sources	District Budget
Projected Completion Date	On-Going
Criterion for Completion	Building Safety Audits and Intruder Drills

Integration into Other Planning Mechanisms

The district's safety committee has become extremely active. It meets on a monthly basis and has an annual budget that updates safety features district-wide.

COLUMBIA PUBLIC SCHOOLS

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Columbia Public Schools Administration
Partners, if any	N/A
Plan for Implementation and Administration	Implementation of Emergency/Crisis Plan
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	2016
Criterion for Completion	Train all Admin in NIMS based Crisis plan

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Columbia Public School Administration, Building Principals/Directors/Coordinators/Staff
Partners, if any	
Plan for Implementation and Administration	Columbia Public Schools will carry out the requirements of the Revised Statutes.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Actions as outlined in Revised Statutes are carried out

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Columbia Public School Administration
Partners, if any	
Plan for Implementation and Administration	Columbia Public School administration will meet on a regular basis to evaluate our crisis plans.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness plans are evaluated and maintained

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Columbia Public School Administration, Building Principals/Directors/Coordinators/Staff
Partners, if any	
Plan for Implementation and Administration	Columbia Public Schools will continue to conduct emergency preparedness drills periodically per state mandates and recommendations.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness exercises are conducted
Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	Medium
Lead Department or Agency	Columbia Public School Administration
Partners, if any	
Plan for Implementation and Administration	Build tornado safe rooms as funding becomes available.
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	FEMA Mitigation Grants/Local Matching Funds
Projected Completion Date	2018
Criterion for Completion	Tornado safe rooms are built.
Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Columbia Public Schools Safety and Security
Partners, if any	Columbia Police and Boone County Sheriff's Department
Plan for Implementation and Administration	Columbia Public Schools Emergency/Crisis Plan
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Immediately
Criterion for Completion	Yearly drills conducted with LE and training for every employee

Integration into Other Planning Mechanisms

The earthquake emergency planning and other emergency preparedness plans/exercises are ongoing and integrated in the Emergency Response Plans; the action concerning building tornado safe rooms will be looked at and prioritized in the general planning process.

HALLSVILLE R-IV SCHOOL DISTRICT

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Superintendent
Partners, if any	School Board, Admin Team
Plan for Implementation and Administration	Meet with stakeholders and identify priorities; research possible solutions for some of the tougher issues; write and test plan.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Moderate
Potential Funding Sources	Local funding
Projected Completion Date	July 1, 2016
Criterion for Completion	COOP is in place and is being tested periodically.

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Admin Team
Partners, if any	Teachers
Plan for Implementation and Administration	Required drills are carried out and literature distribution takes place yearly.
Benefits (Losses Avoided)	IC,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Admin Team
Partners, if any	
Plan for Implementation and Administration	Forms are filled out after each drill or exercise re: any problems and/or changes needed; forms are evaluated by the administrative team; emergency plans are updated as needed
Benefits (Losses Avoided)	IC,EM
Projected Cost	Minimal
Potential Funding Sources	Internal
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Admin Team
Partners, if any	Teachers
Plan for Implementation and Administration	Exercises are conducted yearly
Benefits (Losses Avoided)	IC,EM
Projected Cost	Minimal
Potential Funding Sources	Internal
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	Medium
Lead Department or Agency	School Board
Partners, if any	Superintendent, Admin Team, City of Hallsville
Plan for Implementation and Administration	Build tornado safe room if/when funding becomes available.
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	FEMA mitigation grants
Projected Completion Date	Ongoing
Criterion for Completion	Tornado safe room is built.

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	School Resource Officer
Partners, if any	Administrative Team
Plan for Implementation and Administration	All employees go through active shooter at least once a year; bus drivers go through this training more than once a year.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low
Potential Funding Sources	Internal
Projected Completion Date	Ongoing
Criterion for Completion	Ongoing

Integration into Other Planning Mechanisms

A number of the mitigation actions are ongoing school priorities and will remain so. The actions re: developing a COOP and building a tornado safe room will be discussed at School Board meetings and action plans developed.

