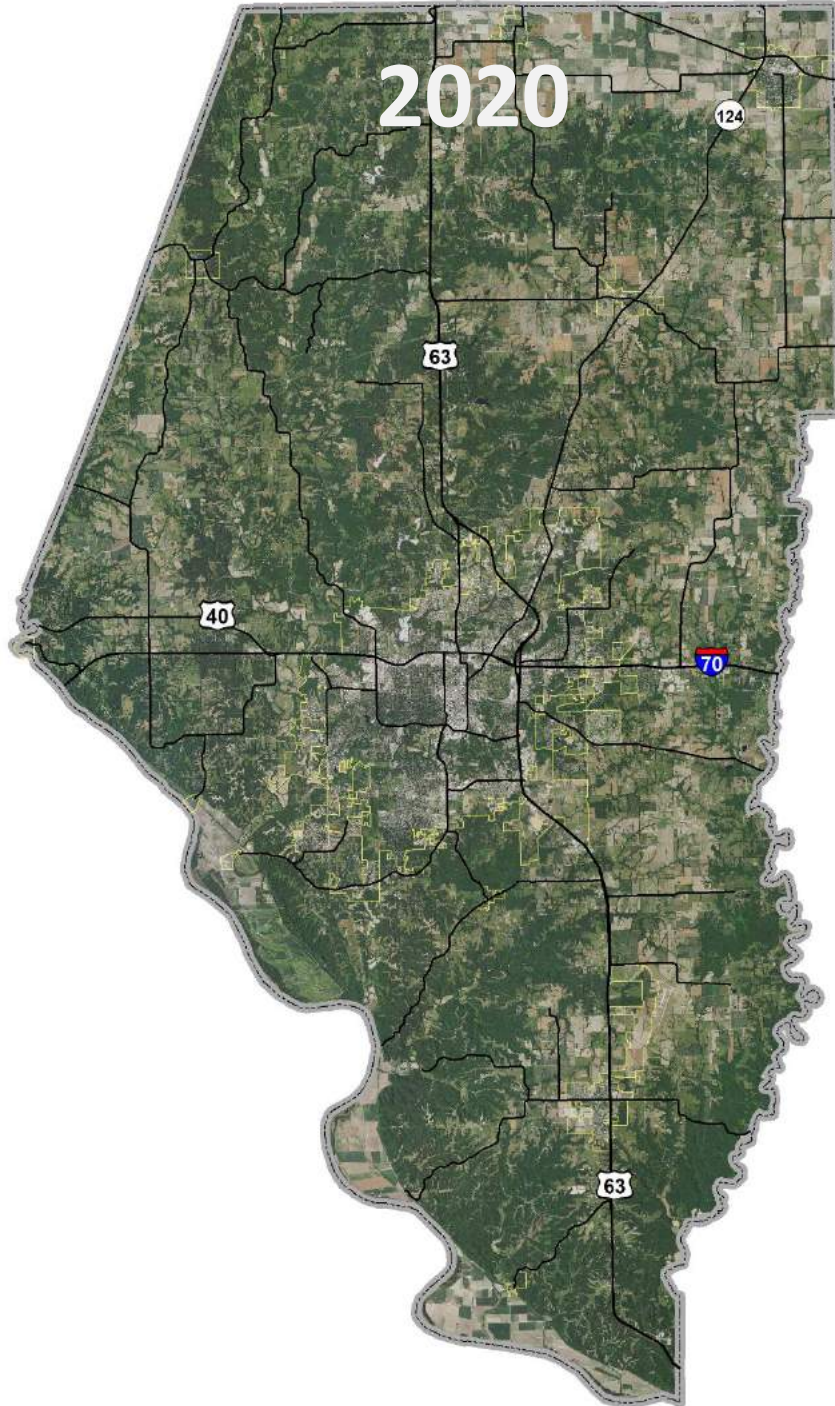


Boone County, MO

Hazard Mitigation Plan



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



Boone County Hazard Mitigation Plan 2020

U.S. Department of Homeland Security
FEMA Region VII
11224 Holmes Road
Kansas City, MO 64131



FEMA

December 18, 2020

Mr. James Remillard, Acting Director
State Emergency Management Agency
P. O. Box 116
Jefferson City, Missouri 65102

Subject: Review of the Boone County Multi-jurisdiction Hazard Mitigation Plan Update

Dear Mr. Remillard:

The purpose of this letter is to provide the status of the above referenced Local Hazard Mitigation Plan, pursuant to the requirements of 44 CFR Part 201 - Mitigation Planning and the Local Multi-Hazard Mitigation Planning Guidance. The Local Hazard Mitigation Plan Review Tool documents the Region's review and compliance with all required elements of 44 CFR Part 201.6, as well as identifies the jurisdictions participating in the planning process. FEMA's approval will be for a period of five years effective starting with the approval date indicated below.

Prior to the expiration of the plan the community will be required to review and revise their plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities. After the review or revisions are completed the plan will need to be resubmitted for approval by FEMA in order to continue to be eligible for mitigation project grant funding.

Plan Name	Date Submitted	Date Approved	Date of Plan Adoption	Date of Plan Expiration	Review Status
Boone County	November 17, 2020	December 18, 2020	August 17, 2020	December 18, 2025	Approved

If you have any questions or concerns, please contact Joe Chandler, Planning Team Lead, at (816) 283-7071.

Sincerely,

TERI A MAYER Digitally signed by TERI A MAYER
Date: 2020.12.18 11:13:50 -06'00'

Catherine R. Sanders, Director
Mitigation Division

www.fema.gov

CONTRIBUTORS

Boone County Hazard Mitigation Planning Committee

Jurisdictional Representatives of Boone County Mitigation Planning Committee

Name	Title	Department	Jurisdiction/Agency
Haley Campbell	Mitigation & Recovery	Emergency Management	Boone County
Tom Hurley	EMA Director	Emergency Management	Boone County
Sherril Gladney	Planning & Prep	Emergency Management	Boone County
Heather Russell	Administrator	City	Centralia
Eric Hempel	Housing Specialist	Sustainability	City of Columbia
Barbara Buffaloe	Manager	Sustainability	City of Columbia
Steve Crosswhite	Mayor	City	Sturgeon
Brianna Lennon	Clerk	County	Boone County
John Zondca	Mayor	City	Rocheport
David Kelb	Police Chief	Sturgeon Police Dep.	Sturgeon
Rebecca Estes	Planning Supervisor	Health Dep.	Boone County
Tom Ratterman	Manager	Sewer Dep.	Boone County
Justin Nichols	Manager	Administration	Hallsville School District
Brian Schultz	Police Chief	Hallsville Police Dep.	Hallsville
Geoff Neill	Superintendent	Administration	Sturgeon School District
Chris Femlee	Superintendent	Administration	Southern Boone School District
Ken Gregory	Assistant Director	Safety	Columbia Public Schools
Steve Chancellor	Superintendent	Administration	Centralia School District
Tony St Romaine	Administrator	City	Ashland
Bill Molendorp	Mayor	City	Hartsburg
Reggie Wilhite	Chairman	City	Harrisburg
Debby Lancaster	Mayor	City	Huntsdale
Doug Schwandt	Police Chief	MUPD	University of Missouri
Ken Hammond	Director	Campus Safety	Stephens College
Dawn Malone	District Bookkeeper	Administration	Harrisburg School District
Stakeholders			
Mike Parks	Manager		Columbia Regional Airport
Steve Walsh	Press Secretary		State-Rep Vicky Hartzler Office

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

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Executive Summary

Hazard mitigation, at its core, 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 handful of decades. Averaging 121 disaster declarations between 1999 – 2019 the numbers are more than showing an extreme uptake compared to an average of 45 per year as noted between the years 1979-1998. Between January 2014 to December 2018 alone, presidential disaster declarations have totaled 528 (FEMA.Gov). <https://www.fema.gov/disasters/year>.

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 2018 study by the National Institute of Building Sciences finds \$6 saved for every dollar invested in mitigation activities to reduce risk and disaster losses ,” In the case of riverine flood, the savings are a \$7-to-\$1 benefit for proactive mitigation steps such as acquiring or demolishing flood-prone buildings “(Laura Lightbody, 2018). Hazard mitigation is a good business practice for both the public and private sectors. [https://www.pewtrusts.org/en/research-and-analysis/articles/2018/01/11/every-\\$1-invested-in-disaster-mitigation-saves-\\$6](https://www.pewtrusts.org/en/research-and-analysis/articles/2018/01/11/every-$1-invested-in-disaster-mitigation-saves-$6)

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. Since 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 (Chapter 3) indicates the natural hazards posing the greatest threat to Boone County 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.

Several mitigation actions have been completed since the 2015 update of the plan: In unincorporated Boone County, Route 63 over Gans Creek, south of Discovery Parkway - Bridge rehabilitation in the southbound lanes continues. The Boone County Emergency management

agency acquired a new 175kW generator as well as laptops for their Incident Response Trailer and the city of Sturgeon has started to place utilities underground in their new subdivisions.

2020 Mitigation Strategy: The current mitigation strategy, found in chapter 4 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 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 applicable to many jurisdictions is “review and formalize relationships with cooling centers in each community”; this is an important action which many of the jurisdictions will be undertaking to address their own circumstances.

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 2020 countywide mitigation strategy is shown in its entirety below, organized by the five major mitigation goals

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

- Mitigate the effects of flooding on public infrastructure
- Continue to enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
- Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data.
- Review building codes every three years for potential update.
- 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.
- Conduct a flow study along major highway routes to help determine quantities of hazardous materials being transported through Boone County.
- 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).
- Ensure evacuation plans are adequate for nursing homes and special needs population
- 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.
- Encourage shelters to have an alternative heating source

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.
- Review building codes every three years for potential update.
- Add sinkhole regulations to stream buffer/storm water ordinance.
- Develop policy and enforcement regulations concerning burning permits.
- 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.

- Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.
- Replace 2, 3, and 4-inch water lines with 6-inch lines to ensure adequate supply for fire flow.
- Secure high value equipment located outside county and municipal buildings (generators, signs, com-equipment)
- Mitigate the effects of flooding on public infrastructure.
- Ensure evacuation plans are adequate for nursing homes and special needs populations.
- Evaluate and maintain emergency preparedness plans.
- Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.
- Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.
- 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.
- 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.

Goal 4: Public Awareness - Increase public awareness of natural, technological, and humanmade 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.

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 2020 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 Boone County Hazard Mitigation Plan 2020 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 2019-2020. Jurisdictions from both within and surrounding Boone were invited to participate and give feedback during the plan update.

The update was completed with the active participation of eighteen jurisdictions in Boone County (the county itself, ten communities, five school districts, one college, and one university).

Jurisdictions that participated in the plan update include:

- Unincorporated Boone County
- Ashland
- Centralia
- Columbia
- Hallsville
- Hartsburg
- Harrisburg
- Huntsdale
- Rocheport
- Sturgeon

- Centralia R-VI School District
- Columbia Public Schools
- Hallsville R-IV
- Harrisburg R-VIII
- Southern Boone School District
- Sturgeon R-V School District
- Stephen's College
- University of Missouri

Jurisdictions that were invited but chose not to participate in this update include:

- Columbia College
- Unincorporated Howard County
- Unincorporated Cooper County
- Unincorporated Moniteau County
- Unincorporated Cole County
- Unincorporated Callaway County
- Fayette R-III
- North Callaway R-1
- New Franklin R-I

Representatives from these jurisdictions comprised the hazard mitigation planning committee which met for four 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 one public meeting 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/.

Prerequisites

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

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 appendix A.

Chapter 1: Introduction and Planning Process

- 1.1 Purpose.....1
- 1.2 Background and Scope.....2
- 1.3 Plan Organization.....3
- 1.4 Planning Process.....4
 - 1.4.1 Multi- Jurisdictional Participation
 - 1.4.2 The Planning Steps

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, man-made, and technological hazards in Boone County. Each year natural, man-made, and technological hazards take a great toll in the United States. Boone County is not immune; it is subject to numerous natural, man-made, and technological 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 2018 study by the National Institute of Building Sciences finds \$6 saved for every dollar invested in mitigation activities to reduce risk and disaster losses.

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

1.2 Background and Scope

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 2015-2020

The Boone County Hazard Mitigation Plan 2015 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.midmorpc.org) since it was approved and adopted in 2015.

The maintenance plan in the 2015 document called for an annual monitoring and review of the plan to be facilitated by the Mid-MO RPC. This monitoring and review were carried out in early 2017, again in the spring of 2018, and finally the fall of 2019 when the updating process ensued.

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.

Jurisdictions that participated in the 2015 plan as well as the 2020 plan update include:

- Unincorporated Boone County
- Ashland
- Centralia
- Columbia

- Hallsville
- Hartsburg
- Harrisburg
- Huntsdale
- Rocheport
- Sturgeon
- Centralia R-VI School District
- Columbia Public Schools
- Hallsville R-IV
- Harrisburg R-VIII
- Southern Boone School District
- Sturgeon R-V School District
- Stephen’s College
- University of Missouri

Columbia College was the only jurisdiction that participated in the 2015 update but did not participate in the 2020 update. Jurisdictions that were invited but chose not to participate in this update include:

- Columbia College
- Unincorporated Howard County
- Unincorporated Cooper County
- Unincorporated Moniteau County
- Unincorporated Cole County
- Unincorporated Callaway County
- Fayette R-III
- North Callaway R-1
- New Franklin R-I

Jurisdictions received email notifications of upcoming meetings and their corresponding agendas, along with any “homework” in the form of questionnaires or surveys. Meeting notices were also posted on the RPC website, meeting information was put on the RPC calendar that is emailed to the 6 county RPC region, as well as notices posted to the RPC Facebook page. Phone calls were also made by the planner and the County Office of Emergency Management to encourage participation.

1.3 PLAN ORGANIZATION

The plan is formatted into 5 Chapters with several sub-sections per section. The 2015 plan contained 6 sections. Planning Area Overview and Planning Area Assets and Capabilities were originally separate sections. For this plan the two sections were combined to match the updated outline for the local hazard mitigation plan released by the Missouri State Emergency Management Agency (SEMA) in 2017. The adjusted plan sections include:

- Chapter 1: Introduction and the Planning Process
- Chapter 2: Planning Area Overview, Assets, and Capabilities

- Chapter 3: Risk Assessment
- Chapter 4: Mitigation Strategy
- Chapter 5: Plan Implementation and Maintenance
- Appendices

Table 1.1: Changes Made in Plan Update

Plan Section	Summary of Updates
Chapter 1 – Introduction and Planning Process	Updated members of the Mitigation Planning Committee (MPC) Updated chapter format
Chapter 2 – Planning Area Profile and Capabilities	Updated chapter format
Chapter 3 – Risk Assessment	Combined Extreme Heat and cold into one hazard: extreme temperatures Updated chapter format
Chapter 4 – Mitigation Strategy	Updated chapter format Changed action worksheet layout/info
Chapter 5 – Plan Implementation and Maintenance	Updated chapter format Added planning mechanisms for hazard mitigation

1.4 PLANNING PROCESS

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

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 the emergency management planner from Mid-MO RPC (Jennifer Bowden) as specified in a Memorandum of Agreement (MOA) with the Missouri State Emergency Management Agency (SEMA). The roll of Mid-MO RPC in the planning process is to:

- Assist in establishing a Mitigation Planning Committee (MPC) as defined by the Disaster Mitigation Act (DMA),
- Organize Planning Committee Meetings locations and times
- Ensure the updated plan meets the DMA requirements as established by federal regulations and follows the most current planning guidance of the Federal Emergency Management Agency (FEMA),
- Facilitate the entire plan development process,
- Identify the data that MPC participants could provide and conduct the research and documentation necessary to augment that data,
- Assist in soliciting public input,
- Produce the draft and final plan update in a FEMA-approvable document and coordinate the Missouri State Emergency Management Agency (SEMA) and (FEMA) plan reviews.

The update process consisted of 4 planning committee meetings over the update period. Meeting announcements and sign-in sheets are included in Appendix B.

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).

Table 1.2 Jurisdictional Representatives of Boone County Mitigation Planning Committee

Name	Title	Department	Jurisdiction/Agency
Haley Campbell	Mitigation & Recovery	Emergency Management	Boone County
Chris Kelly	EMA Director	Emergency Management	Boone County
Sherril Gladney	Planning & Prep	Emergency Management	Boone County
Chris Kelly	EMA Director	Emergency Management	Boone County
Heather Russell	Administrator	City	Centralia
Eric Hempel	Housing Specialist	Sustainability	City of Columbia
Barbara Buffaloe	Manager	Sustainability	City of Columbia
Steve Crosswhite	Mayor	City	Sturgeon
Brianna Lennon	Clerk	County	Boone County
John Zondca	Mayor	City	Rocheport
David Kelb	Police Chief	Sturgeon Police Dep.	Sturgeon
Rebecca Estes	Planning Supervisor	Health Dep.	Boone County
Tom Ratterman	Manager	Sewer Dep.	Boone County
Justin Nichols	Manager	Administration	Hallsville School District
Brian Schultz	Police Chief	Hallsville Police Dep.	Hallsville
Geoff Neill	Superintendent	Administration	Sturgeon School District
Chris Felmlee	Superintendent	Administration	Southern Boone School District
Ken Gregory	Assistant Director	Safety	Columbia Public Schools
Steve Chancellor	Superintendent	Administration	Centralia School District
Tony St Romaine	Administrator	City	Ashland
Reggie Wilhite	Chairman	City	Harrisburg
Bill Molendorp	Mayor	City	Hartsburg
Debby Lancaster	Mayor	City	Huntsdale
Doug Schwandt	Police Chief	MUPD	University of Missouri
Ken Hammond	Director	Campus Safety	Stephens College
Dawn Malone	District Bookkeeper	Administration	Harrisburg School District
Stakeholders			
Mike Parks	Manager		Columbia Regional Airport
Steve Walsh	Press Secretary		State-Rep Vicky Hartzler Office

Table 1.3 Demonstrates the expertise in the six mitigation categories of jurisdictional representatives.

Table 1.3: MPC Capability with Six Mitigation Categories

Community Department/Office	Prevention	Structure and Infrastructure Projects		Natural Systems Protection	Education and Awareness Programs	Emergency Services
		Property Protection	Structural Flood Control Projects			
Boone County EOC	X				X	X
Centralia	X	X	X		X	X
Columbia	X	X	X		X	X

Rocheport	X	X	X		X	
Sturgeon	X	X	X		X	X
Boone County	X	X	X		X	X
Hallsville	X	X	X		X	X
Ashland	X	X	x		X	X
Harrisburg	X				X	
Hartsburg	X				X	
Huntsdale	X				X	
University of Missouri	x				X	X
Hallsville School	x				X	
Sturgeon School	X				X	
Southern Boone	X				X	
Columbia Public School	X				X	
Centralia School	x				X	
Stephens College	X				X	
Harrisburg School	X				X	
Columbia Regional Airport	X				X	
State Rep. Office	X				X	

1.4.1 Multi-Jurisdictional Participation

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

Multiple jurisdictions within Boone County participated in the development of this plan. Having a current and approved hazard mitigation plan is a prerequisite for participating jurisdictions to be eligible to apply for FEMA pre-disaster mitigation grants and the mitigation portion of post disaster mitigation grants. Invitations to participate in the development of the plan were sent to commissioners, incorporated community leaders, public schools and colleges, special districts, and various other stakeholders multiple times throughout the update to encourage participation in some manner. Each jurisdiction who participated will have to adopt the updated plan.

- Participation in a meeting was not required as long as other participation was had. Representatives from Ashland, City of Harrisburg, Harrisburg School District, Huntsdale, and Stephens College participated through phone meetings and emails with the planner and provided feedback through the questionnaire. Meeting participation could be in-person or by proxy.
- Each participating jurisdiction must provide sufficient information to support plan development by completion and return of surveys.
- For plan updates, eliminate from further consideration those actions from the previously approved plan that were not implemented because they were impractical, inappropriate, not cost-effective, or were otherwise not feasible.
- Review and comment on plan drafts
- Provide documentation to show time donated to the planning effort

- All participants should formally adopt the mitigation plan prior to submittal to SEMA and FEMA for final approval.

Table 1.4 Jurisdictional Participation in Planning Process

Jurisdiction	Kick-off Meeting	Meeting #2	Meeting #3	Meeting #4	Phone/Email	Data Collection Questionnaire	Update/Develop Mitigation Actions
Boone County	X	X	X	X		X	X
Ashland					X	X	X
Centralia	X					X	X
Columbia	X		X			X	X
Hallsville			X			X	X
Harrisburg					X	X	X
Hartsburg				X		X	X
Huntsdale					X	X	X
Rocheport	X					X	X
Sturgeon	X		X			X	X
Centralia R-VI				X		X	X
Columbia Public Schools				X		X	X
Hallsville R-IV			X			X	X
Harrisburg R-VIII					X	X	X
Southern Boone School D.			X	X		X	X
Sturgeon R-V				X		X	X
Stephens College					X	X	X
University of Missouri				X		X	X

1.4.2 The Planning Steps

Surveys and questionnaires were important in getting first-hand information from jurisdictions. One-on-one time, public meetings, and many emails produced a wealth of information taken into the plan.