HARRISBURG R-VIII SCHOOL DISTRICT

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Harrisburg R-VIII Administration
Partners, if any	Unknown
Plan for Implementation and Administration	A committee of local business people, parents, and school staff will be convened to begin the process of developing a COOP. Development of this plan will be an ongoing process throughout the upcoming school year.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Unknown at this time
Potential Funding Sources	Unknown
Projected Completion Date	8/1/2017
Criterion for Completion	Adoption by Board of Education

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Harrisburg Superintendent of Schools
Partners, if any	None
Plan for Implementation and Administration	Ongoing
Benefits (Losses Avoided)	IC,EM
Projected Cost	None
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Documented communications and annual drill documentation

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Harrisburg R-VIII Administration
Partners, if any	Boone County Sheriff's Department, Boone County Fire Protection District
Plan for Implementation and Administration	Ongoing review and revisions (as necessary) of emergency plans
Benefits (Losses Avoided)	IC,EM
Projected Cost	None
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Board of Education Approved Emergency Preparedness Plan

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Harrisburg R-VIII Administration
Partners, if any	None
Plan for Implementation and Administration	Ongoing bi-annual drills for bus evacuations, severe weather, fire/bomb threats, intruders/active shooters, and earthquakes
Benefits (Losses Avoided)	IC,EM
Projected Cost	None
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Completed emergency Drill Logs

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	Medium
Lead Department or Agency	Harrisburg Board of Education
Partners, if any	possibly Village of Harrisburg; SEMA/FEMA
Plan for Implementation and Administration	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	Grants
Projected Completion Date	Unknown
Criterion for Completion	Tornado Safe Rooms are completed

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Harrisburg R-VIII Administration
Partners, if any	Boone County Sheriff's Department & Boone County Fire Protection District
Plan for Implementation and Administration	Annual training and bi-annual drills will be conducted on an ongoing basis
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Unknown at this time; will depend on strategies pursued
Potential Funding Sources	Unknown
Projected Completion Date	Ongoing
Criterion for Completion	Completed training and drill logs

Integration into Other Planning Mechanisms

Each of the mitigation actions for the school district will be incorporated into both the ongoing School Improvement Plan process and ongoing safety review/planning process. A committee of local business people, parents, and school staff will be convened to begin the process of developing a COOP. It is anticipated this will be a lengthy process as we will be starting from scratch.

The school district has had some very preliminary conversations with the Harrisburg City Council regarding the potential for a joint effort to construct a tornado safe room/facility that could be utilized by the school and community members. These conversations will continue and hopefully a plan will be developed to complete such a project if/when funds become available.

SOUTHERN BOONE SCHOOL DISTRICT

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Southern Boone County School District
Partners, if any	Southern Boone County Economic Development and Chamber, Cities of Ashland and Hartsburg, Mid-MO Regional Planning Commission, and MU ExCEED, local faith based organizations
Plan for Implementation and Administration	Multiple meetings with area stakeholders to develop commitments in the event of a regional emergency
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	\$5,000
Potential Funding Sources	Local and grant
Projected Completion Date	2018
Criterion for Completion	A Continuity of Operations Plan in place

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Southern Boone Administration
Partners, if any	N/A
Plan for Implementation and Administration	Continue to instruct and train students and staff on earthquake emergency preparedness including sending out information concerning earthquake procedures.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Actions outlined in Revised Statues are carried out

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Southern Boone Administration
Partners, if any	Boone County Sheriff's Department
Plan for Implementation and Administration	Southern Boone Administration will continue to meet regularly to evaluate the crisis plan and flipchart.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Emergency Preparedness plans are evaluated and maintained

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Southern Boone Principals/Staff
Partners, if any	Boone County Sheriff's Department
Plan for Implementation and Administration	Southern Boone School District will conduct emergency preparedness drills periodically per state mandates and recommendation.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Emergency Preparedness drills are conducted

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	Medium
Lead Department or Agency	Southern Boone Administration
Partners, if any	
Plan for Implementation and Administration	Build tornado safe rooms as funding becomes available.
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	FEMA Mitigation Grants/Local Matching Funds
Projected Completion Date	2018
Criterion for Completion	Tornado safe rooms are built.

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Southern Boone Administration
Partners, if any	
Plan for Implementation and Administration	Install key card system campus wide.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	\$200,000
Potential Funding Sources	Local
Projected Completion Date	2018
Criterion for Completion	System in place

Integration into Other Planning Mechanisms

The Superintendent has been working closely with the members of the board and has conducted walk through tours of each of the facilities. A needs assessment has been conducted and projects have been prioritized. A facilities plan will be in place by January 2016 to address the identified needs.

STURGEON R-V SCHOOL DISTRICT

Action #	1.1.10
Mitigation Action	Develop a Continuity of Operations Plan (COOP).
Priority	High
Lead Department or Agency	Superintendent's office
Partners, if any	other admin. and ancillary staff
Plan for Implementation and Administration	Begin the process of involving stakeholders in the process of accomplishing the steps necessary for a comprehensive COOP.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Unknown at this time - probably low/moderate
Potential Funding Sources	Local funds
Projected Completion Date	Ongoing
Criterion for Completion	Completed COOP document

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Sturgeon R-V School Administration
Partners, if any	
Plan for Implementation and Administration	Continue to instruct and train students and staff on earthquake emergency preparedness including sending out information concerning earthquake procedures.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Actions outlined in Revised Statutes are carried out.