Development of the plan followed the 10-step planning process adapted from FEMA’s Community Rating System (CRS) and Flood Mitigation Assistance programs. The 10-step process allows the plan to meet funding eligibility requirements of the Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, and Flood Mitigation Assistance Program as well as qualify for points under Activity 510 for Mitigation Plans, under the Community Rating System.

Table 1.5 County Mitigation Plan Update Process

Community Rating System (CRS) Planning Steps (Activity 510)	Local Mitigation Planning Handbook Tasks (44 CFR Part 201)
Step 1. Organize	Task 1: Determine the Planning Area and Resources
	Task 2: Build the Planning Team 44 CFR 201.6(c)(1)
Step 2. Involve the public	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)

Step 3. Coordinate	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)
Step 4. Assess the hazard	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)
Step 5. Assess the problem	
Step 6. Set goals	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)
Step 7. Review possible activities	
Step 8. Draft an action plan	
Step 9. Adopt the plan	Task 8: Review and Adopt the Plan
Step 10. Implement, evaluate, revise	Task 7: Keep the Plan Current
	Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)

Step 1. Organize

Contact lists were made for past participating jurisdictions as well as neighboring communities to Boone, and email notices were directly sent out to all jurisdictions and special districts in Boone County making sure to update contacts for positions who may have changed personnel. The notice consisted of a meeting announcement and short summary of what the meeting would be covering and its importance.

A kick-off meeting was hosted June 25, 2019 at the Boone County Emergency Management building. The foundation topic of this meeting was to outline the process of the hazard mitigation plan update and its importance. Surveys were passed out to each jurisdiction in attendance to identify what data the participants could provide. This meeting also served as an introduction to the types of hazards that would be included in the plan. Those in attendance were asked to sign in. Documentation can be found in the following appendices. They were instructed to either email the finished surveys to the lead planner or they had the option to return them in person at the next scheduled meeting. The date for the next meeting was set before everyone left the current meeting. Any jurisdictions not at the meeting were noted.

Meeting 2 took place on July 30, 2019 at the Boone County Emergency Management building. Anyone who wasn't at the first meeting was given a survey to fill out for their jurisdiction. Anyone done with their survey had the opportunity to turn it in if they had not emailed it prior to the meeting. There was discussion on parts of the survey that may not have been easily understood how to answer or where to get the information from. Risk Assessment results were shared with the group.

Meeting 3 took place October 1, 2019 at the Boone County Emergency Management building. Eric Hempel with Columbia Water and Light gave a presentation on the Columbia Climate Action and Adaptation Plan and climate change in our area. More surveys were turned in. There was discussion about making sure that everyone logs their hours to meet the "in-kind" match.

Meeting 4 took place December 10, 2019 at the Boone County Emergency Management building. Mitigation Actions list was discussed. Projects were either removed because they were done or no longer feasible, added, or listed as on-going.

Table 1.6: Schedule of MPC Meetings

Meeting	Topic	Date
Kick-Off Meeting	<ul style="list-style-type: none"> • Importance of Hazard Mitigation Planning • Why the Plan needs updated and what is included • Planning process • How to Participate • Handed out questionnaires 	6/25/2019
Meeting #2	<ul style="list-style-type: none"> • Return questionnaires • Discussed questions about the questionnaire • Discussed Risk Assessments 	7/30/2019
Meeting #3	<ul style="list-style-type: none"> • Presentation on climate change and adaptation • How in-kind match works 	10/1/2019
Meeting #4	<ul style="list-style-type: none"> • Discussion on mitigation actions • Actions removed or added 	12/10/2019

Step 2. Public Involvement

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

Each of the 4 meetings of the MPC were open to the public. It was advertised through the Mid-MO RPC (www.mmrpc.org) website, posted at the office, and included on the RPC Facebook page. The draft is available at the Mid-MO RPC website for anyone to review. Comments can be taken through email, phone, or in-person at the office. Individual invites and meeting notices were emailed to each jurisdiction for participation. Jurisdictions that did not show up or return email contact after the second meeting were called directly and educated on the importance of their participation. Anyone who did not come in-person to a meeting was emailed a survey to fill out for their jurisdiction. No public comments were received during the planning process. The needs and concerns of the public were considered based on the feedback given by jurisdictional representatives and their knowledge and interaction with the public outside the planning process.

Step 3. Coordinate

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

Participants from all incorporated cities, towns, and villages were invited to every meeting, along with all school districts and colleges. Other invitees were emergency response agencies, county offices, etc. Once a draft of the plan was complete it was posted to the Mid-MO RPC website for review by all interested parties. Invitations were sent by email and notices were published to the RPC Facebook page and a calendar with meetings shared via email to jurisdictions and stakeholders throughout the 6 county RPC region.

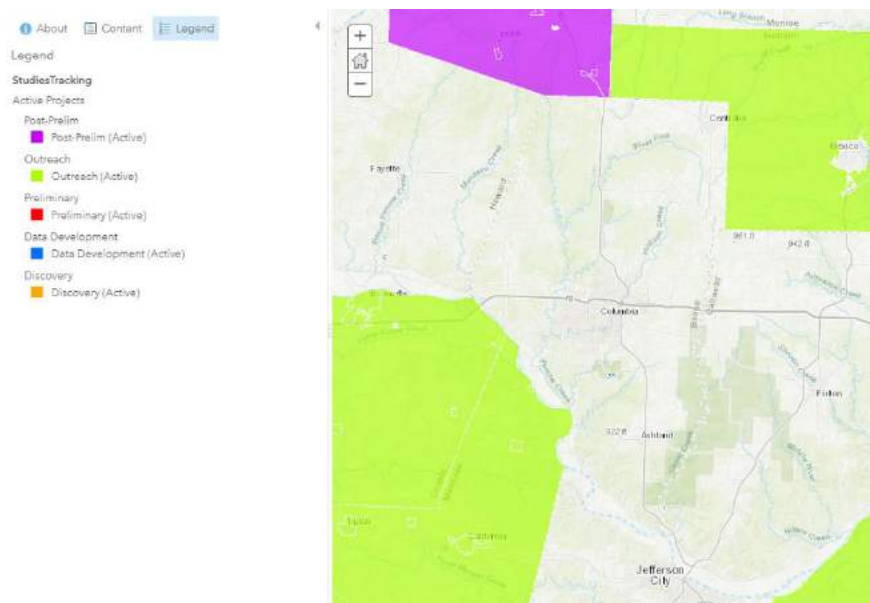
Table 1.7: Invited Stakeholders

Stakeholder/Jurisdiction	Position/Department
Columbia Regional Airport	Manager
Fayette R-III	Superintendent
North Callaway R-I	Superintendent
New Franklin R-I	Superintendent
Howard County	Presiding Commissioner
Cooper County	Presiding Commissioner
Moniteau County	Presiding Commissioner
Cole County	Presiding Commissioner
Callaway County	Presiding Commissioner

Coordination with FEMA Risk MAP Project

Figure 1.1 shows the status of Risk Mapping in Boone County. Currently there are no active projects or data development taking place in Boone County. The southern boundary of Boone is edged by the Missouri River which is prone to flooding. The risks of this will be more clearly defined in Section 3: Risk Assessment.

Figure 1.1 FEMA Risk Studies Tracker



Source: FEMA Mapping Information Studies Tracker

Integration of Other Data, Reports, Studies, and Plans

Several other sources and documents were consulted to update the Plan. These documents and studies provide statistics for consideration, as well as preparedness and mitigation options viable to the planning area. Those documents and sources include:

- Flood Insurance Rate Maps (FIRMs)
- State Department of Natural Resources (DNR) dam information
- The National Inventory of Dams (NID)
- 2013 & 2018 Missouri State Hazard Mitigation Plans
- Wildland/Urban Interface and Intermix areas from the SILVIS Lab – Department of Forest Ecology and Management – University of Wisconsin
- United States Department of Agriculture – Census of Agriculture
- Corp of Engineers - National Levee Database *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 (2019)*
- *Columbia Imagined, 2013*
- *Communicating Before and After a Nuclear Power Plant Incident (June 2013)*, FEMA
- *Comprehensive Economic Development Strategy for the Mid-MO Region (2016)*, 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 (2018)*, Missouri State Emergency Management Agency (SEMA)
- *National Climate Assessment 2018*, U.S. Global Change Research Program (GlobalChange.gov)
- *Regional Transportation Plan (2016)*, Mid-MO Regional Planning Commission
- Situation Reports (online), Missouri SEMA
- *Source Water Protection Plan, City of Columbia Missouri, 2013*
- *FEMA’s Local Mitigation Planning Handbook (March 2013)*
- *Online tools provided by SEMA and other State Agencies*

Step 4: Assess the Hazard

Risk Assessment surveys were compiled and discussed at the second meeting, July 30, 2019. The risk of hazards were based on previous disasters, hazards that were identified in the State Hazard Mitigation Plan, and hazards from the previously approved hazard mitigation plan. Hazards were prioritized by their likelihood and severity of impacts by each jurisdiction, then totaled to rate each hazard on a whole. Additional details about the individual hazards can be found in the chapter on Risk Assessment.

Step 5: Assess the Problem

Assets for each jurisdiction were identified through the use of HAZUS, the data questionnaire, and Census. Losses were estimated by utilizing the HAZUS database and the 2018 State Hazard Mitigation Plan when needed.

Step 6: Set Goals

The goals set in the previous plan update were carried over for this plan. It was felt that the current set of goals were still relevant and necessary during the 4th meeting that took place December 10, 2019, when the Mitigation Actions List was discussed and updated. Those goals summarized are:

- Goal 1: Mitigation Planning - Mitigate the effects of future natural, technological, and humanmade 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 humanmade 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.

Step 7: Review Possible Mitigation Actions and Activities

Mitigation Actions were discussed at the 4th meeting held December 10, 2019. Each action from the last update was reviewed and updated individually by the MPC. A link to the FEMA publication *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (2013)* was provided at the Kickoff meeting with the questionnaire to give everyone projects to think about for their jurisdiction. A focus for the MPC was the addition of safe rooms in schools and public places to the Mitigation Action Plan across the county.

Step 8: Draft an Action Plan

Based on the response from the final MPC meeting in December an Action Plan was formed from any on-going and remaining actions identified as well as actions added to the list. Possible grant opportunities to assist in achieving the set goals and actions were also discussed at the final meeting. On-going efforts and mitigation achievements through projects and policy is a priority for stakeholders.

Step 9: Adopt the Plan

Throughout the whole update process it was reiterated in word and text that in order for participation in the plan to count a jurisdiction must participate by attending meetings or returning the survey/questionnaire, and lastly by signing an adoption resolution of the plan that can be included in the draft to SEMA.

Step 10: Implement, Evaluate, and Revise the Plan

Plan implementation was discussed at the final meeting while discussing grant and partnership opportunities to move the actions on the mitigation list along. Future revisions will be discussed in more detail one-on-one with the participating jurisdictions. Further details regarding implementation, monitoring and maintenance can be found in chapter 5, Plan Maintenance Process.

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Chapter 2: Planning Area Profile

2.1 Boone County Planning Area Profile

Boone County is a steadily growing county in central Missouri. The 2010 census indicated a county of 162,551 people, which was a 20% increase over the 2000 census count of 135,454. According to the American Community Survey (ACS) estimates show the county should have continued to grow, though not nearly as rapidly. Estimates show the county with a 9.6% increase to 180,005 in 2018. In relation, the state of Missouri as well as national population numbers have also shown an increase, but to a much smaller extent with a state increase of only 2.2% and a national population increase of 5.6%.

Median income for Boone County has seen nearly a 12% increase to \$52,005 since 2010 and is slightly above the state median income of 51,542, which has only seen a 10.2% increase over the last decade. While Boone has a slightly lower medium income than the national \$57,652 average the national median income has shown growth more in line with the state’s at about 10%.

With the rising income rates comes equally rising housing costs. The median home value in Boone County increased 15.5% from 2010 to 2017 according to ACS estimates. In 2010 homeowners would pay a median price of \$153,900 for a home. In 2017 the median price was around \$177,800, which is over the Missouri median home cost of only \$145,400. Missouri has seen a median price tick up slightly since 2010 but only by slightly over 5%. Both Boone County and the state of Missouri have seen more increase in median value than the national increase of 2.6%, but both remain significantly under the national median home price of \$193,500.

2.1.1 Geography, Geology, and Topography

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 2.2).

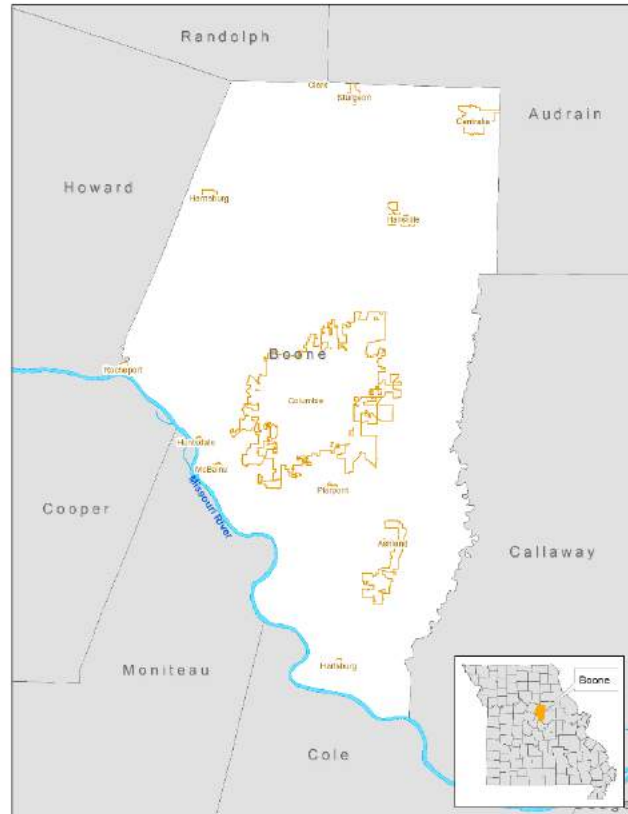
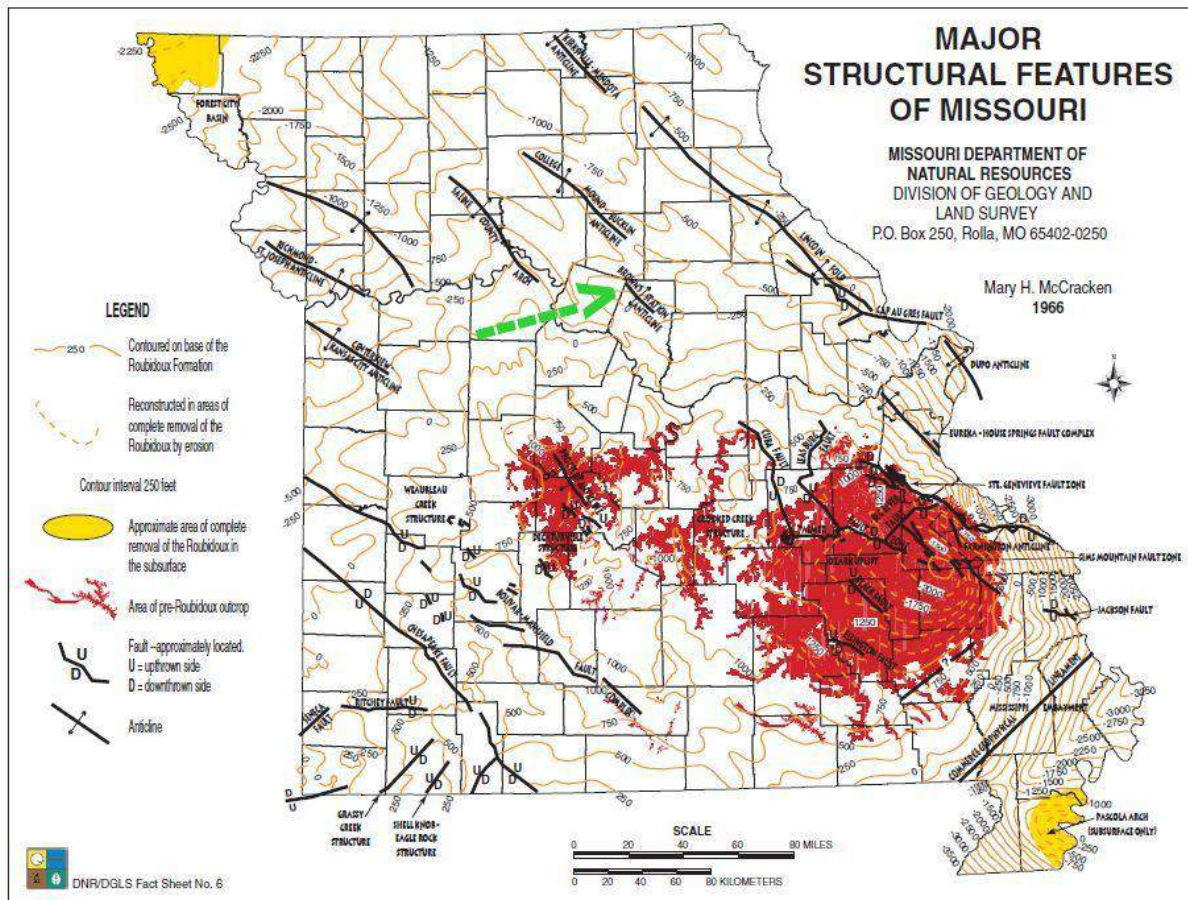


Figure 2. 1

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).

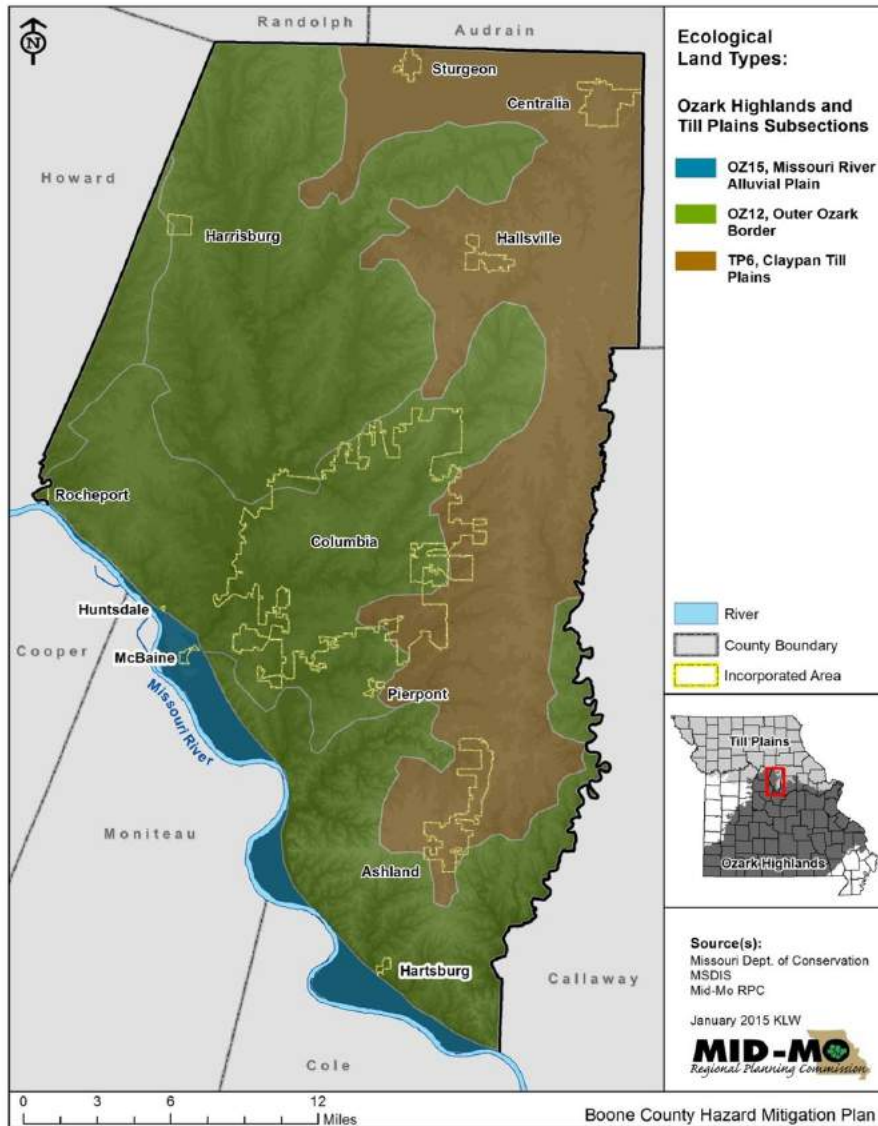
Figure 2.2



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 3.

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.

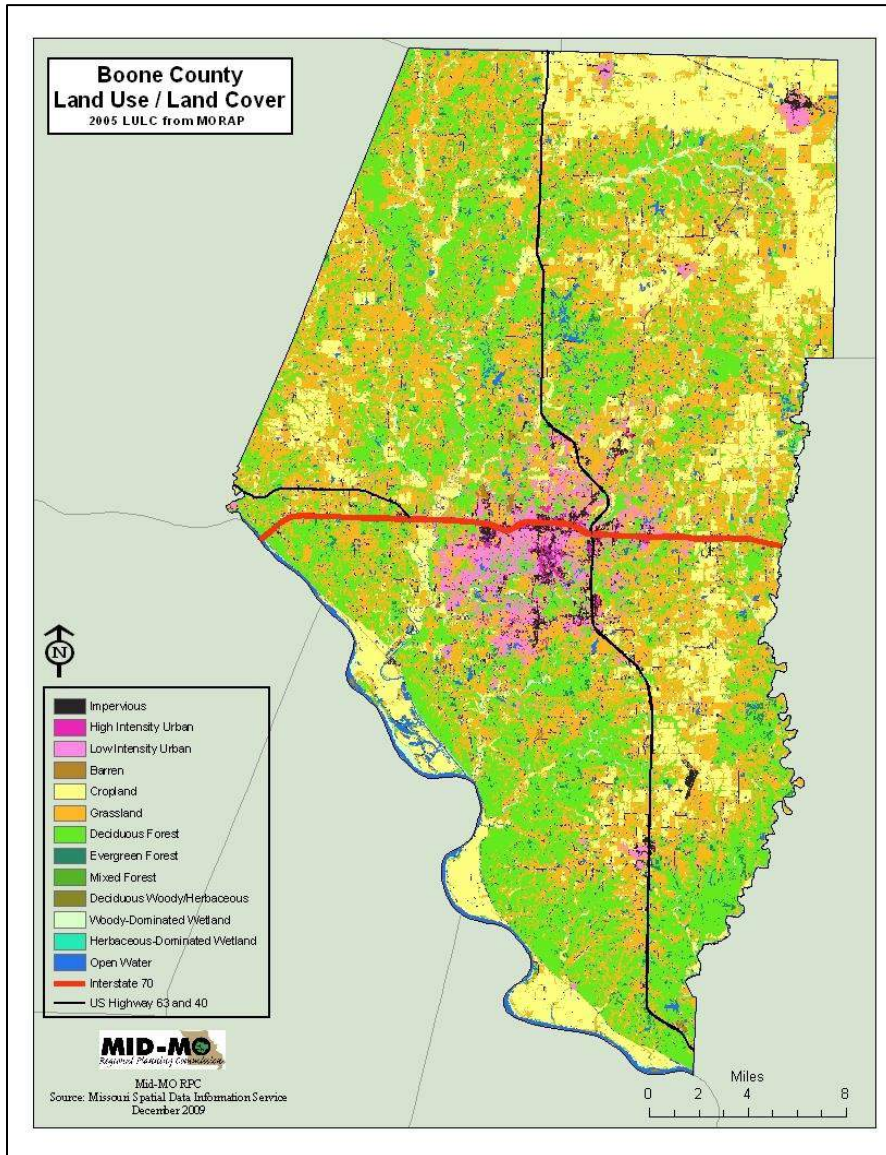
In both 1994 and 1995 the Missouri River was listed as one of the “10 Most Endangered Rivers in the Country” by American Rivers, a river conservation group (<http://www.americanrivers.org/>). This “Most Endangered” list does not reflect rivers in the worst condition; rather, it seeks to highlight rivers “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.

2.1.2 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



2.1.3 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.

National Centers for Environmental Information (NCEI) 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. Additional information on climate change and impacts to the planning area can be found in Appendix C.

Figure 2.5

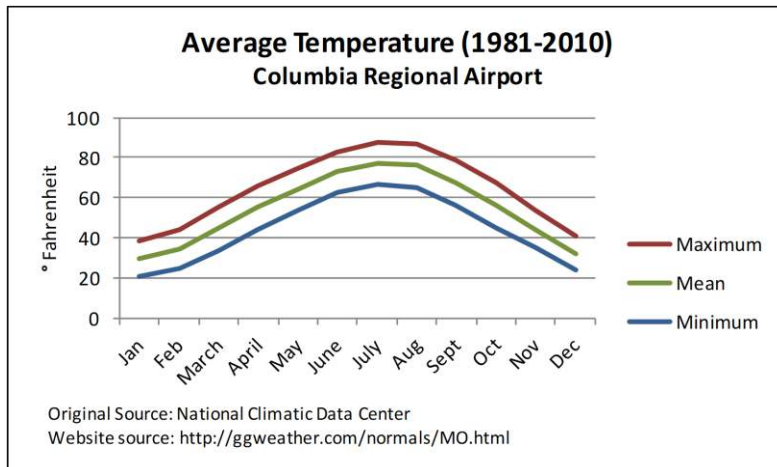
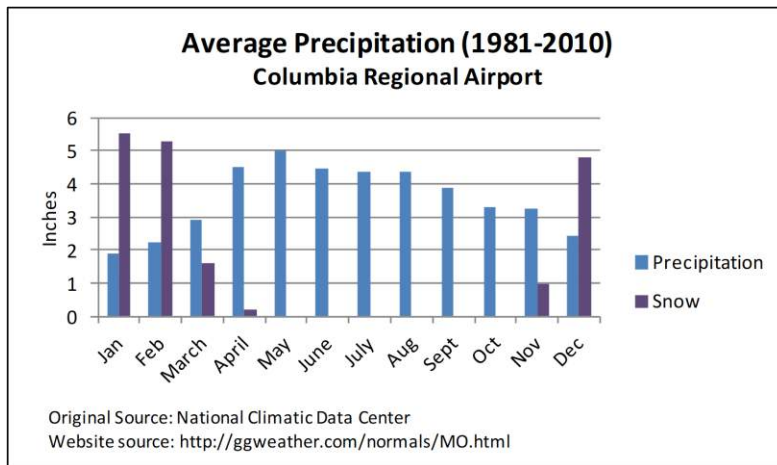


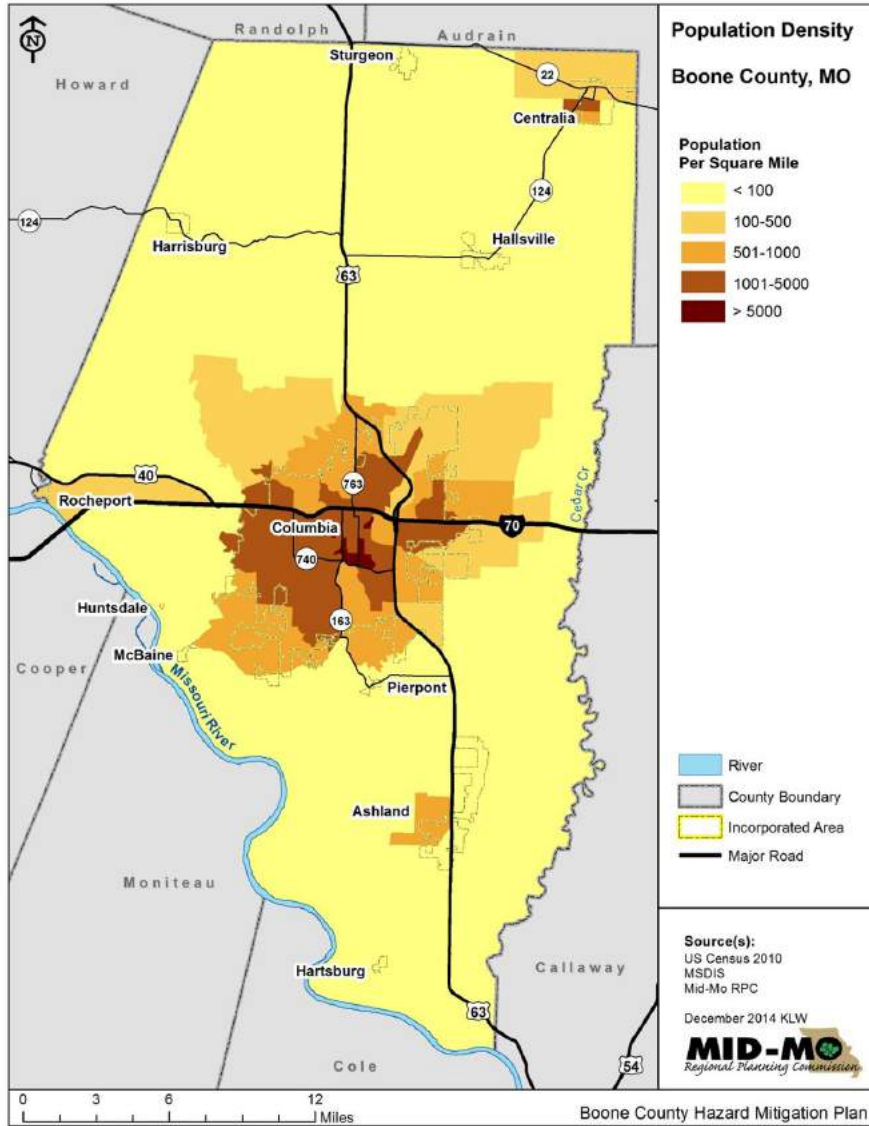
Figure 2.6



2.1.4 POPULATION/DEMOGRAPHICS

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 2.7).

Figure 2.7



The 2010 Census indicated a rapid rise in population since the 2000 census; the population increased by 20%.

An inspection of the data in Table 2.1 indicates that the vast majority of population growth took place 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 from 2000 to 2010. American Community Survey estimates have predicted a much slower growth rate since the 2010 census but the majority of all incorporated and unincorporated Boone County are estimated to have seen some level of increase in population.

Table 2.1 Boone County Population 2000-2018 by Jurisdiction

Jurisdiction	2000 Population	2010 Population	2018 Annual Population Estimate or ACS Population	# Change (2010-2018)	% Change (2010-2018)
Unincorporated Boone	42,841	43,377	45,467	2,090	4.7%
Ashland	1,869	3,707	3,947	240	6.2%
Centralia	3,774	4,027	4,244	217	5.2%
Columbia	84,531	108,500	123,180	14,680	12.6%
Hallsville	978	1,491	1,564	73	4.7%
Harrisburg	184	266	281	15	5.4%
Hartsburg	103	108	108	0	0%
Huntsdale	26	31	33	2	6.2%
Rocheport	208	239	251	12	4.8%
Sturgeon	944	872	930	58	6.4%
Total	135,454	162,699	180,005	17,306	10%

Source: U.S. Bureau of the Census, Decennial Census, annual population estimates/ 5-Year American Community Survey 2018;
 *population includes the portions of these cities in adjacent counties

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. ACS 2017 data estimates that there are currently 39,527 family households in Boone county averaging just over 2 persons per household, which is in line with state and national averages.

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. 6% of the county’s estimated population in 2018 was under the age of 5, similar to the state and national percentage for that age bracket. Over 9% were shown as 65 years and older in 2010. Keeping in trend with an overall state uptick in aging population, 2018 estimates have nearly 11% of Boone’s population over 65 years old, which is

slightly under the state’s 15.5% rate of 65+. That national percentage of over 65 population sits at around 15%.

Table 2.2: Unemployment, Poverty, Education, and Language Percentage Demographics, Boone County, Missouri

Jurisdiction	Total in Labor Force	Percent of Population Unemployed	Percent of Families Below the Poverty Level	Percentage of Population (High School graduate)	Percentage of Population (Bachelor’s degree or higher)	Percentage of population with spoken language other than English
Boone County	97,293	4.4	9.5	93.5	45.9	7.5
Ashland	1,892	4.9	5.2	91.3	28.5	0.2
Centralia	1,871	4.7	11	88.7	21.9	1.9
Columbia	67,130	4.3	10.8	94.2	53.4	9.4
Hallsville	767	4.7	9.7	89.6	24	1.4
Harrisburg	153	3.3	10.2	90.2	21.2	2.3
Hartsburg	49	0	5.6	93.8	32.5	0
Huntsdale	15	0	0	86.4	13.6	4.2
Rocheport	127	3.9	3.2	93.8	31.3	0.9
Sturgeon	397	3.3	5.4	89	22.6	1.1
Missouri	3,062,657	5.8	10.3	89.2	28.2	6
United States	162,184,235	6.6	10.5	87.3	30.9	21.3

Source: U.S. Census, 2017 American Community Survey, 5-year Estimates.

2.1.5 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.

2.1.6 OCCUPATIONS

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. Table --- shows the breakdown of occupation percentages by jurisdiction. The majority of the workforce as a whole works in management, business, science, or art occupations.

Table 2.3: Occupation Statistics, Boone County, Missouri

Place	Management, Business, Science, and Arts Occupations	Service Occupations	Sales and Office Occupations	Natural Resources, Construction, and Maintenance Occupations	Production, Transportation, and Material Moving Occupations
Boone County	44.7	17.8	23.1	6.2	7.9
Ashland	36.2	13.2	36.7	6.2	7.5
Centralia	34.2	12.1	28	11.5	13.9
Columbia	46.1	19.4	22.5	4.9	6.8
Hallsville	34.6	16.6	25.9	9	13.6
Harrisburg	36.4	14.8	30.4	10.1	8.1
Hartsburg	34.6	20.4	26.5	10.2	8.1
Huntsdale	6.6	0	60	33.3	0
Rocheport	35.2	11.4	28.6	12.2	12.2
Sturgeon	34.2	15.4	23.5	11.5	15.1

Source: U.S. Census, 2017 American Community Survey, 5-year Estimates.

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).

2.1.7 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 2017 and 2012 Agricultural Censuses (Figure 2.18) indicates 27,978 acres of farmland (-11.6%) lost during that 5-year period.

Interestingly, the number of farms rose from 1,171 to 1,184. Over 212,000 acres (approximately 48.8%) 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 rose significantly. The 2017 agricultural census showed over \$105 Million dollars in sales. Total sales as well as sales per farm both rose substantially between 2012 and 2017 with nearly double or greater than double in gains.

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

	2017	2012	Change
Approx. land area (acres)	438,739	438,739	
Land in farms (acres)	212,732	240,710	-11.6%
Percentage in farms	48.5%	54.9%	-11.6%
Number of farms	1184	1,171	1%
Avg size of farm (acres)	180	206	-12.6%
Estimated market value-land & buildings	\$1,202,754,000	\$877,218,000	37.1%
Avg value per farm	\$1,015,839	\$749,119	35.6%
Avg value per acre	\$5,654	\$3,644	55.2%
Total sales	\$105,007,000	\$52,185,000	101.2%
Average sales per farm	\$88,688,000	\$44,564,000	99%

Source: USDA Census of Agriculture 2012, 2017

2.1.8 Hazard Mitigation Assistance (HMA) Grants in Planning Area

There has been more than a half million dollars in Hazard Mitigation Assistance (HMA) provided to Boone County projects since 1993. The four projects listed below account for \$559,077.17 in funding.

Table 2.5: HMA Grants

Disaster Declaration	Project Type	Subgrantee	Project Total	Date Approved
995	200.1: Acquisition of Private Real Property (Structures and Land) - Riverine	BOONE	330356	6/29/1994
	402.1: Infrastructure Protective Measures (Roads and Bridges)	County of Boone	57026.17	2/11/2006
995	200.1: Acquisition of Private Real Property (Structures and Land) - Riverine	HARTSBURG	93595	6/10/1994
	402.1: Infrastructure Protective Measures (Roads and Bridges)	County of Boone	78100	9/14/2005

2.1.9 FEMA Public Assistance (PA) Grants in Planning Area

There has been nearly \$2 million in Public Assistance (PA) grants awarded in Boone County. Below is \$1,804,877.97 in projects that have varied in size and location through the county.

Table 2.6: PA Grants

disasterNumber	applicant	damageCategory	projectSize	projectAmount
1412	Hallsville	Roads and Bridges	Small	1847.67
1412	Columbia	Public Utilities	Large	86241.57
1412	Columbia	Public Utilities	Large	-37028.42
1412	Columbia	Public Utilities	Large	77000
1412	Columbia	Public Utilities	Large	-3050
1412	Columbia	Recreational or Other	Small	8978.26
1412	Boone County	Roads and Bridges	Small	16520.04
1412	Boone County	Roads and Bridges	Large	-64351.98
1412	Boone County	Roads and Bridges	Large	321451.05
1412	Boone County	Public Buildings	Large	15000
1412	Boone County	Roads and Bridges	Small	37431
1412	Boone County	Roads and Bridges	Small	2194.94
1412	Boone County	Public Buildings	Large	244629.5
1412	Boone County	Public Buildings	Large	-64907.37
1412	Boone County	Public Buildings	Small	48818.78
1412	Boone County	Public Buildings	Small	-12204.69
1412	Boone County	Roads and Bridges	Small	22981.56
1412	Boone County	Roads and Bridges	Large	57479.92
1412	Boone County	Roads and Bridges	Large	70065.28

Disaster Number	Applicant	incidentType	Request Total
DR-372-MO	Boone County	Severe Storm(s)	73030
DR-867-MO	Boone County	Flood	90020
DR-995-MO	Boone County	Flood	93030
DR-1054-MO	Boone County	Severe Storm(s)	95028
DR-1412-MO	Boone County	Severe Storm(s)	2033
DR-1631-MO	Boone County	Severe Storm(s)	6070
DR-1673-MO	Boone County	Severe Storm(s)	6177
DR-1676-MO	Boone County	Severe Ice Storm	7787
DR-1749-MO	Boone County	Severe Storm(s)	8037
DR-1736-MO	Boone County	Severe Ice Storm	7934
DR-1961-MO	Boone County	Severe Storm(s)	11026
EM-3017-MO	Boone County	Drought	76081
EM-3232-MO	Boone County	Hurricane	5109
EM-3281-MO	Boone County	Severe Ice Storm	7931
EM-3303-MO	Boone County	Severe Ice Storm	9012
EM-3317-MO	Boone County	Severe Storm(s)	11007
EM-3325-MO	Boone County	Flood	11152
EM-3374-MO	Boone County	Flood	16001
DR-4317-MO	Boone County	Flood	17047
DR-4451-MO	Boone County	Severe Storm(s)	19045
EM-3482-MO	Boone County	Biological	20057
DR-4490-MO	Boone County	Biological	20081

2.2 JURISDICTIONAL PROFILES AND MITIGATION CAPABILITIES

The following is the individual profiles for each participating jurisdiction. Information regarding previous mitigation initiatives and ongoing efforts can be found in the summary tables below. These tables indicate specific capabilities of each jurisdiction that relate to their ability to implement mitigation opportunities. Unincorporated Boone County is profiled first, followed by the incorporated communities, the special districts, and the public schools and universities.

2.2.1 Unincorporated Boone County

Boone County consists of all the unincorporated areas with the county boundary.

The Boone 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, as well as supervises the operations of:

- Public Works
- Planning and Zoning
- Building Codes
- Human Resources
- Purchasing
- Information Technology
- Facilities and Grounds Maintenance

The commission also 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
- Treasurer

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 Boone County Emergency Operations Plan was updated in October 2019.

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. The tax also allowed the county to hire more call-takers and to upgrade radio equipment and information technology hardware and software. The Boone County Emergency Communications Center (ECC) opened in 2016 and 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.

Table 2.7: Unincorporated Boone County Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	Columbia Comprehensive Plan: 2013
Builder’s Plan	Proposed Budget Book: 2018
Capital Improvement Plan	N/A
City Emergency Operations Plan	N/A
County Emergency Operations Plan	Yes: Annual Review
Local Recovery Plan	In Progress
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	2015
Debris Management Plan	2018
Economic Development Plan	REDI
Transportation Plan	Regional Transportation Plan: 2015
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	Bonne Femme: 2007
Firewise or other fire mitigation plan	No
School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	EOP in review: 2017
Policies/Ordinance	
Zoning Ordinance	Yes
Building Code	N/A
Floodplain Ordinance	Yes
Subdivision Ordinance	Yes
Tree Trimming Ordinance	N/A
Nuisance Ordinance	N/A
Stormwater Ordinance	N/A
Drainage Ordinance	N/A

Site Plan Review Requirements	N/A
Historic Preservation Ordinance	N/A
Landscape Ordinance	N/A
Seismic Construction Ordinance	N/A
Program	
Zoning/Land Use Restrictions	N/A
Codes Building Site/Design	N/A
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes: Portions of County
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	Yes: 2019
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	Varies
Economic Development Program	N/A
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	N/A
Stream Maintenance Program	Yes: DNR/Wastewater Management
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	Yes
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	Yes
Critical Facilities Inventory	N/A

Vulnerable Population Inventory	N/A
Land Use Map	Yes
Staff/Department	
Building Code Official	Yes
Building Inspector	Yes
Mapping Specialist (GIS)	Yes
Engineer	Yes
Development Planner	Yes
Public Works Official	Yes
Emergency Management Director	Yes
NFIP Floodplain Administrator	Yes
Emergency Response Team	Yes
Hazardous Materials Expert	Yes
Local Emergency Planning Committee	Yes
County Emergency Management Commission	No
Sanitation Department	Yes
Transportation Department	Yes
Economic Development Department	Yes
Housing Department	N/A
Historic Preservation	Yes
Non-Governmental Organizations (NGOs)	
American Red Cross	No
Salvation Army	Yes
Veterans Groups	Yes
Local Environmental Organization	Yes
Homeowners Associations	Yes
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, Etc.)	Yes
Local Funding Availability	
Apply for Community Development Block	Yes

Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	N/A
Ability to incur debt through general obligation bonds	N/A
Ability to incur debt through special tax bonds	N/A
Ability to incur debt through private activities	N/A
Withhold spending in hazard prone areas	N/A

2.2.2 ASHLAND

The City of Ashland is located in the southern portion of Boone County and straddles US Route 63. The Board of Aldermen is the policy making body of the city government and consists of two representatives from each of its three wards. The Board of Aldermen members and the Mayor is elected to two-year terms. Departments and positions managed and employed by the City of Ashland include:

- City Administrator
- City Clerk
- City Treasurer
- Police Department
- Public Works Department

Ashland has experienced robust growth in the past several years. 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. Strong growth is expected for the 2020 census as well largely fueled by the Southern Boone School District.