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Crisis Committee Chairperson
Partners, if any	Administration
Plan for Implementation and Administration	Sturgeon R-V Crisis Committee will continue to meet regularly to evaluate the crisis plan and flipchart. Regularly scheduled drills and other needed drills will be discussed during the meetings also.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness plans are evaluated and maintained.

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Sturgeon R-V School Principals/Staff
Partners, if any	
Plan for Implementation and Administration	Sturgeon R-V School District will conduct emergency preparedness drills periodically per state mandates and recommendation.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	N/A
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness plans are conducted.

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Superintendent's office
Partners, if any	BoCoMo Sheriff's Dept, Sturgeon Local police
Plan for Implementation and Administration	The district will continue and expand efforts to ensure the constant safety of our students, staff, and visitors.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	\$ 3,000 annually
Potential Funding Sources	Rural Education Achievement Program (REAP) funding
Projected Completion Date	Ongoing
Criterion for Completion	Constant safe climate in both of our district's buildings

Integration into Other Planning Mechanisms

The district will train staff to carry out plan objectives. The district may use plan info in long range planning document. The district may incorporate policy changes using plan info. The district can help regulate district spending using plan info. Incorporating plan strategies can change job duties.

COLUMBIA COLLEGE

Action #	3.2.2
Mitigation Action	Participate in state sponsored awareness programs concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Campus Safety
Partners, if any	
Plan for Implementation and Administration	Annual participation
Benefits (Losses Avoided)	IC,EM
Projected Cost	Low
Potential Funding Sources	In Budget
Projected Completion Date	Completed
Criterion for Completion	In progress.

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Campus Safety
Partners, if any	Crisis Response Team
Plan for Implementation and Administration	Plan in place. Revisions conducted regularly and as needed.
Benefits (Losses Avoided)	IC,EM
Projected Cost	Low
Potential Funding Sources	In Budget
Projected Completion Date	Plan in place. Revisions conducted regularly and as needed.
Criterion for Completion	Reviewed by Crisis Response Team

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Campus Safety
Partners, if any	Crisis Response Team; Columbia Police and Fire Departments
Plan for Implementation and Administration	Pre-planning
Benefits (Losses Avoided)	IC,EM
Projected Cost	Unknown
Potential Funding Sources	Unknown
Projected Completion Date	2016
Criterion for Completion	Plan is established with Emergency Services

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	Low
Lead Department or Agency	Plant & Facilities Operations
Partners, if any	Crisis Response Team
Plan for Implementation and Administration	Benefit Analysis
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	This is currently a low priority action for the college; funding sources will be explored if/when movement on this begins.
Projected Completion Date	Unknown
Criterion for Completion	Tornado safe room or hardened structure is completed.

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Campus Safety
Partners, if any	Crisis Response Team; Columbia Police Department
Plan for Implementation and Administration	In Progress
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Low/Moderate
Potential Funding Sources	Internal
Projected Completion Date	2016
Criterion for Completion	When regular training and response plan revisions in place.

Integration into Other Planning Mechanisms

Most of the mitigation actions in this updated plan are already integrated into work plans; if a decision were to be made to build a tornado safe room or harden part(s) of building(s) that would be integrated into planning through the following process: An assessment of necessity would be conducted by an established committee. A decision would be made by the Executive Director of Plant & Facilities Operations in coordination with the College President and appropriate board members. Communication and coordination with applicable departments and contractors would be facilitated if implementation of the project has been approved.

STEPHENS COLLEGE

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Campus Security and the Emergency Management Team
Partners, if any	
Plan for Implementation and Administration	Stephens College will instruct and train staff and faculty on earthquake emergency preparedness. In addition, information will be posted concerning campus earthquake procedures.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Actions outlined in Revised Statutes are carried out.

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	Stephens College Emergency Management Team, College President
Partners, if any	
Plan for Implementation and Administration	Stephens College will continue to conduct regular meetings of the Emergency Management Team to evaluate our Emergency Operations Plan.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness plans are evaluated and maintained.

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Stephens College Emergency Management Team
Partners, if any	
Plan for Implementation and Administration	Stephens College will continue to conduct emergency preparedness drills and exercises per state and federal mandates and recommendations.
Benefits (Losses Avoided)	IC,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness exercises are conducted.