Leadership strategies are focused on effectively managing growth. The Baptist Home, a private not-for-profit retirement community, has expressed 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. Industrial and commercial growth is proposed on the east side of U.S. Highway 63 off of Route Y. Plans for a YMCA with a designated FEMA rated safe room are currently in the works.

Table 2.8: Ashland Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	Yes: Update In Progress
Builder’s Plan	N/A
Capital Improvement Plan	N/A
City Emergency Operations Plan	Yes
County Emergency Operations Plan	Yes
Local Recovery Plan	N/A
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	2015
Debris Management Plan	N/A
Economic Development Plan	N/A

Transportation Plan	2015: Regional Transportation Plan
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	N/A
Firewise or other fire mitigation plan	No
School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	Yes
Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	Yes
Tree Trimming Ordinance	N/A
Nuisance Ordinance	N/A
Stormwater Ordinance	Yes
Drainage Ordinance	N/A
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	N/A
Landscape Ordinance	N/A
Seismic Construction Ordinance	N/A
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	Yes
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	4

Economic Development Program	N/A
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	Yes
Stream Maintenance Program	N/A
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	Yes
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	N/A
Land Use Map	
Staff/Department	
Building Code Official	N/A
Building Inspector	N/A
Mapping Specialist (GIS)	N/A
Engineer	N/A
Development Planner	N/A
Public Works Official	Yes
Emergency Management Director	N/A
NFIP Floodplain Administrator	Yes
Emergency Response Team	N/A
Hazardous Materials Expert	N/A
Local Emergency Planning Committee	N/A

County Emergency Management Commission	N/A
Sanitation Department	Yes
Transportation Department	N/A
Economic Development Department	N/A
Housing Department	N/A
Historic Preservation	No
Non-Governmental Organizations (NGOs)	
American Red Cross	N/A
Salvation Army	N/A
Veterans Groups	N/A
Local Environmental Organization	N/A
Homeowners Associations	N/A
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, Etc.)	Lions
Local Funding Availability	
Apply for Community Development Block	N/A
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	N/A
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	Yes
Withhold spending in hazard prone areas	Yes

2.2.3 CENTRALIA

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

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.

There are two subdivisions located in the southwest portion of the city which have not been fully built out.

Table 2.9: Centralia Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	Yes
Builder’s Plan	N/A
Capital Improvement Plan	N/A
City Emergency Operations Plan	Yes
County Emergency Operations Plan	Yes
Local Recovery Plan	N/A
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	2015
Debris Management Plan	N/A
Economic Development Plan	CREDI
Transportation Plan	Regional Transportation Plan (Mid-MO)
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	N/A
Firewise or other fire mitigation plan	No

School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	Yes
Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	Yes
Tree Trimming Ordinance	N/A
Nuisance Ordinance	Yes
Stormwater Ordinance	No
Drainage Ordinance	N/A
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	N/A
Landscape Ordinance	N/A
Seismic Construction Ordinance	N/A
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	N/A
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	5
Economic Development Program	CREDI
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	Yes

Stream Maintenance Program	N/A
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	N/A
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	N/A
Land Use Map	N/A
Staff/Department	
Building Code Official	County
Building Inspector	County
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	Yes
Emergency Management Director	County
NFIP Floodplain Administrator	Yes
Emergency Response Team	Yes
Hazardous Materials Expert	No
Local Emergency Planning Committee	Yes
County Emergency Management Commission	N/A
Sanitation Department	Yes
Transportation Department	Yes
Economic Development Department	Yes
Housing Department	No

Historic Preservation	N/A
Non-Governmental Organizations (NGOs)	
American Red Cross	N/A
Salvation Army	N/A
Veterans Groups	N/A
Local Environmental Organization	N/A
Homeowners Associations	N/A
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, Etc.)	Yes
Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	N/A
Withhold spending in hazard prone areas	N/A

2.2.4 COLUMBIA

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

The City of Columbia has continued in its efforts to bury electric lines and offer flood buyouts when possible.

It is anticipated that the City of Columbia will continue to grow. Growth is primarily expected to occur within the Urban Services Area (USA) boundary identified in Columbia Imagined, The City’s adopted comprehensive plan, 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.

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 few years include a new airport terminal, Police headquarters, remodels of fire stations, and many expansions to stormwater and sewer handling. The City is also making efforts toward infrastructure that is not only resilient, but also green.

Table 2.10: City of Columbia Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	Yes: 2013
Builder’s Plan	N/A
Capital Improvement Plan	Yes: 2018
City Emergency Operations Plan	Yes
County Emergency Operations Plan	Yes
Local Recovery Plan	In Progress
County Recovery Plan	In Progress

City Mitigation Plan	N/A
County Mitigation Plan	2015
Debris Management Plan	N/A
Economic Development Plan	N/A
Transportation Plan	CATSO TIP: 2019-2022
Land-Use Plan	Yes
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	Bonne Femme: 2007
Firewise or other fire mitigation plan	No
School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	Yes
Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	Yes
Tree Trimming Ordinance	Yes
Nuisance Ordinance	Yes
Stormwater Ordinance	Yes
Drainage Ordinance	Yes
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	Yes
Landscape Ordinance	N/A
Seismic Construction Ordinance	N/A
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	Yes
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A

National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	2
Economic Development Program	REDI
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	Yes
Stream Maintenance Program	N/A
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	Yes
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	N/A
Land Use Map	Yes
Staff/Department	
Building Code Official	Yes
Building Inspector	Yes
Mapping Specialist (GIS)	Yes
Engineer	Yes
Development Planner	N/A
Public Works Official	Yes
Emergency Management Director	N/A

NFIP Floodplain Administrator	Yes
Emergency Response Team	N/A
Hazardous Materials Expert	N/A
Local Emergency Planning Committee	Yes
County Emergency Management Commission	Yes
Sanitation Department	Yes
Transportation Department	Yes
Economic Development Department	REDI
Housing Department	Yes
Historic Preservation	N/A
Non-Governmental Organizations (NGOs)	
American Red Cross	Yes
Salvation Army	N/A
Veterans Groups	Yes
Local Environmental Organization	N/A
Homeowners Associations	N/A
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, Etc.)	N/A
Local Funding Availability	
Apply for Community Development Block	N/A
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	Yes
Withhold spending in hazard prone areas	Yes

2.2.5 HALLSVILLE

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
- Public Works Superintendent

Hallsville has pursued a policy of continued slow growth with careful planning. This has been 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 and minimum lot sizes and setbacks.

Table 2.11: Hallsville Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	No
Builder's Plan	No
Capital Improvement Plan	No
City Emergency Operations Plan	In Progress
County Emergency Operations Plan	Annual Review
Local Recovery Plan	No
County Recovery Plan	In Progress
City Mitigation Plan	No
County Mitigation Plan	2015
Debris Management Plan	Yes
Economic Development Plan	No
Transportation Plan	Regional Transportation Plan: 2015
Land-Use Plan	No
Flood Mitigation Assistance (FMA) Plan	No
Watershed Plan	No
Firewise or other fire mitigation plan	No
School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	No
Policies/Ordinance	

Zoning Ordinance	Yes
Building Code	Yes: 2015
Floodplain Ordinance	Yes: 2016
Subdivision Ordinance	Yes
Tree Trimming Ordinance	No
Nuisance Ordinance	Yes
Stormwater Ordinance	Yes
Drainage Ordinance	Yes
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	No
Landscape Ordinance	Yes
Seismic Construction Ordinance	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	Yes
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	4
Economic Development Program	N/A
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	Yes
Stream Maintenance Program	N/A
Tree Trimming Program	No
Engineering Studies for Streams (Local/County/Regional)	N/A

Mutual Aid Agreements	Yes
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	Yes
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	In Progress/County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	No
Land Use Map	Yes
Staff/Department	
Building Code Official	Boone County
Building Inspector	Boone County
Mapping Specialist (GIS)	Boone County
Engineer	No
Development Planner	No
Public Works Official	Yes
Emergency Management Director	Yes
NFIP Floodplain Administrator	Yes
Emergency Response Team	Yes/CERT
Hazardous Materials Expert	No
Local Emergency Planning Committee	Yes/CERT
County Emergency Management Commission	Yes
Sanitation Department	Contracted Out
Transportation Department	No
Economic Development Department	No
Housing Department	No
Historic Preservation	No
Non-Governmental Organizations (NGOs)	
American Red Cross	No

Salvation Army	No
Veterans Groups	No
Local Environmental Organization	No
Homeowners Associations	No
Chamber of Commerce	No
Community Organizations (Lions, Kiwanis, Etc.)	Yes
Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	No
Withhold spending in hazard prone areas	No

2.2.6 HARRISBURG

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

- City Clerk

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 and the Harrisburg School (“The Old School House”) and its grounds.

Table 2.12: Harrisburg Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	No
Builder’s Plan	N/A
Capital Improvement Plan	N/A
City Emergency Operations Plan	Yes
County Emergency Operations Plan	Annual Review
Local Recovery Plan	N/A
County Recovery Plan	In progress
City Mitigation Plan	N/A
County Mitigation Plan	N/A
Debris Management Plan	No
Economic Development Plan	No
Transportation Plan	Regional Transportation Plan: 2015
Land-Use Plan	No
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	N/A
Firewise or other fire mitigation plan	No
School Mitigation Plan	No
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	No

Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	No
Tree Trimming Ordinance	No
Nuisance Ordinance	N/A
Stormwater Ordinance	N/A
Drainage Ordinance	N/A
Site Plan Review Requirements	N/A
Historic Preservation Ordinance	Yes
Landscape Ordinance	N/A
Seismic Construction Ordinance	No
Program	
Zoning/Land Use Restrictions	No
Codes Building Site/Design	N/A
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	N/A
Economic Development Program	N/A
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	N/A
Stream Maintenance Program	N/A
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A

Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	N/A
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	No
Land Use Map	N/A
Staff/Department	
Building Code Official	No
Building Inspector	N/A
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	N/A
Emergency Management Director	N/A
NFIP Floodplain Administrator	Yes
Emergency Response Team	N/A
Hazardous Materials Expert	No
Local Emergency Planning Committee	N/A
County Emergency Management Commission	N/A
Sanitation Department	N/A
Transportation Department	N/A
Economic Development Department	N/A
Housing Department	No
Historic Preservation	N/A
Non-Governmental Organizations (NGOs)	
American Red Cross	No
Salvation Army	No

Veterans Groups	No
Local Environmental Organization	No
Homeowners Associations	No
Chamber of Commerce	No
Community Organizations (Lions, Kiwanis, Etc.)	No
Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	N/A
Impact fees for new development	N/A
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	N/A
Withhold spending in hazard prone areas	N/A

2.2.7 HARTSBURG

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

Table 2.13: Hartsburg Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	No
Builder's Plan	N/A
Capital Improvement Plan	N/A
City Emergency Operations Plan	Yes
County Emergency Operations Plan	Annual Review
Local Recovery Plan	N/A
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	Yes: 2015
Debris Management Plan	No
Economic Development Plan	N/A
Transportation Plan	Regional Transportation Plan? 2015
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	N/A
Firewise or other fire mitigation plan	No
School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	Yes
Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	N/A
Tree Trimming Ordinance	N/A
Nuisance Ordinance	N/A

Stormwater Ordinance	N/A
Drainage Ordinance	N/A
Site Plan Review Requirements	N/A
Historic Preservation Ordinance	N/A
Landscape Ordinance	N/A
Seismic Construction Ordinance	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	N/A
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	5
Economic Development Program	N/A
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	N/A
Stream Maintenance Program	N/A
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	N/A
FEMA Flood Insurance Study (Detailed)	N/A

Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	No
Land Use Map	N/A
Staff/Department	
Building Code Official	No
Building Inspector	No
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	No
Emergency Management Director	No
NFIP Floodplain Administrator	Yes
Emergency Response Team	N/A
Hazardous Materials Expert	No
Local Emergency Planning Committee	N/A
County Emergency Management Commission	N/A
Sanitation Department	N/A
Transportation Department	No
Economic Development Department	N/A
Housing Department	No
Historic Preservation	N/A
Non-Governmental Organizations (NGOs)	
American Red Cross	No
Salvation Army	No
Veterans Groups	No
Local Environmental Organization	No
Homeowners Associations	No
Chamber of Commerce	No
Community Organizations (Lions, Kiwanis, Etc.)	No

Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	N/A
Impact fees for new development	N/A
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	N/A
Withhold spending in hazard prone areas	N/A

2.2.8 HUNTSDALE

The Mayor and the Board of Aldermen are the policy making bodies of the government. Some aldermen members have attended training to be CERT certified through the county. The Village of Huntsdale doesn't own any buildings or vehicles.

An engineering firm was hired to redesign the streets and stormwater ditches throughout the village. The project began in 2007 and construction was completed in 2012.

Since the last update a music venue and café have come to the Village of Huntsdale. A large portion of the Huntsdale city limits fall within the floodplain but the Katy Trail draws hikers and cyclists through and a boat ramp allows for visitors and residents access to the Missouri River.

Table 2.14: Huntsdale Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	No: county
Builder's Plan	No
Capital Improvement Plan	No
City Emergency Operations Plan	N/A
County Emergency Operations Plan	Annual Review
Local Recovery Plan	N/A
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	Yes: 2015
Debris Management Plan	N/A
Economic Development Plan	N/A
Transportation Plan	Regional Transportation Plan: 2015
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	N/A
Firewise or other fire mitigation plan	No
School Mitigation Plan	No
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	Yes

Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	N/A
Tree Trimming Ordinance	N/A
Nuisance Ordinance	N/A
Stormwater Ordinance	N/A
Drainage Ordinance	N/A
Site Plan Review Requirements	N/A
Historic Preservation Ordinance	N/A
Landscape Ordinance	N/A
Seismic Construction Ordinance	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	No
Hazard Awareness Program	No
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	No
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	No
ISO Fire Rating	10
Economic Development Program	No
Land Use Program	No
Public Education/Awareness	No
Property Acquisition	No
Planning/Zoning Boards	Yes
Stream Maintenance Program	No
Tree Trimming Program	No
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	N/A

Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	N/A
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	N/A
Land Use Map	N/A
Staff/Department	
Building Code Official	Yes
Building Inspector	No
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	No
Emergency Management Director	Yes: County
NFIP Floodplain Administrator	Yes: Part-time Volunteer
Emergency Response Team	Yes: BCFPD
Hazardous Materials Expert	Yes: BCFPD
Local Emergency Planning Committee	Yes: County
County Emergency Management Commission	N/A
Sanitation Department	No
Transportation Department	No
Economic Development Department	No
Housing Department	No
Historic Preservation	No
Non-Governmental Organizations (NGOs)	
American Red Cross	No
Salvation Army	No

Veterans Groups	No
Local Environmental Organization	No
Homeowners Associations	No
Chamber of Commerce	No
Community Organizations (Lions, Kiwanis, Etc.)	No
Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	No
Impact fees for new development	N/A
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	N/A
Withhold spending in hazard prone areas	N/A

2.2.9 ROCHEPORT

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

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. Past mitigation actions include exploring effective strategies to mitigate flooding at the wastewater treatment plant in Rocheport. In the spring of 2019 flooding reached more than 33 ft in June 2019. Sandbagging efforts were enacted to protect the town and the wastewater treatment plant. While businesses were not directly under water there was a marked decrease in economic activity due to Katy Trail closures.

Table 2.15: Rocheport Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	No
Builder’s Plan	N/A
Capital Improvement Plan	N/A
City Emergency Operations Plan	Yes: Backup city hall
County Emergency Operations Plan	Annual Review
Local Recovery Plan	N/A
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	2015
Debris Management Plan	County: 2018
Economic Development Plan	N/A
Transportation Plan	Regional Transportation Plan: 2015
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	N/A
Watershed Plan	N/A
Firewise or other fire mitigation plan	No
School Mitigation Plan	N/A
Critical Facilities Plan (Mitigation/Response/Recover)	N/A
Policies/Ordinance	
Zoning Ordinance	Yes

Building Code	Yes
Floodplain Ordinance	Yes
Subdivision Ordinance	Yes
Tree Trimming Ordinance	N/A
Nuisance Ordinance	N/A
Stormwater Ordinance	No
Drainage Ordinance	N/A
Site Plan Review Requirements	N/A
Historic Preservation Ordinance	N/A
Landscape Ordinance	N/A
Seismic Construction Ordinance	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	N/A
Hazard Awareness Program	N/A
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	N/A
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	N/A
ISO Fire Rating	5
Economic Development Program	N/A
Land Use Program	N/A
Public Education/Awareness	N/A
Property Acquisition	N/A
Planning/Zoning Boards	N/A
Stream Maintenance Program	N/A
Tree Trimming Program	N/A
Engineering Studies for Streams (Local/County/Regional)	No
Mutual Aid Agreements	N/A

Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	N/A
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	N/A
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	No
Vulnerable Population Inventory	No
Land Use Map	N/A
Staff/Department	
Building Code Official	No
Building Inspector	No
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	N/A
Emergency Management Director	N/A
NFIP Floodplain Administrator	Yes
Emergency Response Team	N/A
Hazardous Materials Expert	N/A
Local Emergency Planning Committee	N/A
County Emergency Management Commission	N/A
Sanitation Department	No
Transportation Department	No
Economic Development Department	No
Housing Department	No
Historic Preservation	No
Non-Governmental Organizations (NGOs)	
American Red Cross	No
Salvation Army	No

Veterans Groups	No
Local Environmental Organization	No
Homeowners Associations	No
Chamber of Commerce	No
Community Organizations (Lions, Kiwanis, Etc.)	No
Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	County
Impact fees for new development	N/A
Ability to incur debt through general obligation bonds	N/A
Ability to incur debt through special tax bonds	N/A
Ability to incur debt through private activities	N/A
Withhold spending in hazard prone areas	N/A

2.2.10 STURGEON

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.

Since the last update the city project to change the wastewater system to a no discharge/land application system and the addition of a holding basin for treated wastewater from the lagoons has been completed. Residential development since 2015 includes the Sterling Meadows Subdivision and the Penkins Subdivision. Commercial additions include a Dollar General and the Sturgeon Meat Market.