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	Stephens College Emergency Management Team
Partners, if any	Local emergency responders
Plan for Implementation and Administration	Stephens College conducts training campuswide for response to active armed intruder situations
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	0
Potential Funding Sources	NA
Projected Completion Date	Ongoing
Criterion for Completion	Training and preparedness ongoing

Integration into Other Planning Mechanisms

Stephens College is a separate private entity for most practical purposes. Stephens does try to have planning documents and policies consistent with those of Boone County and the City of Columbia; however it may be necessary to establish individual policies based on circumstance. Stephens College complies with all local, state and federal permitting requirements and regulations. The information in the plan has little relevance, if any, to Stephens job descriptions. Stephens College staff training is conducted on a regular basis to meet the college needs. Stephens College maintains a working relationship with the City and County with regards to emergency planning and exercises.

UNIVERSITY OF MISSOURI

Action #	3.1.4
Mitigation Action	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.
Priority	High
Lead Department or Agency	Campus Facilities
Partners, if any	MU Division of Design & Construction, City of Columbia
Plan for Implementation and Administration	The MU Division of Design & Construction will research a new location for the salt dome, taking into account such things as ingress/egress, laws and regulations, and safety of new location. Engineering plans will be developed for new facility.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	\$ 0.5 Million (estimate)
Potential Funding Sources	Insurance funds (University is self-insured)
Projected Completion Date	2020
Criterion for Completion	Salt dome is moved to safer location.

Action #	3.2.2
Mitigation Action	Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
Priority	High
Lead Department or Agency	Vice Chancellor for Operations
Partners, if any	
Plan for Implementation and Administration	Earthquake emergency preparedness is part of the MU Emergency Operations Plan.
Benefits (Losses Avoided)	IC,EM
Projected Cost	Minimum
Potential Funding Sources	General operating funds
Projected Completion Date	Ongoing - emergency plans are reviewed periodically.
Criterion for Completion	Earthquakes are addressed in both the MU Emergency Operations Plan and in building specific emergency plans that have been prepared for each campus building.

Action #	3.2.3
Mitigation Action	Evaluate and maintain emergency preparedness plans.
Priority	High
Lead Department or Agency	MU Emergency Management
Partners, if any	MU Police, MU Campus Facilities, MU Environmental Health & Safety
Plan for Implementation and Administration	Emergency Operations Plan has been prepared and is a format very similar to the City/County Emergency Plan.
Benefits (Losses Avoided)	IC,EM
Projected Cost	Moderate
Potential Funding Sources	General operating funds
Projected Completion Date	Ongoing
Criterion for Completion	Emergency preparedness plans are evaluated and maintained.

Action #	3.2.4
Mitigation Action	Conduct emergency preparedness exercises periodically throughout the year.
Priority	High
Lead Department or Agency	Drills are usually developed and controlled by the local MU department.
Partners, if any	MU Police, MU Campus Facilities and/or MU Environmental Health and Safety usually involved; City and/or County emergency response agencies also involved in some drills.
Plan for Implementation and Administration	Six home football games, fire drills at residence halls and Greek houses each semester, periodic drills at the Research Reactor, Hospital, Athletics, and other departments.
Benefits (Losses Avoided)	IC,EM
Projected Cost	Moderate
Potential Funding Sources	Departmental budgets
Projected Completion Date	Ongoing
Criterion for Completion	Emergency exercises are conducted.

Action #	3.2.5
Mitigation Action	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Priority	High
Lead Department or Agency	MU Emergency Management
Partners, if any	MU Division of Finance
Plan for Implementation and Administration	Research and apply for grants for hardening select parts of existing buildings or constructing new buildings to FEMA 361 standards.
Benefits (Losses Avoided)	IC,EM
Projected Cost	High
Potential Funding Sources	Grants; operating budget for local match
Projected Completion Date	Ongoing
Criterion for Completion	Existing buildings have areas hardened to FEMA 361 standards or new buildings with safe rooms are constructed.

Action #	3.2.9
Mitigation Action	Continue to increase capacity to prevent and respond to unwanted intruder/active shooter events.
Priority	High
Lead Department or Agency	MU Police Dept.
Partners, if any	Boone Co. OEM, City of Columbia Police Dept., other institutions of higher learning
Plan for Implementation and Administration	Prevention and response to unwanted intruders/active shooters is part of the MU Emergency Management overall plan, part of the alert warning capability and is written into all building plans. Continue with regularly scheduled trainings for faculty, staff, and students.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	Moderate
Potential Funding Sources	Operating budget
Projected Completion Date	Ongoing
Criterion for Completion	Prevention of and response to unwanted intruders/active shooters is a continued focus for the University of MO.