Table 2.16: Sturgeon Mitigation Capabilities

Capabilities	Status Including Date of Document or Policy
Planning Capabilities	
Comprehensive Plan	Pending
Builder’s Plan	N/A
Capital Improvement Plan	N/A
City Emergency Operations Plan	N/A
County Emergency Operations Plan	Annual Review
Local Recovery Plan	N/A
County Recovery Plan	In Progress
City Mitigation Plan	N/A
County Mitigation Plan	2015
Debris Management Plan	N/A
Economic Development Plan	N/A
Transportation Plan	Regional Transportation Plan: 2015
Land-Use Plan	N/A
Flood Mitigation Assistance (FMA) Plan	Yes
Watershed Plan	Yes
Firewise or other fire mitigation plan	No
School Mitigation Plan	No
Critical Facilities Plan (Mitigation/Response/Recover)	No
Policies/Ordinance	
Zoning Ordinance	Yes
Building Code	County

Floodplain Ordinance	Yes
Subdivision Ordinance	Yes
Tree Trimming Ordinance	Yes
Nuisance Ordinance	Yes
Stormwater Ordinance	Yes
Drainage Ordinance	Yes
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	Yes
Landscape Ordinance	Yes
Seismic Construction Ordinance	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	County
Hazard Awareness Program	Yes
National Flood Insurance Program (NFIP)	Yes
NFIP Community Rating System (CRS) Program	N/A
National Weather Service (NWS) Storm Ready	Yes
Firewise Community Certification	No
Building Code Effectiveness Grading (BCEGs)	Yes
ISO Fire Rating	4
Economic Development Program	Yes
Land Use Program	No
Public Education/Awareness	Yes
Property Acquisition	No
Planning/Zoning Boards	Yes
Stream Maintenance Program	N/A
Tree Trimming Program	Yes
Engineering Studies for Streams (Local/County/Regional)	N/A
Mutual Aid Agreements	Yes
Studies/Reports/Maps	

Hazard Analysis/Risk Assessment (Local)	No
Hazard Analysis/Risk Assessment (County)	N/A
Flood Insurance Maps	N/A
FEMA Flood Insurance Study (Detailed)	N/A
Evacuation Route Map	County
Critical Facilities Inventory	N/A
Vulnerable Population Inventory	No
Land Use Map	No
Staff/Department	
Building Code Official	County
Building Inspector	County
Mapping Specialist (GIS)	No
Engineer	No
Development Planner	Yes
Public Works Official	Yes
Emergency Management Director	Yes
NFIP Floodplain Administrator	Yes
Emergency Response Team	No
Hazardous Materials Expert	No
Local Emergency Planning Committee	No
County Emergency Management Commission	No
Sanitation Department	No
Transportation Department	No
Economic Development Department	No
Housing Department	No
Historic Preservation	Yes
Non-Governmental Organizations (NGOs)	
American Red Cross	No
Salvation Army	No
Veterans Groups	No

Local Environmental Organization	No
Homeowners Associations	No
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, Etc.)	No
Local Funding Availability	
Apply for Community Development Block	Yes
Fund projects through Capital	No
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	No
Withhold spending in hazard prone areas	No

Table 2.17: Summary of Jurisdictional Capabilities

Capabilities	Uninc. Boone County	Ashland	Centralia	Columbia	Hallsville	Harrisburg	Hartsburg	Huntsdale	Rocheport	Sturgeon
Planning Capabilities										
Comprehensive Plan	Columbia Comprehensive Plan: 2013	Yes: Update In Progress	Yes	Yes: 2013	No	No	No	No: county	No	Pending
Builder's Plan	Proposed Budget Book: 2018	N/A	N/A	N/A	No	N/A	N/A	No	N/A	N/A
Capital Improvement Plan	N/A	N/A	N/A	Yes: 2018	No	N/A	N/A	No	N/A	N/A
City Emergency Operations Plan	N/A	Yes	Yes	Yes	In Progress	Yes	Yes	N/A	Yes: Backup city hall	N/A
County Emergency Operations Plan	Yes: Annual Review	Yes	Yes	Yes	Annual Review	Annual Review	Annual Review	Annual Review	Annual Review	Annual Review
Local Recovery Plan	In Progress	N/A	N/A	In Progress	No	N/A	N/A	N/A	N/A	N/A
County Recovery Plan	In Progress	In Progress	In Progress	In Progress	In Progress	In progress	In Progress	In Progress	In Progress	In Progress
City Mitigation Plan	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	N/A
County Mitigation Plan	2015	2015	2015	2015	2015	N/A	Yes: 2015	Yes: 2015	2015	2015
Debris Management Plan	2018	N/A	N/A	N/A	Yes	No	No	N/A	County: 2018	N/A
Economic Development	REDI	N/A	CREDI	N/A	No	No	N/A	N/A	N/A	N/A

Plan										
Transportation Plan	Regional Transportation Plan: 2015	2015: Regional Transportation Plan	Regional Transportation Plan (Mid-MO)	CATSO TIP: 2019-2022	Regional Transportation Plan: 2015	Regional Transportation Plan: 2015	Regional Transportation Plan? 2015	Regional Transportation Plan: 2015	Regional Transportation Plan: 2015	Regional Transportation Plan: 2015
Land-Use Plan	N/A	N/A	N/A	Yes	In-Progress	No	N/A	N/A	N/A	N/A
Flood Mitigation Assistance (FMA) Plan	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	Yes
Watershed Plan	Bonne Femme: 2007	N/A	N/A	Bonne Femme: 2007	No	N/A	N/A	N/A	N/A	Yes
Firewise or other fire mitigation plan	No	No	No	No	No	No	No	No	No	No
School Mitigation Plan	N/A	N/A	N/A	N/A	N/A	No	N/A	No	N/A	No
Critical Facilities Plan (Mitigation/Response/Recover)	EOP in review: 2017	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	No
Policies/Ordinance										
Zoning Ordinance	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Building Code	N/A	Yes	Yes	Yes	Yes: 2015	Yes	Yes	N/A	Yes	County
Floodplain Ordinance	Yes	Yes	Yes	Yes	Yes: 2016	Yes	Yes	Yes	Yes	Yes
Subdivision Ordinance	Yes	Yes	Yes	Yes	Yes	No	N/A	N/A	Yes	Yes

Tree Trimming Ordinance	N/A	N/A	N/A	Yes	No	No	N/A	N/A	N/A	Yes
Nuisance Ordinance	N/A	N/A	Yes	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Stormwater Ordinance	N/A	Yes	No	Yes	Yes	N/A	N/A	N/A	No	Yes
Drainage Ordinance	N/A	N/A	N/A	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Site Plan Review Requirements	N/A	Yes	Yes	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Historic Preservation Ordinance	N/A	N/A	N/A	Yes	No	Yes	N/A	N/A	N/A	Yes
Landscape Ordinance	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
Seismic Construction Ordinance	N/Z	N/A	N/A	N/A	No	No	No	No	No	No
Program										
Zoning/Land Use Restrictions	N/A	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Codes Building Site/Design	N/A	Yes	N/A	Yes	Yes	N/A	N/A	No	N/A	County
Hazard Awareness Program	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	Yes
National Flood Insurance Program (NFIP)	Yes: Portions of County	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
NFIP Community Rating System	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(CRS) Program										
National Weather Service (NWS) Storm Ready	Yes: 2019	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	Yes
Firewise Community Certification	No	No	No	No	No	No	No	No	No	No
Building Code Effectiveness Grading (BCEGs)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	Yes
ISO Fire Rating	Varies	4	5	2	4	N/A	5	10	5	4
Economic Development Program	N/A	N/A	CREDI	REDI	N/A	N/A	N/A	No	N/A	Yes
Land Use Program	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	No
Public Education/Awareness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	Yes
Property Acquisition	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	No
Planning/Zoning Boards	N/A	Yes	Yes	Yes	Yes	N/A	N/A	Yes	N/A	Yes
Stream Maintenance Program	Yes: DNR/Wastewater Management	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	N/A
Tree Trimming Program	N/A	N/A	N/A	N/A	No	N/A	N/A	No	N/A	Yes
Engineering Studies for Streams	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A

(Local/County/ Regional)										
Mutual Aid Agreements	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
Studies/Reports/Maps										
Hazard Analysis/Risk Assessment (Local)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No
Hazard Analysis/Risk Assessment (County)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flood Insurance Maps	Yes	Yes	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A
FEMA Flood Insurance Study (Detailed)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Evacuation Route Map	Yes	County	County	County	In Progress/ County	County	County	County	County	County
Critical Facilities Inventory	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A
Vulnerable Population Inventory	N/A	N/A	N/A	N/A	No	No	No	N/A	No	No
Land Use Map	Yes		N/A	Yes	Yes	N/A	N/A	N/A	N/A	No
Staff/Department										
Building Code Official	Yes	N/A	County	Yes	Boone County	No	No	Yes	No	County
Building Inspector	Yes	N/A	County	Yes	Boone County	N/A	No	No	No	County

Mapping Specialist (GIS)	Yes	N/A	No	Yes	Boone County	No	No	No	No	No
Engineer	Yes	N/A	No	Yes	No	No	No	No	No	No
Development Planner	Yes	N/A	No	N/A	No	No	No	No	No	Yes
Public Works Official	Yes	Yes	Yes	Yes	Yes	N/A	No	No	N/A	Yes
Emergency Management Director	Yes	N/A	County	N/A	Yes	N/A	No	Yes: County	N/A	Yes
NFIP Floodplain Administrator	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes: Part-time Volunteer	Yes	Yes
Emergency Response Team	Yes	N/A	Yes	N/A	Yes/CERT	N/A	N/A	Yes: BCFPD	N/A	No
Hazardous Materials Expert	Yes	N/A	No	N/A	No	No	No	Yes: BCFPD	N/A	No
Local Emergency Planning Committee	Yes	N/A	Yes	Yes	Yes/CERT	N/A	N/A	Yes: County	N/A	No
County Emergency Management Commission	No	N/A	N/A	Yes	Yes	N/A	N/A	N/A	N/A	No
Sanitation Department	Yes	Yes	Yes	Yes	Contract	N/A	N/A	No	No	No
Transportation Department	Yes	N/A	Yes	Yes	No	N/A	No	No	No	No
Economic Development Department	Yes	N/A	Yes	REDI	No	N/A	N/A	No	No	No
Housing	N/A	N/A	No	Yes	No	No	No	No	No	No

Department										
Historic Preservation	Yes	No	N/A	N/A	No	N/A	N/A	No	No	Yes
Non-Governmental Organizations (NGOs)										
American Red Cross	No	N/A	N/A	Yes	No	No	No	No	No	No
Salvation Army	Yes	N/A	N/A	N/A	No	No	No	No	No	No
Veterans Groups	Yes	N/A	N/A	Yes	No	No	No	No	No	No
Local Environmental Organization	Yes	N/A	N/A	N/A	No	No	No	No	No	No
Homeowners Associations	Yes	N/A	N/A	N/A	No	No	No	No	No	No
Chamber of Commerce	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes
Community Organizations (Lions, Kiwanis, Etc.)	Yes	Lions	Yes	N/A	Yes	No	No	No	No	No
Local Funding Availability										
Apply for Community Development Block	Yes	N/A	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes
Fund projects through Capital	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Authority to levy taxes for a specific purpose	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fees for water, sewer, gas, or	Yes	Yes	Yes	Yes	Yes	N/A	N/A	No	County	Yes

electric services										
Impact fees for new development	N/A	N/A	Yes	Yes	Yes	N/A	N/A	N/A	N/A	Yes
Ability to incur debt through general obligation bonds	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Ability to incur debt through special tax bonds	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Ability to incur debt through private activities	N/A	Yes	N/A	Yes	No	N/A	N/A	N/A	N/A	No
Withhold spending in hazard prone areas	N/A	Yes	N/A	Yes	No	N/A	N/A	N/A	N/A	No

2.3 SPECIAL DISTRICT

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.

2.3.1 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.

2.3.2 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 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.

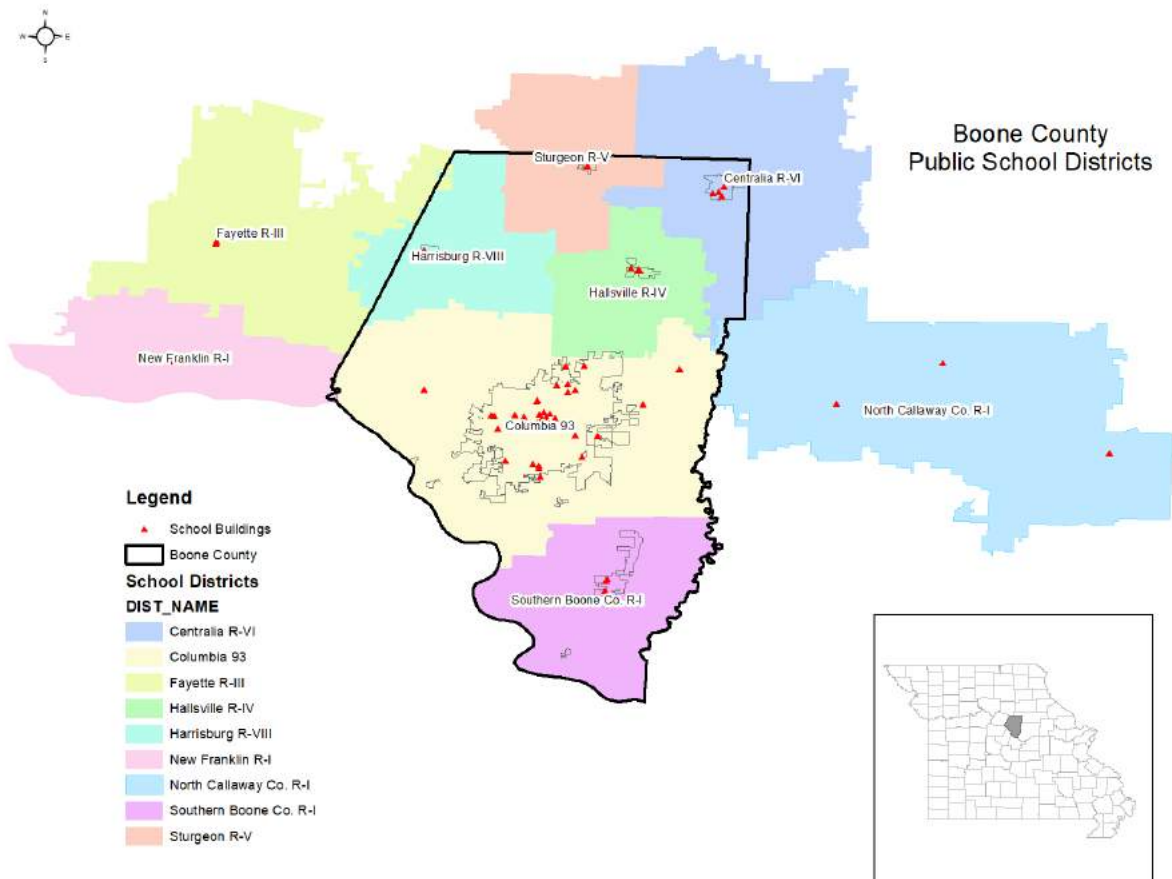
2.4 PUBLIC SCHOOL DISTRICT PROFILES AND MITIGATION CAPABILITIES

There are 9 public School districts that intersect the Boone County boundary. They are:

- Centralia R-VI
- Sturgeon R-V
- Fayette R-III
- Harrisburg R-VIII
- North Callaway R-I
- New Franklin R-I
- Southern Boone R-I
- Columbia Public Schools
- Hallsville R-IV

Figure 2.8 displays the school districts and how they are situated within and around the Boone County boundary.

Figure 2.8: Boone County School Districts



Of the 9 public school districts whose boundaries intersect Boone County only 6 of the districts have buildings and are primarily within Boone County jurisdiction. Centralia, Columbia Public Schools,

Hallsville, Harrisburg, Southern Boone, and Sturgeon own structures within Boone County. Of the 6 main districts only Harrisburg R-VIII did not participate in the planning process.

2.4.1 CENTRALIA R-VI SCHOOL DISTRICT

The District partnered with the City of Centralia in February 2013 to add a School Resource Officer who has been instrumental in all areas of school safety and disaster preparedness. There is great interest in adding a tornado safe room for the district.

Table 2.18			
Centralia R-VI School District			
School Name	Grades	Certified Staff	Enrollment 2019-20
Chance Elementary	PK-2	57	601
Centralia Intermediate	3-5		
Chester Boren Middle	6-8	35	320
Centralia High	9-12	42	451
	Total	134	1,372
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2019			
Property Valuation			
	Count	Replacement Value (including contents)	
Buildings	17	\$43,395,372	
Vehicles	27	na	
Source: School District Insurance Statement			

2.4.2 COLUMBIA PUBLIC SCHOOLS

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. As remodels happen throughout the districts many buildings hardening efforts are added to facilities. The district continues to train all personnel on the various natural and man-made hazards that could face their students and faculty. Preparedness plans are reviewed and altered as needed.

Construction on the John Warner Middle School has begun. It will be taking pressure off the currently over capacity Gentry Middle School.

Table 2.19			
Columbia Public Schools - Overview			
	Schools	Certified Staff	Enrollment 2019-20
Elementary Schools	23	804	9,009
Middle Schools	6	383	4,135
High Schools	5	586	5,411
Total	34	1,773	18,555
Sources: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2019; 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			

Figure 2.2 is a list of school buildings that are part of the Columbia Public Schools district.

Table 2.2			
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	Early Childhood Education Center - Waco	PK
Midway Heights Elementary	PK-05	West Boulevard Elementary	PK-05
Mill Creek Elementary	PK-05	Discovery Early Childhood Center	PK
New Haven Elementary	PK-05	Center for Early Learning – North	PK
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	John Warner Middle	6-8
Frederick Douglass High	9-12	Rock Bridge Sr. High	9-12
Columbia Area Career Center	10-12	Muriel W. Battle High	9-12
Aslin Administration Building		Facilities and Construction Services Building	
Center for Responsive Education		Center for Gifted Education/Title 1	
Source: School District			

2.4.3 HALLSVILLE R-IV SCHOOL DISTRICT

Table 2.21			
Hallsville R-IV School District			
School Name	Grades	Certified Staff	Enrollment 2019-20
Hallsville Primary	PK-1	68	700
Hallsville Intermediate	2-5		
Hallsville Middle	6-8	32	337
Hallsville High	9-12	41	389
	Total	141	1,426
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2019			
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 2019; the bus inspections achieved a 100% approval rate with all buses passing inspection and none out of service. The award is presented by the Missouri Highway Patrol. The Hallsville School District has had a track record of achievement in bus safety.

A science wing and a health and fitness classroom/weight room have been completed on the high school. In 2017 an operating levy increase passed to keep class sizes small, expand technology, and attract and retain quality educators. In 2018, a \$7 million bond issuance passed to construct a second-grade wing, gymnasium, and storm shelter at the primary school. These additions are currently underway and estimated to open in the 2020-2021 school year.

2.4.4 HARRISBURG R-VIII SCHOOL DISTRICT

The Harrisburg School District did not participate in the 2020 Boone County Hazard Mitigation update. According to the last update 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.

Table 2.22			
Harrisburg R-VIII School District			
School Name	Grades	Certified Staff	Enrollment 2019-20
Harrisburg Elementary	K-5	28	307
Harrisburg Middle	6-8	20	152
Harrisburg High	9-12	21	155
	Total	69	614
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2019			
Property Valuation			
	Count	Replacement Value (including contents)	Insured Value
Buildings	15	\$22,129,873	
Vehicles	15		\$47,487
Sources: School District Insurance Statement			

2.4.5 SOUTHERN BOONE COUNTY R-I SCHOOL DISTRICT

Southern Boone has had rapid growth in the last several years. In 2018 a bond initiative funded construction on a new elementary gymnasium, central office building, and high school baseball and softball fields. In 2019 voters approved a tax increase to build an addition onto the primary school. The addition will include 17 new classrooms and 6 additional teachers offices.

Future plans include a no-tax increase bond for 2021 that would focus on current overcrowding in the elementary and middle schools.

Table 2.23			
Southern Boone Co. R-I School District			
School Name	Grades	Certified Staff	Enrollment 2019-20
Southern Boone Primary	PK-2	87	866
Southern Boone Elementary	3-5		
Southern Boone Middle	6-8	39	394
Southern Boone High	9-12	49	482
	Total	175	1,742
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2019			
Property Valuation			
	Count	Replacement Value (including contents)	Insured Value
Buildings	5	\$51,000,000	
Vehicles	32		
Sources: School District Insurance Statement			

2.4.6 STURGEON R-V SCHOOL DISTRICT

Construction on two new classrooms, an outdoor track, and canopy at the high school have finished since the previous update. Safety upgrades to security cameras and the addition of shatterproof film at the Elementary, Middle, and High School are currently in the works.

A no-tax increase bond measure is set for June 2020. If passed, it would go toward upgrading door security features, installing ballistic film to exterior windows throughout the district, communications upgrades, as well as various other maintenance and remodel projects.