Action #	3.2.12
Mitigation Action	Enhance alert and warning capabilities.
Priority	High
Lead Department or Agency	MU Emergency Management
Partners, if any	MU Division of Information Technology
Plan for Implementation and Administration	Improve the software and hardware associated with the current system. Continue to expand the system across campus to buildings currently not served.
Benefits (Losses Avoided)	IC,PD,LF,EM
Projected Cost	High
Potential Funding Sources	Grants; operating budget
Projected Completion Date	2020
Criterion for Completion	System is fully functional.

Integration into Other Planning Mechanisms

The University of Missouri (MU) is a separate government entity for most practical purposes. MU strives to have planning documents and policies consistent with those of the City of Columbia and Boone County. MU is a large city within the City of Columbia with its own power generation capability and separate water system. MU Police Department is one of the very few fully accredited law enforcement agencies in Missouri. MU has an emergency management coordinator who works directly with city and county government agencies to integrate collaborative planning and training opportunities. MU has worked cooperatively with the City and County in emergency preparedness efforts through collaboration on numerous committees.

6.5 FUNDING SOURCES

Funding of many public activities has become increasingly difficult in recent years. In the past, large mitigation projects have relied heavily on federal funding from FEMA; the local government was then responsible for a 25% match for the federal funds. With a few exceptions, these FEMA mitigation funds are increasingly difficult to obtain.

The increase in natural disasters across the county in recent years, coupled with already tight budgets, mean that a large part of the federal mitigation money follows the largest disasters. This poses an increased challenge for local governments to come up with creative ideas for finding funding to move ahead with needed mitigation projects.

This section will review the federal programs, when they may come into play and then discuss other possible avenues and approaches to mitigation funding.

FEDERAL FUNDS

The bulk of federal funding for mitigation is available through three FEMA grant programs:

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)

Jurisdictions which have adopted a FEMA approved Hazard Mitigation Plan are eligible for funding through these programs.

Another possible funding source is Community Development Block Grants (CDBG), which may be a possibility after a Presidential Disaster Declaration.

The **Hazard Mitigation Grant Program (HMGP)** assists states and local communities in implementing long-term mitigation measures following a Presidential Disaster Declaration. HMGP funding is allocated using a “sliding scale” formula based on the percentage of the funds spent on Public and Individual Assistance programs for each Presidential Disaster Declaration. Missouri is one of 12 states, as of March 2015, which has a FEMA-approved Enhanced State Hazard Mitigation Plan; this enhanced plan demonstrates a comprehensive mitigation program in the state and qualifies Missouri for increased HMGP funding (20%) after a disaster declaration.

HMGP funds can be used for projects protecting either public or private property; the proposed projects must fit within the state and local government's overall mitigation strategy for the disaster area and comply with program guidelines.

Eligibility for funding under the HMGP is limited to state and local governments, certain private nonprofit organizations or institutions that serve a public function, Indian tribes and authorized tribal organizations. Applicants work through SEMA which is responsible for setting funding priorities and administering the program.

The **Pre-Disaster Mitigation (PDM)** program provides funding for cost-effective hazard mitigation activities that complement a comprehensive mitigation program, and reduce injuries, loss of life, and damage and destruction of property. The PDM grant funds are provided to the state which then provides sub-grants to local governments for eligible mitigation activities.

The **Flood Mitigation Assistance (FMA)** program was created as part of the National Flood Insurance Reform Act of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the NFIP. Applicants must be participants in good standing in NFIP and properties to be mitigated must have flood insurance.

States administer the FMA program and are responsible for selecting projects for funding from the applicants submitted by all communities within the state. The state forwards selected applications to FEMA for eligibility determinations. Although individuals cannot apply directly for FMA funds, their local government may submit an application on their behalf.

Both the Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) are funded through a yearly appropriation from Congress. These are nationally competitive grants for which MO SEMA submits a statewide application of projects selected from jurisdictions around the state.

Funding Priorities: Mitigation projects within the counties in the disaster declaration are prioritized for HMGP funds; however, if all funds are not used within these counties, they will eventually be made available statewide.

In recent years, PDM funds have severely tightened up; with less money to disperse planning projects appear to be FEMA's top priority for the program. In Missouri, PDM is primarily used for the planning grants which allow updates of the state and county hazard mitigation plans.

FEMA's highest priority for FMA funds in recent years has been flood planning projects. The next priority has been the buyout of Severe Repetitive Loss (SRL) flooded properties. A jurisdiction which needs help with flood planning or SRL buyouts is a potential candidate for FMA funding.