Table 2.24			
Sturgeon R-V School District			
School Name	Grades	Certified Staff	Enrollment 2019-20
Sturgeon Elementary	K-4	23	175
Sturgeon Middle	5-8	16	126
Sturgeon High	9-12	20	132
	Total	59	433
Source: Missouri Department of Elementary and Secondary Education - Data as of 11/17/2019			
Property Valuation			
	Count	Replacement Value (including contents)	
Buildings	3	\$15,895,192	
Vehicles	8		
Sources: School District Insurance Statement			

Table 2.25 Summary of Mitigation Capabilities for Boone County School Districts

Capability	Centralia R-VI	Columbia Public Schools	Hallsville R-IV	Harrisburg R-VIII	Southern Boone	Sturgeon R-V
Planning Elements						
Master Plan/Date	N/A	N/A	N/A	N/A	N/A	N/A
Capital Improvement Plan/Date	Yes: 2013	Yes:2018	Yes:2019	Yes: N/A	Yes:N/A	Yes: N/A
School Emergency Plan/Date	Yes: N/A	Yes:2014	Yes: N/A	Yes	Yes:N/A	Yes: N/A
Weapons Policy/Date	Yes: N/A	Yes	N/A	Yes	Yes	Yes
Personnel Resources						
Full-Time Building Official (Principal)	Yes	Yes	Yes	Yes	Yes	Yes
Emergency Manager	N/A	N/A	N/A	N/A	N/A	N/A
Grant Writer	N/A	N/A	N/A	N/A	N/A	N/A
Public Information Officer	N/A	Yes	Yes	N/A	N/A	N/A
Financial Resources						
Capital Improvements Project Funding	Yes	Yes	Yes	Yes	Yes	Yes
Local Funds	Yes	Yes	Yes	Yes	Yes	Yes
General Obligation Bonds	Yes	Yes	Yes	Yes	Yes	Yes
Special Tax Bonds	N/A	N/A	N/A	N/A	N/A	N/A
Private Activities/Donations	N/A	N/A	N/A	N/A	N/A	N/A
State and Federal Funds/Grants	Yes	Yes	Yes	Yes	Yes	Yes
Other						
Public Education Programs	N/A	N/A	N/A	N/A	N/A	N/A
Privately or Self- Insured?	N/A	N/A	N/A	N/A	N/A	N/A
Fire Evacuation Training	Yes	Yes	Yes	Yes	Yes	Yes
Tornado Sheltering Exercises	Yes	Yes	Yes	Yes	Yes	Yes
Public Address/Emergency Alert System	Yes	Yes	Yes	Yes	Yes	Yes
NOAA Weather Radios	N/A	Yes	N/A	Yes	Yes	N/A
Lock-Down Security Training	Yes	Yes	Yes	Yes	Yes	Yes
Mitigation Programs	N/A	N/A	N/A	N/A	N/A	N/A
Tornado Shelter/Saferoom	Yes	Yes	Yes	Yes	Yes	Yes
Campus Police	SRO	Yes	SRO	N/A	N/A	N/A

2.5 HIGHER EDUCATION

2.5.1 Stephens College

A large renovation project was conducted in 2015 on Sampson Hall. An existing portion of the building was demolished and rebuilt to include new classrooms, faculty offices, labs, and multiuse areas for the physician studies program.

Table 2.27		
Stephens College		
	Count	Property Valuation
Student Population	775 on-campus	Not available
	385 commuting	
Faculty and Staff	318	
Total Buildings	14	
Residential dorms	5	
Office & Operations facilities	4	
Learning Center	4 and the library	
Plant Facilities	1	
Source: Stephens College		

2.5.2 UNIVERSITY OF MISSOURI

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.

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: <https://masterplan.missouri.edu/mu-master-plan/>

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.

Table 2.28		
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		

Chapter 3: Natural Hazards Risk Assessment

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Chapter 3: Natural Hazard Risk Assessment

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

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.

- **Section 3.1 Hazard Identification** identifies the natural and man-made hazards that threaten the area and provides basis for the elimination of hazards from further consideration.
- **Section 3.2 Assets at Risk** provides the planning area's total exposure to natural and man-made hazards, considering critical facilities and other community assets at risk.
- **Section 3.3 Land Use and Development** discusses development that has occurred since the last plan update and any increased or decreased risk that resulted. There will also be discussion of areas of planned future development and implications of such development.
- **Section 3.4 Hazard Profiles and Vulnerability Analysis** provides more detailed information about the hazards impacting the planning area. Each hazard will have a Hazard Profile that provides a general description and threat discussion, a Vulnerability Assessment to further define and quantify populations, structures and other community assets at risk, and a Problem Statement that summarizes the problem and possible solutions.

3.1 Hazard Identification

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

As part of the planning process each jurisdiction was asked to evaluate the probability and potential severity of each hazard addressed in this plan. Those responses were used to evaluate mitigation options.

3.1.1 Review of Existing Mitigation Plans

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.

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 (2018) 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.

3.3.2 Review Disaster Declaration History

Severe storms and flooding are the most common events to warrant a disaster declaration in Boone County. In the event of flooding the declaration is brought on by mounting costs due to widespread water damage and the closure or destruction of several homes and businesses that impact the local economy of the affected area.

Table 3.1: FEMA Disaster Declaration that included Boone County, Missouri 1965-Present

Disaster Number	Description	Declaration Date Incident Period	Individual Assistance (IA) Public Assistance (PA)
3482	Covid-19 Pandemic	1/20/20-Ongoing	Ongoing
4451	Severe Storms and Flooding	4/29/19-7/5/19	IA/PA
4317	Severe Storms and Flooding	4/28/17-5/11/17	PA

3374	Severe Storms and Flooding	12/22/15-1/9/16	PA
3325	Missouri Flooding	6/1/11-8/1/11	PA
1961	Severe Winter Storm	1/31/11-2/5/11	PA
3303	Severe Winter Storm	1/26/09-1/28-09	PA
1809	Severe Storms and Flooding	9/11/08-9/24/08	IA
1749	Severe Storms and Flooding	3/17/08-5/9/08	PA
1736	Severe Winter Storm	12/6/07-12/15/07	PA
3281	Severe Winter Storm	12/8/07-12/15/07	PA
1676	Severe Winter Storm	1/12/07-1/22/07	PA
3232	Hurricane Katrina Evacuation	8/29/05-10/1/05	PA
1463	Severe Storms and Flooding	5/4/03-5/30/03	IA
1403	Ice Storm	1/29/02-2/13/02	IA
1054	Severe Storms and Flooding	5/13/95-6/23/95	IA/PA
995	Flooding	6/10/93-10/25/93	IA/PA
867	Severe Storms and Flooding	5/15/90-5/31/90	IA/PA
779	Severe Storms and Flooding	9/18/86-10/15/86	IA
3017	Drought	9/24/76	PA
372	Severe Storms and Flooding	44/19/73	IA/PA

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

3.1.3 Research Additional Sources

Sources utilized for information regarding past disaster incidents and research in the planning area include:

- Missouri Hazard Mitigation Plans (2013 and 2018)
- Previously approved Boone County Hazard Mitigation Plan (2015)
- Federal Emergency Management Agency (FEMA)
- Missouri Department of Natural Resources
- National Drought Mitigation Center Drought Reporter
- US Department of Agriculture’s Ag Census
- Data Collection Questionnaires completed by each jurisdiction
- State of Missouri GIS data
- Hazards US (Hazus)
- Missouri Department of Transportation
- County Emergency Management
- County Flood Insurance Rate Map, FEMA
- U.S. Army Corps of Engineers
- United States Geological Survey (USGS)
- National Oceanic and Atmospheric Administration’s (NOAA) Nation Centers for Environmental Information (NCEI)

- Note: NOAA and NCEI are the only centralized source of data for many of the weather-related hazards. Although it is usually the best and most current source, there are limitations to the data which should be noted.

3.1.4 Hazards Identified

Profiled below is a summary of Natural Hazards in alphabetical order that have significant impacts on the planning area. Each jurisdiction is unique and may not be affected by every hazard. X indicates hazards that impact that jurisdiction.

Table 3.2: Natural Hazard Summary

Jurisdiction	Dam Failure	Drought	Earthquake	Extreme Temperatures	Flooding (River and Flash)	Land Subsidence/Sinkholes	Levee Failure	Severe Winter Weather	Thunderstorm/Lightning/Hail/High Wind	Tornado	Wildfire
Boone	x	x	x	x	x	x	x	x	x	x	x
Ashland		x	x	x	x	x		x	x	x	x
Centralia	x	x	x	x	x	x		x	x	x	x
Columbia	x	x	x	x	x	x	x	x	x	x	x
Hallsville	x	x	x	x	x			x	x	x	x
Harrisburg		x	x	x	x			x	x	x	x
Hartsburg	x	x	x	x	x	x	x	x	x	x	x
Huntsdale		x	x	x	x		x	x	x	x	x
Rocheport		x	x	x	x	x		x	x	x	x
Sturgeon		x	x	x	x			x	x	x	x
Schools and Special Districts											
Columbia Public Schools		x	x	x	x			x	x	x	x
Hallsville R-IV School District		x	x	x	x			x	x	x	x
Southern Boone School District		x	x	x	x			x	x	x	x
Sturgeon R-V School District		x	x	x	x			x	x	x	x
Stephens College		x	x	x	x			x	x	x	x
University of Missouri		x	x	x	x			x	x	x	x

3.1.5 Multi-Jurisdictional Risk Assessment

The 2020 Boone County Hazard Mitigation plan is an update of an earlier plan. The hazard profiles that follow are assessed on a county-wide basis but each jurisdiction will have unique levels of impact based on population and geographical location. The City of Columbia is the urban center of the planning area, with dense development and infrastructure that brings vulnerability state-wide if a hazard were to cause widespread destruction in the city. Other areas of the county are rural with little population or infrastructure to be damaged in the event of a natural hazard.

The planning area is subject to various natural hazards such as dam failure, drought, earthquake, extreme temperature, flooding, levee failure, wildland fire, severe winter weather, sinkholes/land subsidence, and thunderstorms and lightning. Each natural hazard poses different levels of risk depending on the jurisdiction and each will be discussed further in detail later in this section.

3.2 Assets At Risk

3.2.1 Total Exposure of Population and Structures

Unincorporated County and Incorporated Cities

The following tables provide population data based on the 2018 American Community Survey estimates which are calculated over a 5-year period. Building counts and building exposure values are based on data developed by the State of Missouri Geographic Information Systems (GIS) database. Contents exposure values were calculated by factoring a multiplier to the building exposure values based on usage type. The multipliers were derived from the Hazus and are defined below. Land values have been excluded from consideration due to the fact that land remains following disasters and any market devaluations are often short term and difficult to quantify. State and Federal assistance programs do not generally address loss of land outside that of crop insurance. The total valuation of buildings is based on county assessor’s data which may not be current and government-owned properties are usually taxed differently or not at all. This may cause some inaccuracies in the representation of true value. Public school district assets and special districts are included in the total exposure tables assets by community or county.

The following tables provide a look at population, building and content exposure by jurisdiction, as well as a look at exposure by usage type and building counts per each jurisdiction. The exposure and building information for each school district is also included

Table: 3.3 Maximum Population and Building Exposure by Jurisdiction

Jurisdiction	2018 Annual Population Estimate	Building Count	Building Exposure (\$)	Content Exposure (\$)	Total Exposure (\$)
Boone Unincorporated	45,155	18045	4603273	2663329	7266602
Ashland	3,893	1575	444767	261732	706499
Centralia	4,192	1765	523378	339639	863017
Columbia	118,620	36199	13112885	8816797	21929682
Hallsville	1,554	622	138379	79282	217661
Harrisburg	281	136	36868	24908	61776
Hartsburg	95	70	23554	15104	38658
Huntsdale	33	15	3574	1787	5361
Rocheport	247	145	35050	20929	55979
Sturgeon	833	400	81300	54427	135727

Grand Total	174903	58972	19003028	12277934	31280962
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Source: U.S. Bureau of the Census, Annual population estimates/ 5-Year American Community Survey 2017; Building Count and Building Exposure, Missouri GIS Database from SEMA Mitigation Management; Contents Exposure derived by applying multiplier to Building Exposure based on Hazus MH 2.1 standard contents multipliers per usage type as follows: Residential (50%), Commercial (100%), Industrial (150%), Agricultural (100%). For purposes of these calculations, government, school, and utility were calculated at the commercial contents rate.

Table: 3.4 Building Values/Exposure by Usage Type

Jurisdiction	Residential	Commercial	Industrial	Agriculture	Total
Boone Unincorporated	5911750	828499	234874	109142	7266602
Ashland	563448	80613	23784	1978	706499
Centralia	573973	118189	37477	5970	863017
Columbia	14387341	5071712	685403	65130	21929682
Hallsville	179300	17834	4503	908	217661
Harrisburg	35902	9500	166	1266	61776
Hartsburg	25348	3946	758	54	38658
Huntsdale	5361	0	0	0	5361
Rocheport	43696	8563	1824	0	55979
Sturgeon	82131	14529	2249	0	135727
Grant Total	21808250	6153385	991038	184448	31339934

Source: Missouri GIS Database, SEMA Mitigation Management Section

Table: 3.5 Building Counts by Usage Type

Jurisdiction	Residential	Commercial	Industrial	Agriculture	Total
Boone Unincorporated	16756	731	271	174	18045
Ashland	1466	69	16	3	1575
Centralia	1589	108	29	9	1765
Columbia	32954	2273	426	82	36199
Hallsville	573	28	9	2	622
Harrisburg	118	9	0	3	136
Hartsburg	60	4	1	0	70
Huntsdale	15	0	0	0	15
Rocheport	126	12	5	0	145
Sturgeon	367	21	4	0	400
Grant Total	54024	3255	761	273	58972

Source: Missouri GIS Database, SEMA Mitigation Management Section

While schools' total assets are included in the tables above, additional information gathered through the data questionnaires and school websites allow for further discussion. The table below shows enrollment and building information, including counts and replacement cost (exposure).

Table: 3.6 School District Building and Enrollment Summary

Public School District	Enrollment	Building Count	Building Exposure (\$)	Content Exposure (\$)	Total Exposure (\$)
Centralia R-VI	1,372	17	N/A	N/A	43,395,372
Columbia Public	18,555	38	N/A	N/A	N/A
Hallsville R-IV	1,426	5	N/A	N/A	N/A
Harrisburg R-VIII	614	15	N/A	N/A	22,129,873
Southern Boone R-I	1,742	5	N/A	N/A	51,000,000
Sturgeon R-V	433	3	N/A	N/A	15,895,192

Source: Missouri GIS Database, SEMA Mitigation Management Section. <http://mcds.dese.mo.gov/quickfacts/Pages/District-and-School-Information.aspx>

Table 3.7: Jurisdictional Assets Summary

Jurisdiction	Airport Facility	Bus Facility	Childcare Facility	Electric Power Facility	Emergency Operations	Fire Service	Government	Housing	Shelters	Hospital/Health Care	Military	Natural Gas Facility	Nursing Homes	Police Station	Potable Water Facility	Rail	Sanitary Pump Stations	School Facilities	Tier II Chemical Facility	Wastewater Facility	TOTAL
Unincorporated Boone	0	0	0	0	1	20	3	16756	0	1	0	0	0	1	4	0	0	0	0	14	16,800
Ashland	0	0	5	0	0	0	2	1466	4	1	0	0	3	1	1	0	2	5	0	1	1,491
Centralia	0	0	1	0	0	1	2	1589	7	2	0	0	3	1	1	3	0	17	0	1	1,628
Columbia	1	1	71	1	1	9	2	32954	22	12	1	0	14	1	1	1	0	38	1	1	33,132
Hallsville	0	0	3	0	0	1	3	667	3	1	0	0	0	1	1	1	0	5	0	1	687
Harrisburg	0	0	1	0	0	0	1	118	0	0	0	0	0	0	1	0	0	15	0	0	136
Hartsburg	0	0	0	0	0	0	1	60	2	0	0	0	0	0	0	0	0	0	0	1	64
Huntsdale	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	15
Rocheport	0	0	0	0	0	0	1	126	0	0	0	0	0	0	0	0	0	0	0	0	127
Sturgeon	0	0	1	0	0	0	2	367	2	0	0	0	1	1	1	1	0	3	0	1	380
Totals	1	1	82	1	2	30	16	54024	45	16	1	0	21	6	10	6	2	83	1	20	54,368

Source: Data Questionnaire

3.2.2 Critical and Essential Facilities and Infrastructure

There are four main types of facilities of concern in a hazard event. Critical Facility, essential facility, high potential loss facility, and transportation and lifeline facilities. These 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. 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.

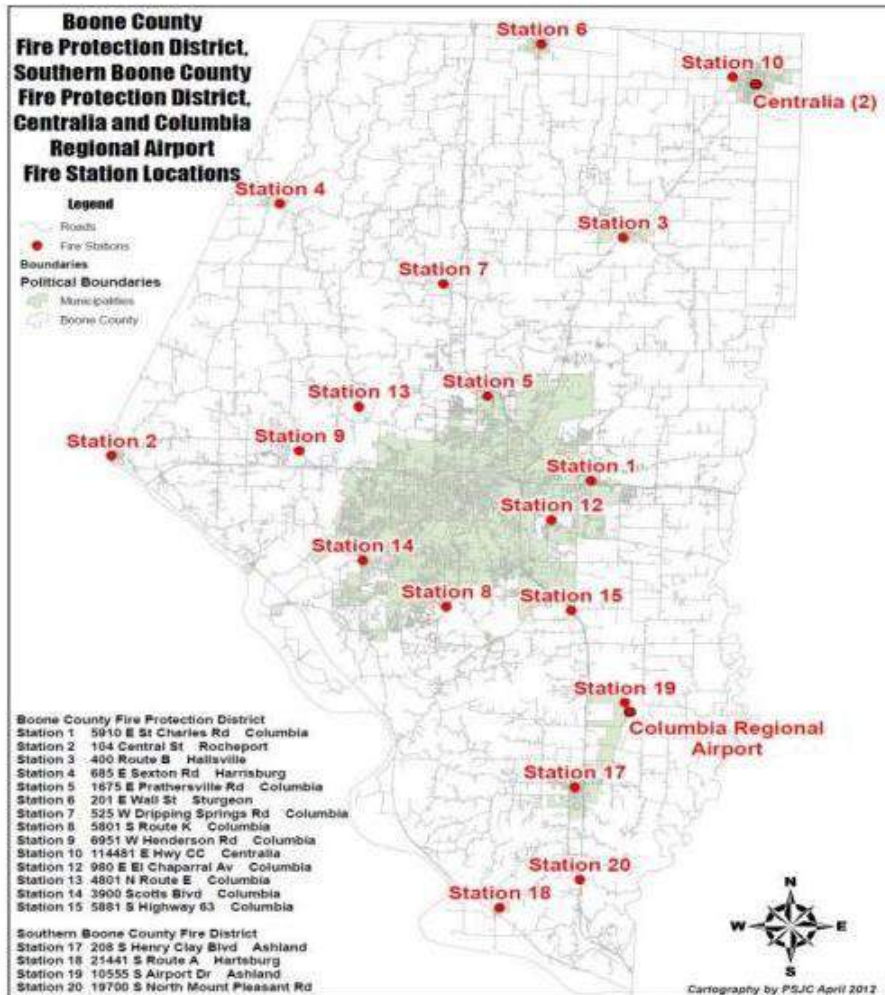
Government

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, which serves the entire county, are located there.

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 3.1).

Figure 3.1



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.

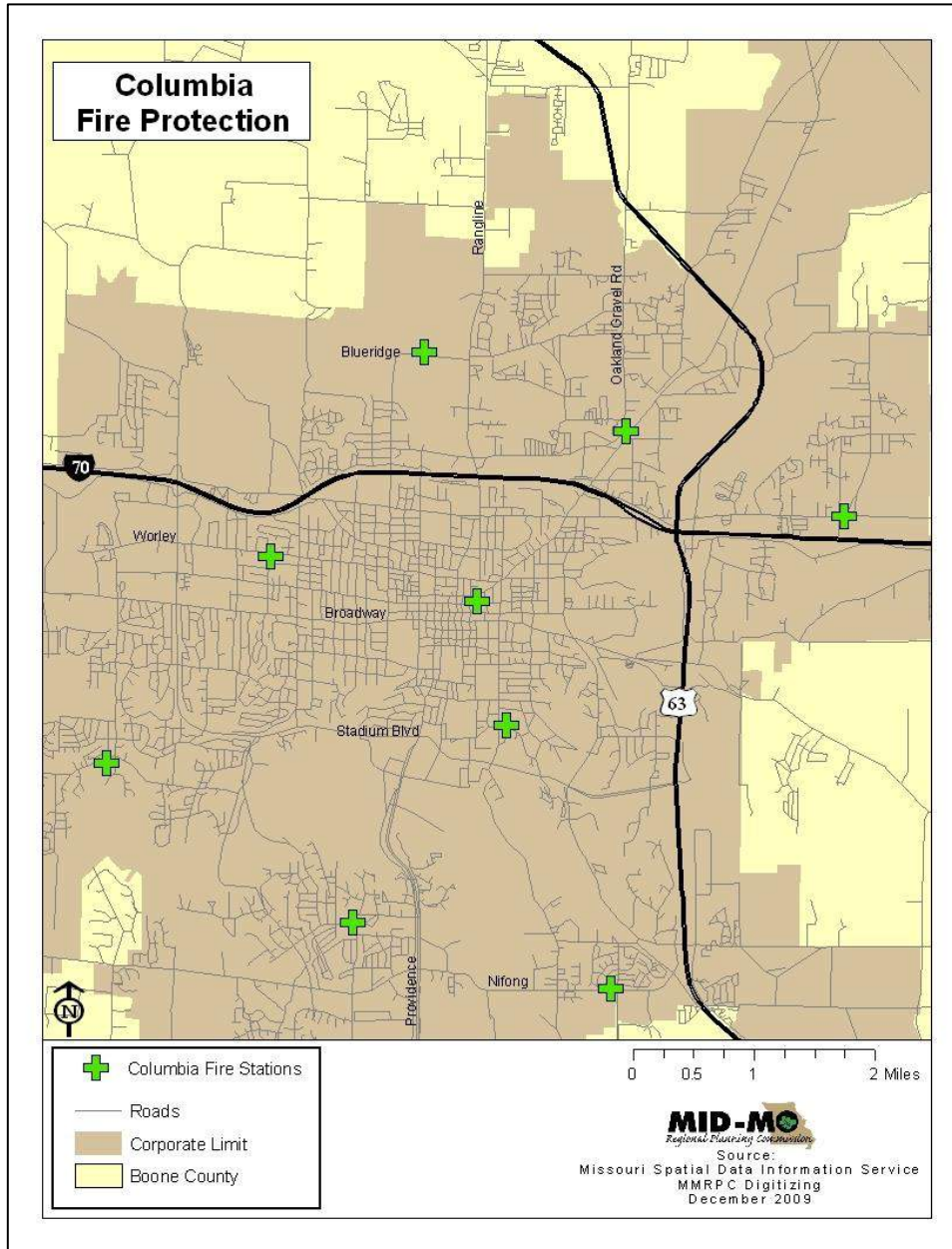
The Southern Boone County Fire Protection District is governed by a three-member elected body and serves the southern one-third of the county. It has a limited hazardous materials response capability. The district protects an area of 100 square miles and a population of approximately 10,000 from four 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 3.2



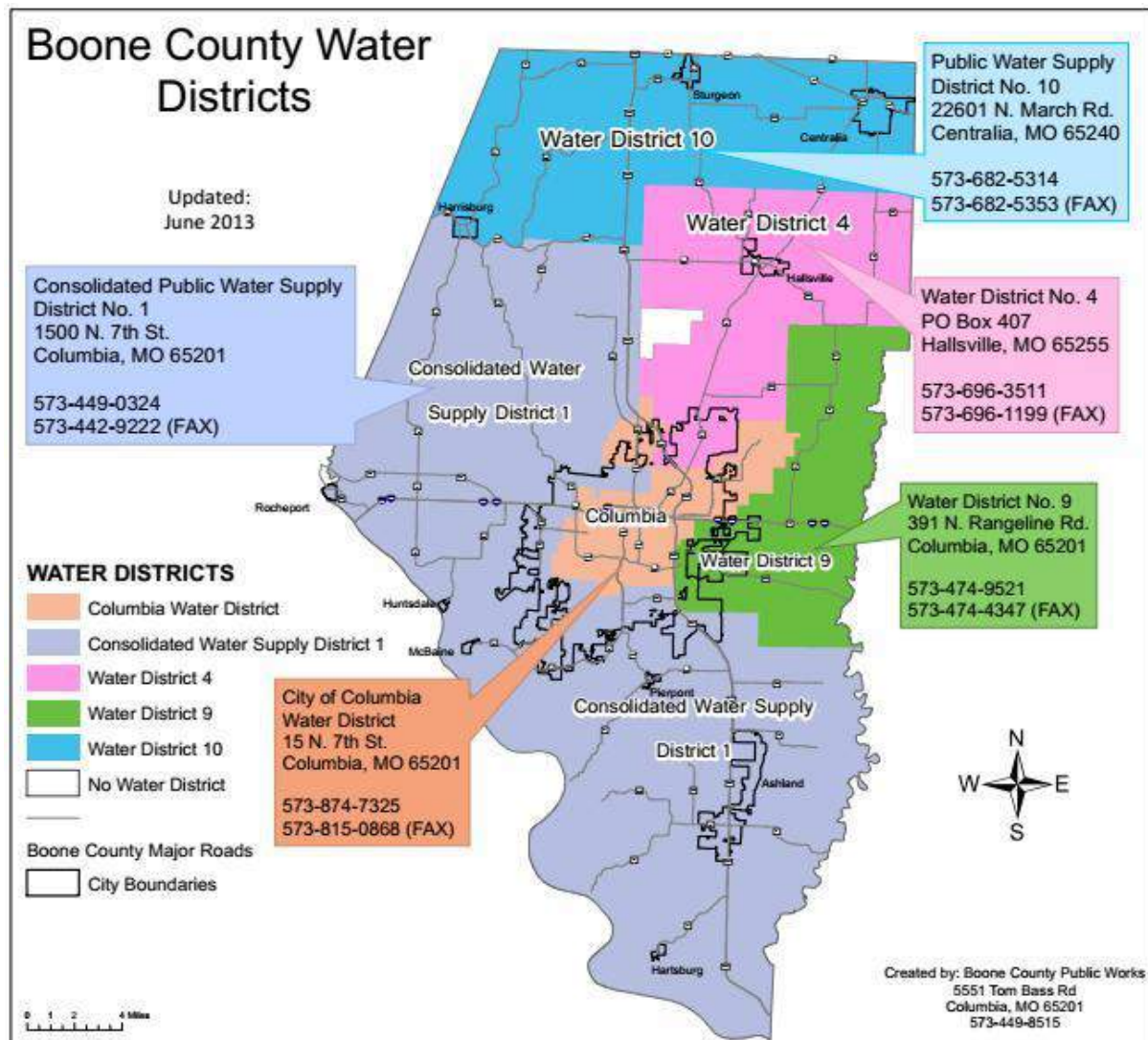
Public Water Supply Districts

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 3.3



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. 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 3.4

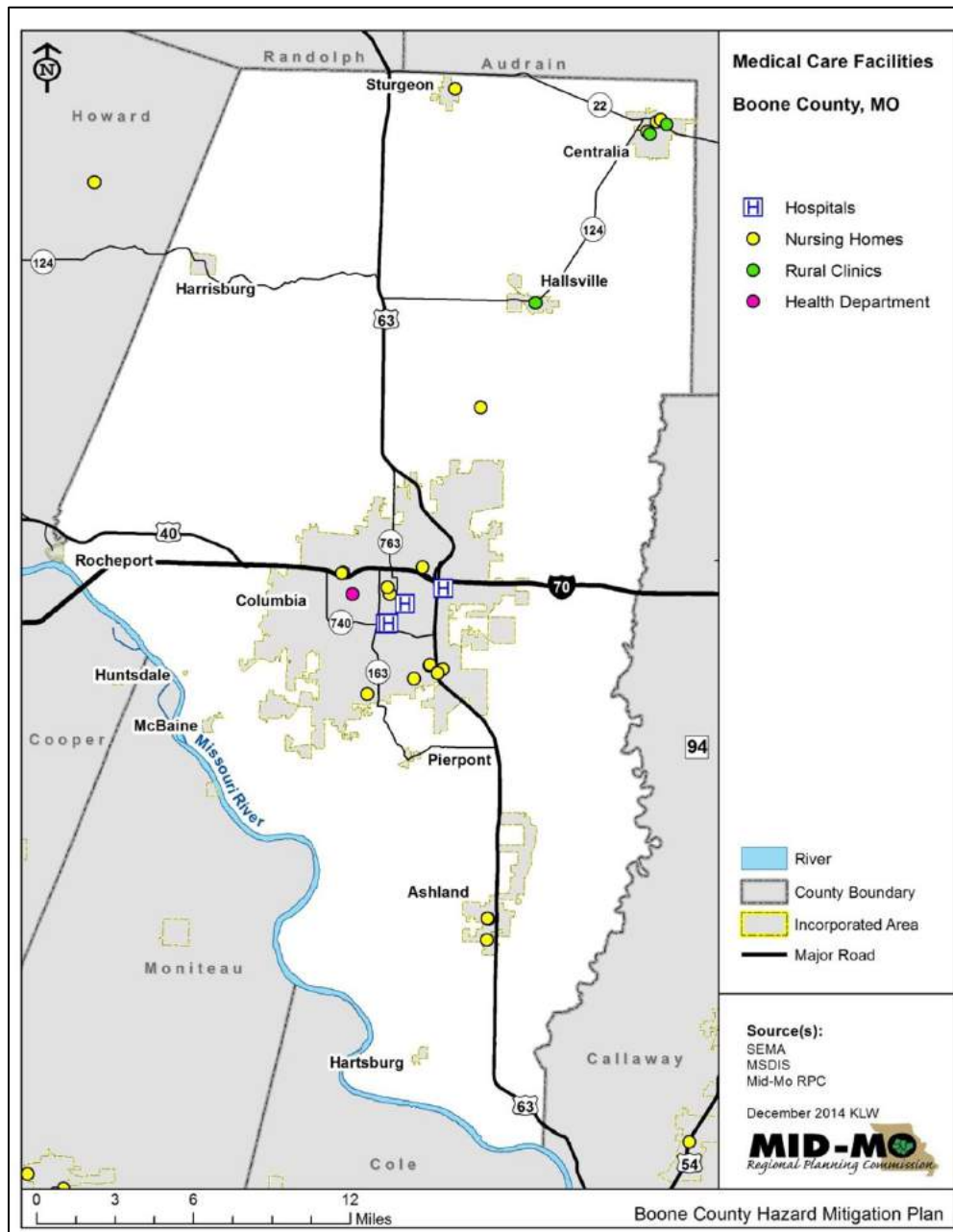


Table 3.8		
Critical Medical Facilities		
Type of Facility	Location	Beds
Level 1 Trauma Center		
University Hospital	Columbia	
Hospitals		
Boone Hospital Center	Columbia	397
Harry S. Truman Memorial Veterans Hospital	Columbia	na
Landmark Hospital of Columbia, LLC	Columbia	42
Rusk Rehabilitation Center (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

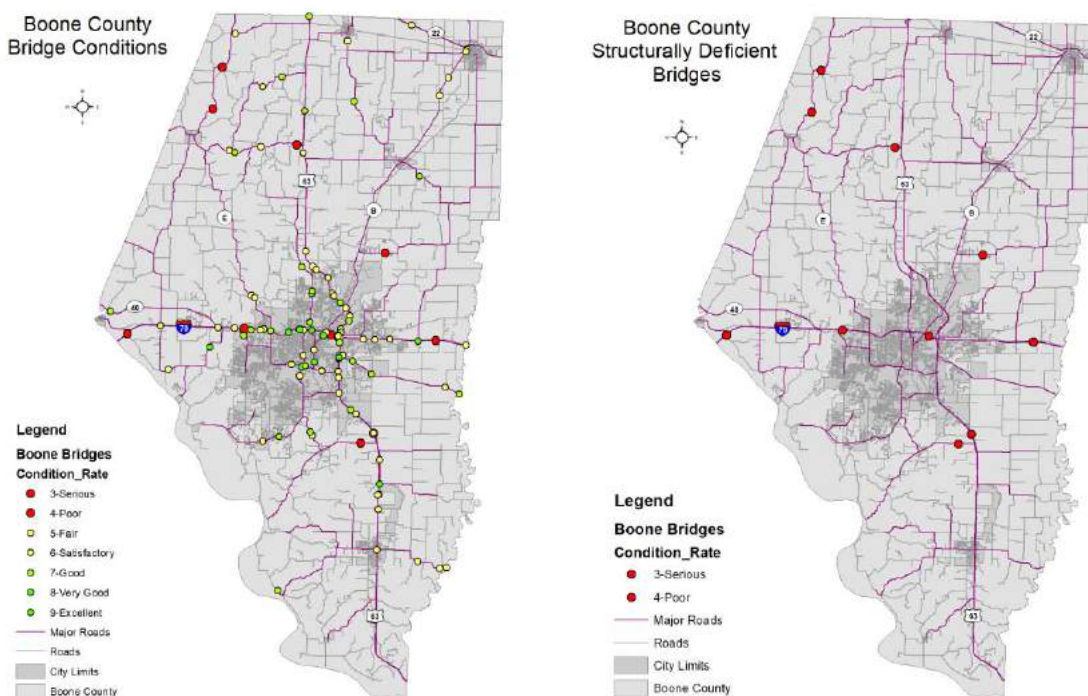
The Boone County Office of Emergency Management (OEM) is in charge of emergency management for the County and all its jurisdictions, with the exception of the Villages of McBaine and Pierpont (which are not participating jurisdictions in the Boone County Hazard Mitigation Plan).

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.

Transportation

Boone County is crossed by two major highway systems and has a regional airport. 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 3.5 Boone County Bridge Conditions



Bridges

Bridge conditions are described using a “scour index”. This index rates bridges on their vulnerability to scour during a flood and is based on a scale of 0 to 9. Zero are failed bridges. Bridge with a scour index of 9 are new bridges. An index rating of 1 to 3 are in critical condition.

A rating of 4 is poor. Anything 5 and higher are fair to excellent. The only poor condition bridges that are located within a city jurisdiction are within the city limits of Columbia.

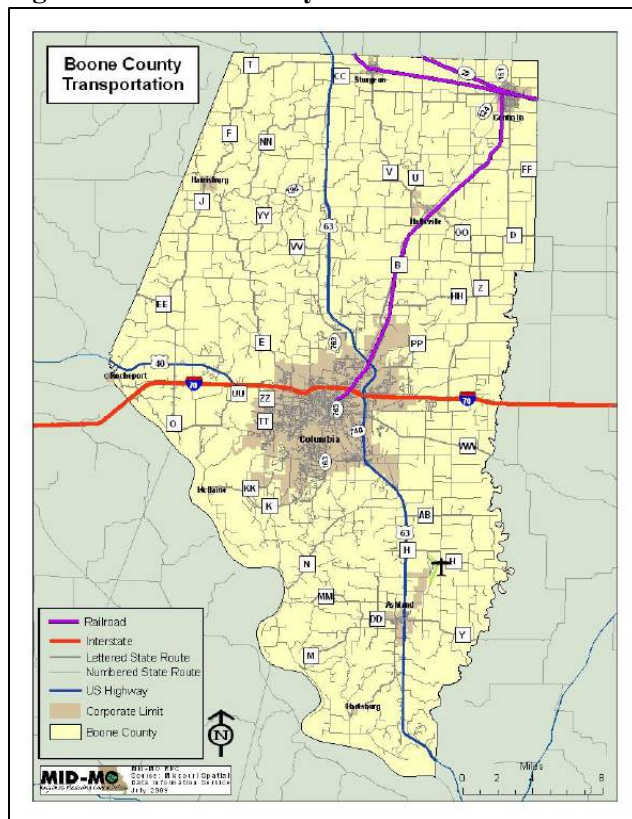
In 2019 legislation passed the Governor’s Focus on Bridges program. Through this program 3 critical or poor condition bridges in Boone county are slated to be replaced between 2020-2023.

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

Figure 3.6 Boone County Roads



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.

3.2.3 Other Assets

Threatened and Endangered Species

There are 9 plant and animal species listed as threatened or endangered that are known or are believed to occur in Boone county.

Table 3.9 Threatened and Endangered Species in Boone County

Common Name	Scientific Name	Status
Eastern prairie fringed orchid (plant)	Plantanthera leucophaea	Threatened
Red Knot (bird)	Calidris canutus rufa	Threatened
Topeka shiner (fish)	Notropis topeka	Endangered
Indiana Bat (mammal)	Myotis sodalist	Endangered
Gray Bat (mammal)	Myotis grisescens	Endangered
Northern Long Eared Bat (mammal)	Myotis septentrionalis	Threatened
Running Buffalo Clover (plant)	Trifolium stoloniferum	Endangered
Least Tern (bird)	Sterna antillarum	Endangered
Pallid Sturgeon (fish)	Scaphirhynchus albus	Endangered

Source: U.S. Fish and Wildlife Service, <http://ecos.fws.gov/ecp/report/species-listings-by-current-range-county>

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.

The Katy Trail is the longest developed rail-trail in the country and portions of it runs through Boone County and some of its jurisdictions. Many sections of the Katy Trail were damaged and closed in 2019 due to flooding. Sections of the trail are still being worked on to remove flooding debris and repair the trail bed. Caution should be taken for rough surfaces and trail work.

Table 3.10

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
Katy Trail State Park	Missouri Department of Natural Resources	~30 miles

Source: Missouri Spatial Data Information Server (MSDIS)

Boone County Properties on the National Register of Historic Places

Boone county has several properties listed on the National Register of Historic Places and multiple jurisdictions have ordinances that address historic places. This registry is an official list of registered cultural resources that are worth preserving. The National Historic Preservation Act of 1966 authorized such a list as part of a national program. The program is administered by the National Parks Service and acts as a resource to coordinate public and private efforts to find, evaluate, and preserve historically and archeologically significant sites. Properties on the list include districts, buildings, structures, and sites that have significance through history, culture, architecture, archeology, and engineering. Table 3.10 is a list of historic sites located in Boone County.

Table 3.11: Boone County Historic Sites

Property	Address	City	Date Listed
Ballenger Building	27-29 S. 9 th St	Columbia	1/21/04
Bond’s Chapel	MO Route A	Hartsburg	9/9/93
John Boone “Blind” House	4 th St	Columbia	9.4/80
Central Dairy Building	1104-1106 E. Broadway	Columbia	1/20/05
Albert Chance House	319 E Sneed St.	Centralia	7/3/79
Chatol	543 S. Jefferson	Centralia	4/20/79
Coca-Cola Bottling Co. Building	10 Hitt St.	Columbia	2/14/06
Columbia Cemetery	30 E. Broadway	Columbia	2/1/07
Columbia Nat. Guard Armory	701 E. Ash St.	Columbia	3/25/93
Sanford Conley House	602 Sanford Pl.	Columbia	12/18/73
Fred Douglas School	310 N. Providence Rd	Columbia	9/4/80

Downtown Columbia Historic District	7 th , 8 th , 9 th , 10 th , Broadway, etc.	Columbia	11/8/06
East Campus Neighborhood	College, University, High St.	Columbia	2/16/96
8 th Broadway	800-810 E. Broadway	Columbia	4/22/03
Samuel Elkins House	315 N. 10 th St.	Columbia	9/12/96
First Christian Church	101 N. 10 th St.	Columbia	10/29/91
Francis Quadrangle District	Red Campus	Columbia	12/18/73
Frederick Apartments	1001 University Ave.	Columbia	4/16/13
David Gordon/Collins Cabin	2100 E. Broadway	Columbia	8/29/83
Greenwood	3005 Mexico Gravel Rd.	Columbia	1/15/79
David Guitar House	2815 Oakland Gravel Rd.	Columbia	9/9/93
Samuel Hackman Building	30 S. St.	Hartsburg	12/10/98
Hamilton-Brown Shoe factory	1123 Wilkes Blvd	Columbia	7/19/02
Harrisburg School	140 S. Harris St.	Harrisburg	12/24/13
William Hunt House	8939 W. Terrapin Hills Rd.	Columbia	1/9/97
Kress Building	1025 E. Broadway	Columbia	3/9/05
Maplewood	Nifong Blvd/Ponderosa Dr	Columbia	4/13/79
McClain Furniture Store	916 E. Walnut	Columbia	8/17/05
MO, KS, TX Railroad Depot	402 E. Broadway	Columbia	1/29/79
MO Teachers Association	407 S. 6 th St.	Columbia	9/4/80
Missouri Theater	201-215 S. 9 th St.	Columbia	6/6/79
MO United Methodist Church	204 S. 9 th St.	Columbia	9/4/80
Mount Zion Church/Cemetery	11070 Mount Zion Rd.	Hallsville	1/14/13
N. 9 th Street Historic District	5-36 N. 9 th St.	Columbia	1/21/04
Moses Payne House	201 N. Roby Farm Rd.	Rocheport	10/7/94
Pierce Pennant Motor Hotel	1406 Old Hwy 40	Columbia	9/2/82
Rocheport Historic District	MO 240	Rocheport	10/8/76
St. Paul's AME Church	501 Park St.	Columbia	9/4/80
Sanborn Field & Soil Erosion Plots	University of Missouri Campus	Columbia	10/15/66
Second Baptist Church	407 E. Broadway	Columbia	9/4/80
Second Christian Church	401 N. 5 th St.	Columbia	9/4/80
Senior Hall	Stephens College Campus	Columbia	8/2/77
Sigma Alpha Epsilon Building	24 E. Stewart Rd.	Columbia	10/20/14
Stephens college, South Campus	1200 E. Broadway	Columbia	11/25/05
John Taylor House	716 W. Broadway	Columbia	5/25/01
Tiger Hotel	23 S. 8 th St.	Columbia	2/29/80
Virginia Building	111 S. 9 th St.	Columbia	3/13/02
Wabash Railroad Station/Freight House	126 N. 10 th St.	Columbia	10/11/79
West Broadway Historic District	300-922 W. Broadway	Columbia	4/27/10
Wright Brothers Mule Barn	1101-1107 Hinkson/501-507 Fay	Columbia	11/1/07

Source: Missouri Department of Natural Resources – MO National Register Listings by County.