Eligible Activities: For any of the FEMA programs, potential projects must match the stated goals and objectives of the Boone County Hazard Mitigation Plan and the State of Missouri Hazard Mitigation Plan.

A jurisdiction which has a mitigation project for which federal funding is sought should submit a Notice of Interest (NOI) to SEMA. This does not obligate the jurisdiction to proceed with the project but helps SEMA to have a sense of where mitigation funding is needed in the state.

Mitigation activities eligible for funding vary between the programs (Figure 6.8).

Figure 6.8

Eligible Activities for FEMA Mitigation Grant Programs			
Activity	HMGP	PDM	FMA
1. Mitigation Projects	✓	✓	✓
Property Acquisition and Structure Demolition or Relocation	✓	✓	✓
Structure Elevation	✓	✓	✓
Dry Floodproofing of Historic Residential Structures	✓	✓	✓
Dry Floodproofing of Non-residential Structures	✓	✓	✓
Minor Localized Flood Reduction Projects	✓	✓	✓
Structural Retrofitting of Existing Buildings	✓	✓	
Non-structural Retrofitting of Existing Buildings and Facilities	✓	✓	
Safe Room Construction	✓	✓	
Infrastructure Retrofit	✓	✓	
Soil Stabilization	✓	✓	
Wildfire Mitigation	✓	✓	
Post-disaster Code Enforcement	✓		
5% Initiative Projects	✓		
2. Hazard Mitigation Planning	✓	✓	✓
3. Management Costs	✓	✓	✓
Source: www.fema.gov/library/viewRecord.do?id=3648			

Application and Cost Share Requirements:

The application process for the FEMA Mitigation Grant Programs includes a Benefit Cost Analysis (BCA). A potential project must have a Benefit Cost Ratio of at least 1.0 to be considered for funding; a ratio of 1.0 indicates at least \$1 benefit for each \$1 spent on the project.

A BCA is the first step in assessing if a project has the potential to be funded. The BCA for a potential project is run on FEMA's BCA Software; planners at the Mid-MO RPC are trained to assist member jurisdictions with this software.

Cost share requirements and the application format for these programs are shown in Figure 6.9. Contributions of cash, in-kind services or materials, or any combination thereof, may be accepted as part of the non-Federal cost share. For FMA, not more than one half of the non-Federal contribution may be provided from in-kind contributions.

Figure 6.9 FEMA Mitigation Grant Programs			
Program	Federal/Local Match	Notes	Application Process
HMGP	75/25		paper
PDM	75/25		e-grants
PDM (Small Impoverished Community)	90/10	Qualification Requirements for "small impoverished": • A community of 3,000 or fewer individuals identified by the State as a rural community that is not a remote area within the corporate boundaries of a larger city • An average per capita annual income not exceeding 80 percent of the national per capita income, based on best available data. (For current information: http://www.bea.gov) • A local unemployment rate exceeding by 1 percentage point or more the most recently reported, average yearly national unemployment rate. (For current information: http://www.bls.gov/eag/eag.us.htm) • Meet other criteria required by the State/Tribe/Territory in which the community is located	e-grants
FMA	75/25		e-grants
FMA (Severe Repetitive Loss Property)	90/10	In Missouri, this cost share is less than the usual 75/25 because the State has an approved "Enhanced" State Mitigation Plan.	e-grants

Community Development Block Grant (CDBG) The objective of the CDBG program is to assist communities in rehabilitating substandard dwelling structures and to expand economic opportunities, primarily for low-to-moderate-income families. After a Presidential Disaster Declaration, CDBG funds may be used for long-term needs such as acquisition, reconstruction, and redevelopment of disaster-affected areas. There is no low-to-moderate income requirement after a Presidential Disaster Declaration.

LOCAL FUNDS

Local funding sources for mitigation projects is becoming increasingly important due to the frequency and high cost of recent disasters in the U.S. At the same time, local government funds, which have traditionally come from property and sales tax revenues, have been shrinking due to the effects of depressed property values and online commerce.

At the same time that both federal and local funds are shrinking, the need for mitigation funding is increasing due to the increased frequency and severity of the hazards. The following mitigation action to address this issue has been included in the 2015 update:

1.1.11 Strategize and establish local source(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County Hazard Mitigation Plan as direct project funding and/or as local match for outside grants.

It is also important that jurisdictions consider how mitigation can be incorporated and funded through other essential functions. For example, money allocated for a new school could include funds to harden part of that structure to FEMA 361 standards for a tornado safe room.

NON-GOVERNMENTAL FUNDS

Another potential source of revenue for local mitigation efforts are contributions of non-governmental organizations such as churches, charities, community relief funds, the Red Cross, hospitals, businesses, and nonprofit organizations. A variety of these local organizations can be tapped to help carry out local hazard mitigation initiatives.

Section 7: Plan Maintenance Process

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

7.1 PLAN MONITORING AND EVALUATION

The Boone County Hazard Mitigation Plan will be monitored and evaluated on a yearly basis following its approval and adoption. These evaluations will begin approximately one year after the final approval of the plan and continue until the next 5-year update begins.

The monitoring and evaluation will be facilitated through the Mid-MO Regional Planning Commission and will consist of the following:

1. An emailed survey of each participating jurisdiction regarding implementation of mitigation actions, relevant changes in the jurisdiction, and any developing issues
2. A possible meeting of the Hazard Mitigation Planning Committee depending upon the need indicated by survey responses
3. A yearly addendum to the plan summarizing survey responses
4. Entry of any direct changes to the plan in the “Log of Changes Made to the Plan following Approval” (which follows the Executive Summary)

7.2 PLAN UPDATING

FEMA requirements state a hazard mitigation plan must be updated and reapproved by FEMA every five years; the five years is counted from when the first participating jurisdiction adopts the approved plan.

A proposed schedule for the update is shown in Figure 7.1.

Figure 7.1		
Proposed Schedule for 5-year Update of Hazard Mitigation Plan		
KEY: PED = Plan Expiration Date		
Activity	Timeline to Begin	Responsible Party
Preliminary update of data	Yearly during maintenance/ review of plan	Mid-MO RPC
Prepare cost estimates for update of plan and submit to SEMA	PED - 13 months	Mid-MO RPC
Contact participating jurisdictions re: representation on update Planning Committee	PED - 12 months	Mid-MO RPC
Receive Memorandum of Agreement from SEMA for update	PED - 11 months	SEMA
Preliminary data review	PED - 11 months	Mid-MO RPC
Review and update of plan	PED - 10 months	Hazard Mitigation Planning Committee
Public Meeting #1 for comment and input on draft update	PED - 7 months	Mid-MO RPC/HM Planning Committee
Draft of update due at SEMA	PED - 6 months	Mid-MO RPC
Public Meeting #2 for comment and input on final update	PED - 4 months	Mid-MO RPC/HM Planning Committee
Final plan due at SEMA	PED - 3 months	Mid-MO RPC
Plan reviewed by SEMA	PED - 3 months	SEMA
Required changes/additions made to plan	PED - 2.5 months	Mid-MO RPC
Plan submitted to FEMA	PED - 2 months	SEMA
Participating jurisdictions adopt approved plan	PED - 1 month	Participating Jurisdictions
At least one adoption resolution submitted to FEMA	before PED	Mid-MO RPC

The ongoing yearly maintenance and evaluation of the plan, as described previously, will be of great value when undertaking the five year update. Continuity of personnel on the Hazard Mitigation Planning Committee throughout the five year process would be highly beneficial in taking mitigation planning to the next level.

The following data gap in the current plan and potential future issue should be followed up on during the 2020 update process, or during the yearly monitoring of the plan, if appropriate:

- Status of dam inundation studies/EAPs for state regulated dams in the planning area; this information is supposed to be released in 2016.
- The possibility of the oil shale of the Browns Station Anticline in northern Missouri being a target for fracking in the future was raised during the public comment period by a registered geologist. According to the information received, fracking in this area would not currently be an economically viable option but it may become so as petroleum supplies dwindle.

7.3 PUBLIC PARTICIPATION IN PLAN MAINTENANCE

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

The Boone County Hazard Mitigation plan will be remain continually available on the website of the Mid-Missouri Regional Planning Commission (www.mmrpc.org) for public review and comment. Either the plan itself or links to the plan will also be posted on as many websites of participating jurisdictions as possible.

The Boone County Emergency Management Director will facilitate presenting the entire plan to interested groups within the county such as:

- Health Department Personnel
- City Fire and Rural Fire Protection Districts
- City Elected Officials/Administrators
- Educational Personnel
- Local Emergency Planning Committees
- Local Police/Sheriff Department Personnel
- Boone County Commissioners/Directors
- Public Safety Joint Communications Committee Meeting

Notice of any public meetings concerning the maintenance of the plan will be given in accordance with Missouri's "Sunshine Law" (Revised Statutes of Missouri 610.010, 610.020, 610.023, and 610.024.)

Appendix A - Planning Process Documentation

(This information is available online at: www.mmrpc.org/reports-library/hazard-mitigation-reports/ or on digital discs of the plan.)

Appendix B - Non-regulated Dams (additional info)

Appendix C

Non-regulated Dams in Planning Area

			Purpose of Reservoir	

[illegible]

Appendix C (cont.)

Non-regulated Dams in Planning Area

			Purpose of Reservoir	

[illegible]

Appendix C (cont.)
Non-regulated Dams in Planning Area

Map ID #	Name	Watershed (acres)	Purpose of Reservoir									Corps ID #
			Recreation	Flood Control/storm water mgmt.	Fire protection, stock, or small farm pond	Other	Debris Control	Irrigation	Water Supply	Fish and Wildlife Pond	Grade Stabilization	
67	Weil Lake Dam	20	✓									MO11588
68	Hopper Dam	50	✓									MO11589
69	Seltsam Lake Dam	17	✓									MO11590
70	Bon-Gor Lake Dam	240	✓									MO11592
71	Rayfield Lake Dam	13	✓									MO11593
72	Mills Lake Dam	12	✓		✓							MO11594
73	Ausburn'S Lake Dam	80	✓									MO11595
74	Lake Cyrene Dam	70	✓									MO11596
75	Moon Valley Lake Dam	2,100	✓	✓								MO11597
76	Shady Lake Dam	220	✓									MO11598
77	Liddell Dam	45	✓									MO11601
78	Fletchall Lake Dam	39	✓									MO11602
80	Smith Lake Dam Sec 1	15	✓						✓			MO11605
81	Univ Of Mo-R1 Dam	140	✓				✓	✓				MO11606
82	Smith Lake Dam	160	✓		✓			✓				MO11607
83	Tincher Lake North Dam	80	✓									MO11609
84	Sapp Lake Dam	87	✓									MO11637
85	Rapp Lake Dam	300	✓	✓	✓							MO11640
86	Kimmy Lake Dam	60	✓									MO11641
87	Dexter Lake Dam	20	✓		✓							MO11642
88	Callahan Creek Watershed Dam A-4	750	✓		✓							MO11644
89	Bennett Lake Dam	290			✓		✓					MO11645
91	Callahan Creek Watershed Dam A-6	267	✓	✓								MO11647
92	Lohmar Lake Dam	65	✓									MO11648
93	Llorens Lake Dam	80	✓		✓							MO11649
94	Blakemore Lake Dam	21	✓		✓				✓			MO11651
95	Windmiller Dam #2	155	✓									MO11675
97	Waters Edge Estates Lake Dam	2,500	✓									MO12102
98	Tincher Lake South Dam	210						✓				MO12104
99	Roddy Lake Dam	65			✓							MO12107
100	Finger Lakes Dam North	740	✓									MO12211
102	Highlands Lake Dam	60	✓	✓								MO12215
103	B & C Subdivision Dam	280	✓									MO12226
104	Limerick Lake Dam	180	✓									MO12229
107	Highlands Lower Lake Dam	91	✓									MO12236
108	Highlands South Lake Dam	20	✓									MO12237
109	Windmiller Lake Dam	120			✓							MO12255
110	Homer Lake Dam	48			✓							MO12256

Appendix C (cont.)
Non-regulated Dams in Planning Area

Map ID #	Name	Watershed (acres)	Purpose of Reservoir									Corps ID #
			Recreation	Flood Control/storm water mgmt.	Fire protection, stock, or small farm pond	Other	Debris Control	Irrigation	Water Supply	Fish and Wildlife Pond	Grade Stabilization	
111	Harrison Lake Dam	111						✓				MO12257
113	Woodbine Lake Dam	150	✓									MO30498
114	Hill Creek Acres Lake Dam	40	✓									MO30499
116	Herny Dam	145	✓									MO30909
117	Cheng Lake Dam	190	✓				✓					MO31060
118	Demarco Lake Dam	42	✓						✓			MO31555
119	Callahan Creek A-2	593		✓								MO50031
120	Callahan Creek B-1	650		✓								MO50032
121	Callahan Creek B-3	582		✓								MO50033
122	Fields Dam	32	✓							✓	✓	MO50034
123	Greg Bunn Lake	96						✓		✓	✓	MO50035
124	Hargis Dam	6	✓							✓	✓	MO50036
125	Kreisel Lake Dam	262						✓		✓	✓	MO50038
126	Silas Mccubbin Lake Dam	19	✓		✓					✓	✓	MO50039
127	Yates Dam	90									✓	MO50041
128	Mcnew Lake											

Source: MO DNR - National Inventory of Dams