<https://dnr.mo.gov/shpo/boone.htm>

The major, non-retail employers with more than 200 personnel employed are shown in Table 3.12

Table 3.12

Major Employers in Boone County			
Employer	Employees	Employer	Employees
University of Missouri	5000 & up	State of Missouri (excludes MU)	500-749
University Hospitals & Clinics	2500-4999	ABC Laboratories, Inc.	250-499
Columbia Public Schools	1500-2499	U.S. Postal Service	250-499
Veterans United Home Loans	1500-2499	Missouri Employers Mutual Insurance	250-499
City of Columbia	1000-1499	Columbia Insurance Group	250-499
Harry S. Truman VA Hospital	1000-1499	3M	250-499
Shelter Insurance Companies	1000-1499	Boone County Government	250-499
Joe Machens Dealerships	750-999	Midway USA	250-499
MBS Textbook Exchange	750-999	Central Bank of Boone County	250-499
State Farm Insurance Companies	500-749	Woodhaven	250-499
Columbia College	500-749	MFA, Inc.	200-249
Hubbell Power Systems	500-749	Pepsico/Quaker Oats	200-249
IBM	750-999	Schneider Electric: Square D	200-249
Kraft Foods	500-749		
www.columbiaredi.com			

While agriculture plays a large roll in Boone County’s land use, the 222 farms listed in Boone County according to the 2017 USDA Ag Census only employ around 651 workers. The majority of the farms only have a couple workers each. The number of workers is down compared to the 2012 Ag Census when 669 workers were listed in Boone County.

3.3 Land Use and Development

3.3.1 Development Since Previous Plan Update

Boone county and its jurisdictions have shown growth since the last census, with the most growth estimated to be in and around the City of Columbia. Amenities such as high-speed internet, municipal water and sewer, and job opportunities can drive such growth.

Table 3.13 County population Growth 2010-2018

Jurisdiction	2010 Total Population	2018 Total Population Estimate	# Change (2010-2018)	% Change (2010-2018)
Unincorporated	43,377	45,467	2,090	4.7%
Ashland	3,707	3,947	240	6.2%
Centralia	4,027	4,244	217	5.2%
Columbia	108,500	123,180	14,680	12.6%
Hallsville	1,491	1,564	73	4.7%
Harrisburg	266	281	15	5.4%
Hartsburg	108	108	0	0%
Huntsdale	31	33	2	6.2%
Rocheport	239	251	12	4.8%
Sturgeon	872	930	58	6.4%
Total	162,699	180,005	17,306	10%

Source: U.S. Bureau of the Census, Decennial Census, annual population estimates/ 5-Year American Community Survey 2018; *population includes the portions of these cities in adjacent counties

Growth translates into a need for more housing, and the expansion of local emergency capabilities to keep up with demand and added fuel to the system. While American Community Survey estimates a growth in population mostly across the board for Boone County and its jurisdictions it also estimates a decline for some jurisdictions in housing units. This could be due to more families choosing to live with multiple generations in a home or some homes being designated as businesses as the trend toward home businesses is on the rise.

Table 3.14 Change in Housing Units, 2010-2018

Jurisdiction	Housing Units 2010	Housing Units 2018	2010-2018 # Change	2000-2018 % Change
Unincorporated	17,956	19,031	1,075	5.9
Ashland	1,536	1,528	-8	-0.5
Centralia	1,723	1,955	232	13.4
Columbia	45,971	52,257	6,286	13.6
Hallsville	707	664	-43	-6
Harrisburg	130	138	8	23.7
Hartsburg	59	73	14	23.7
Huntsdale	13	6	-7	-53.8
Rocheport	83	153	70	84.3
Sturgeon	418	380	-38	-9
Total	68,596	76,185	7,589	11

Source: U.S. Bureau of the Census, Decennial Census, American Community Survey 5-year Estimates; Population Statistics are for entire incorporated areas as reported by the U.S. Census Bureau

3.3.2 Future Land Use and Development

Population growth is expected to continue in Boone County and its jurisdictions. Due to the transportation network that passes through Boone County it continues to be a major shipping corridor which is a draw for companies looking for a place to hub distribution centers which can employ several people. As has already been seen more and more farm land is being developed into housing and businesses throughout the county. With growth comes the need to expand protections such as fire services, storm warning devices, and runoff handling practices.

School District’s Future Development

Columbia Public Schools and Southern Boone School District have experienced steady growth that has forced the need to build additional school buildings to help mitigate overcrowding in classrooms. As new buildings are built and old ones are remodeled it’s a trend across all districts to employ hardening methods to construction to add resiliency against major storms and potential intruders.

3.4 Hazard Profiles, Vulnerability, and Problem Statements

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 discussed in alphabetical order and organized according to the following outline:

HAZARD PROFILES

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

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

Geographic Location – This section describes the geographic areas in the planning area that are affected by the hazard. For some hazards, the entire planning area is at risk.

Strength/Magnitude/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 – This includes available information on historic incidents and their impacts. Historic event records form a solid basis for probability calculations.

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 (2018)*:

- 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.

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 (2018):

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.

Changing Future Conditions Considerations – This discusses the potential future impacts climate change could have on natural hazard events and their affects on the planning area.

VULNERABILITY ASSESSMENTS

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

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

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

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

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.

Within the Vulnerability Assessment, the following sub-headings will be addressed:

- **Vulnerability Overview** – This is an overall summary of each jurisdiction’s vulnerability to the identified hazards. It identifies structures, systems, populations or other community assets that are susceptible to damage and loss for hazard events.
- **Potential Losses to Existing Development/life** – Covers how impacts and potential impacts of the hazard has consequences on existing jurisdictional assets such as buildings, critical facilities, life, etc.
- **Previous and Future Development** - This section goes over how changes in development have impacted the jurisdiction’s vulnerability to the hazard.
- **Hazard Summary by Jurisdiction** – Hazards vary by jurisdiction and this section will provide an overview of such variations.
- **Problem Statements**
The problem statement consists of a brief summary of the problems created by the hazard in the planning area, and possible ways to resolve those problems.

3.4.1 FLOODING (RIVERINE AND FLASH)

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 04/19/17. Overview maps showing the floodplains for the entire planning area (Figure 3.7) and for the City of Columbia (Figure 3.10) included in the following pages. For the smaller jurisdictions with significant flooding risk, the National Flood Hazard Layers from the online system are included (Figures 3.9-3.12). A flood map for Harrisburg was excluded because it does not have any designated floodplain within the jurisdictional boundaries and is not at great risk for significant flooding.

Figure 3.7: Boone County Floodplain

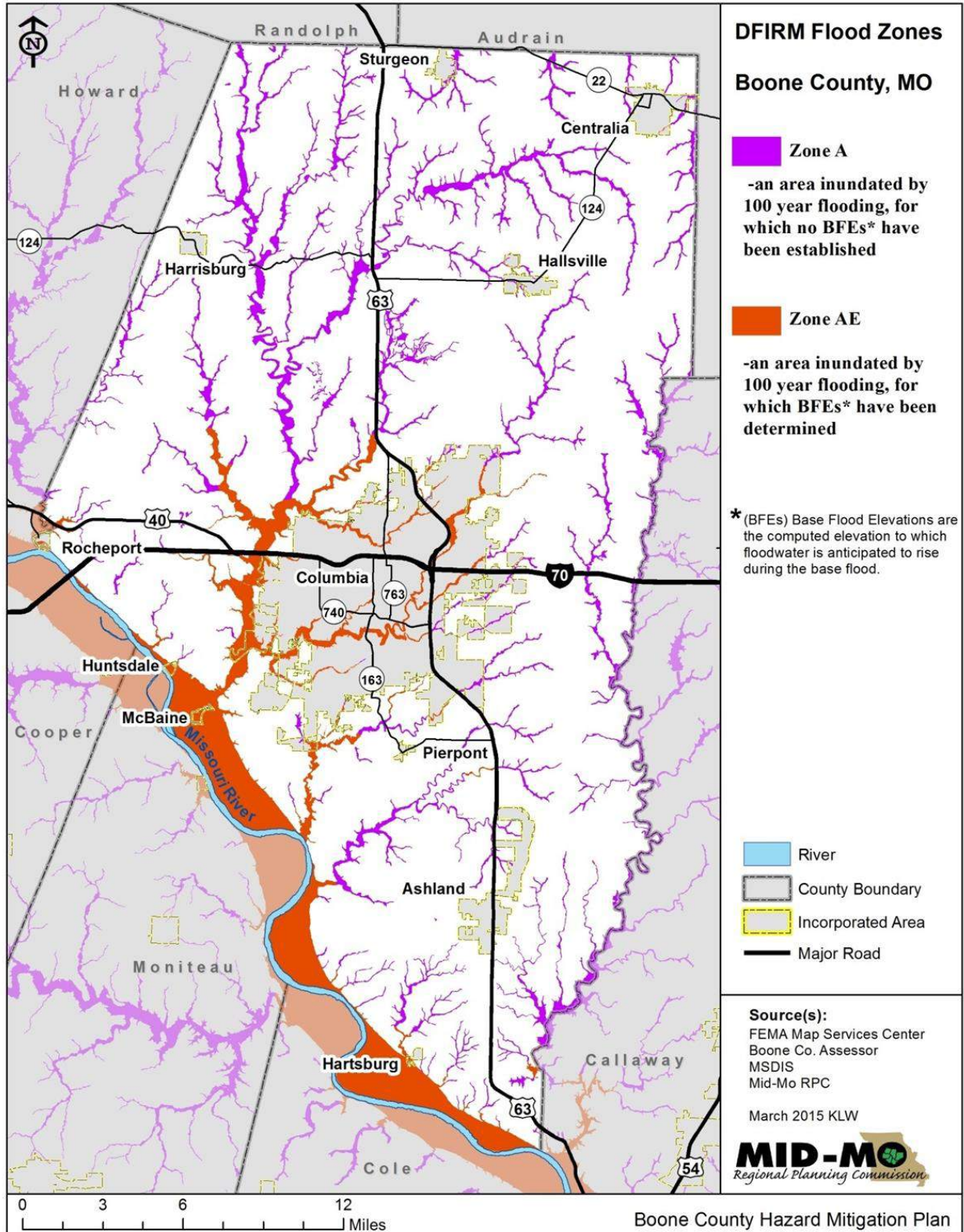


Figure 3.8: Ashland Floodplain

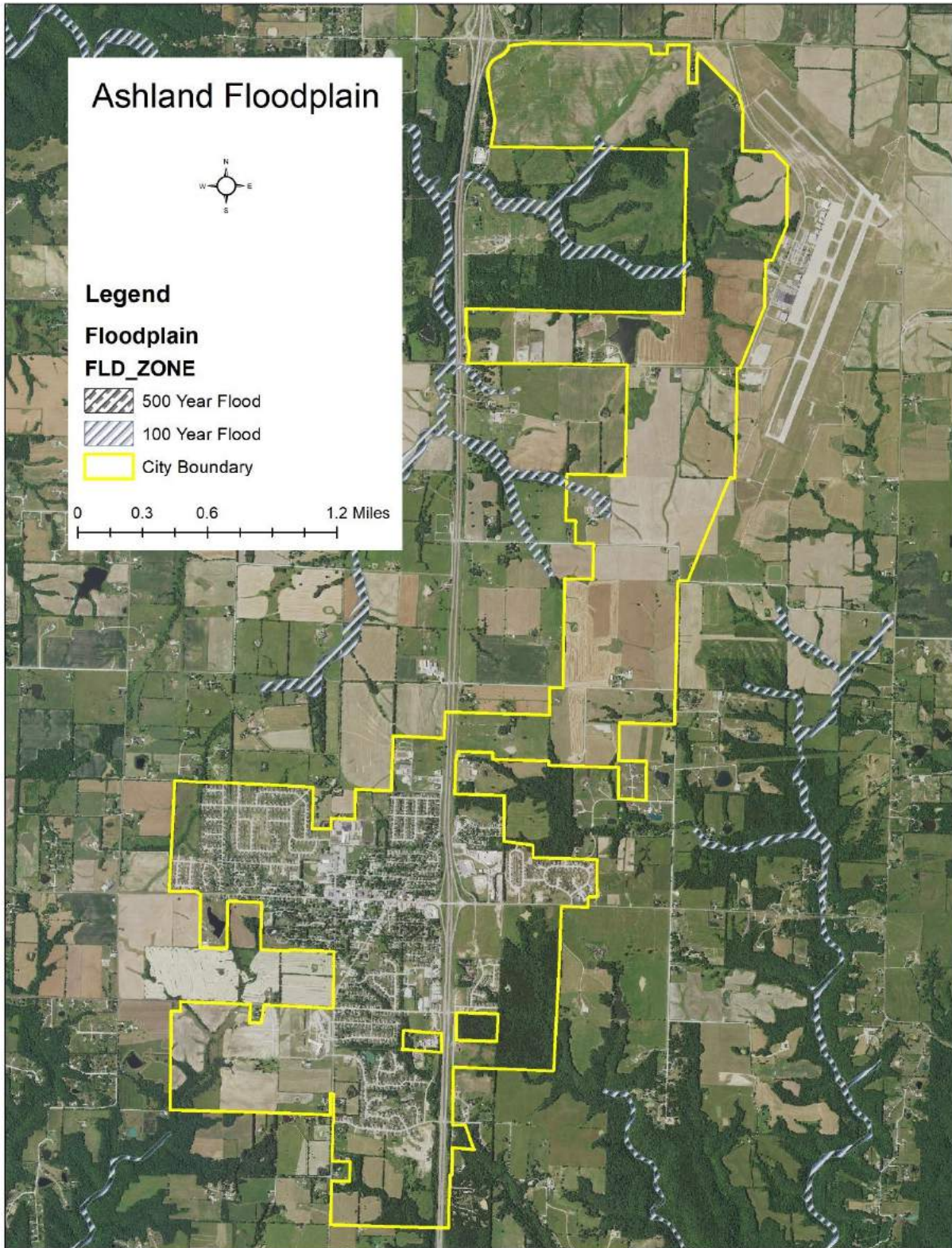


Figure 3.9: Centralia Floodplain

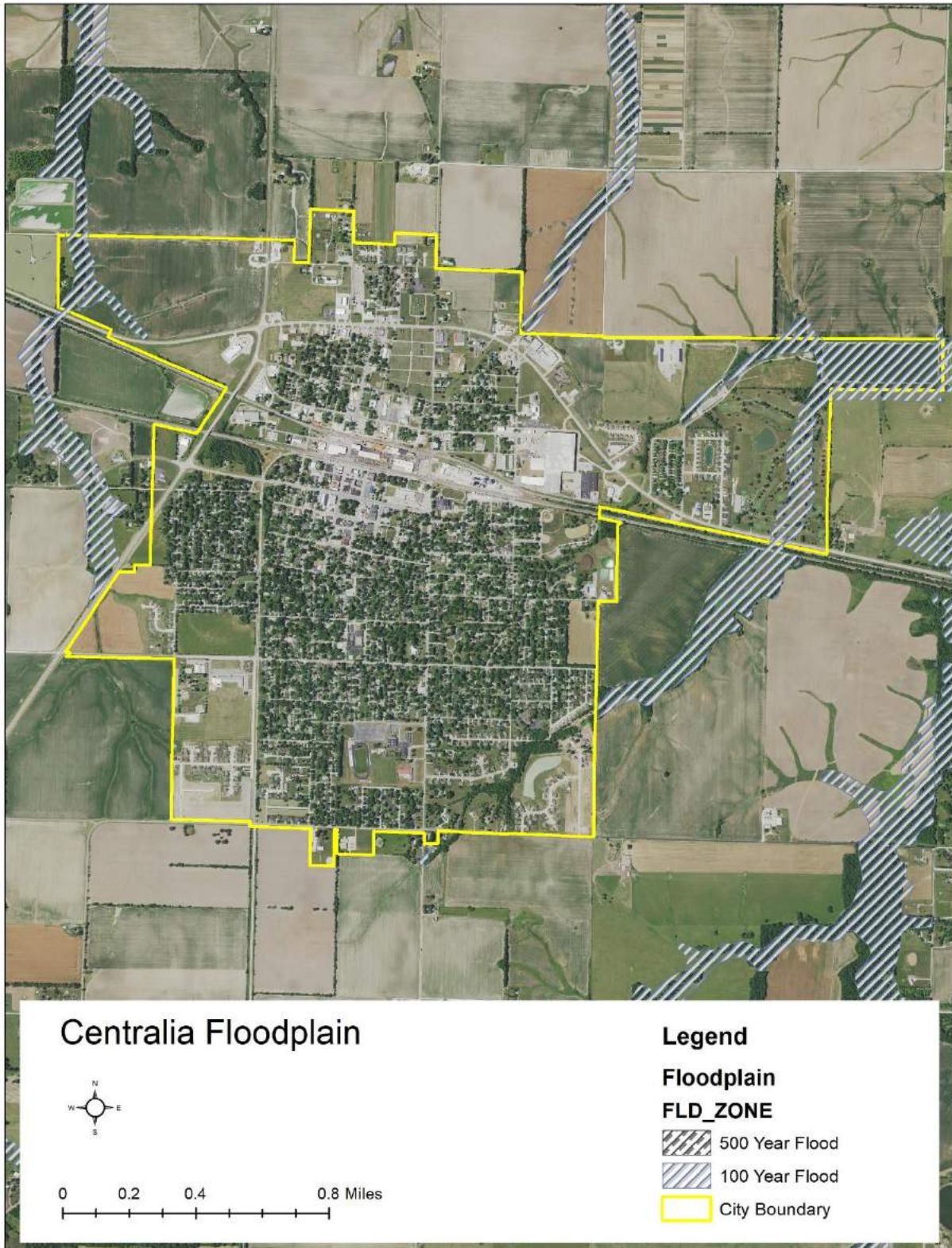


Figure 3.10: Columbia Floodplain

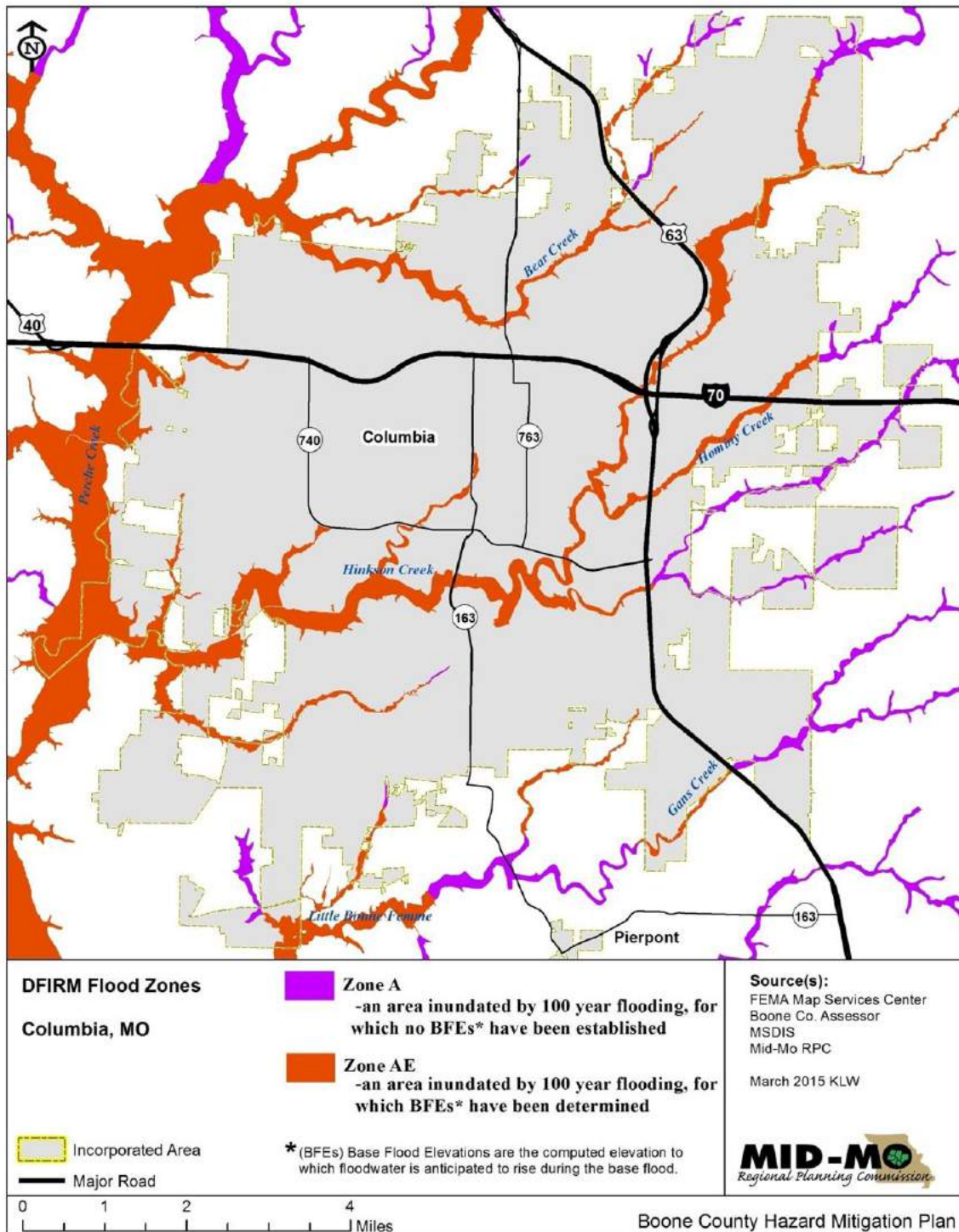


Figure 3.11: Hallsville Floodplain

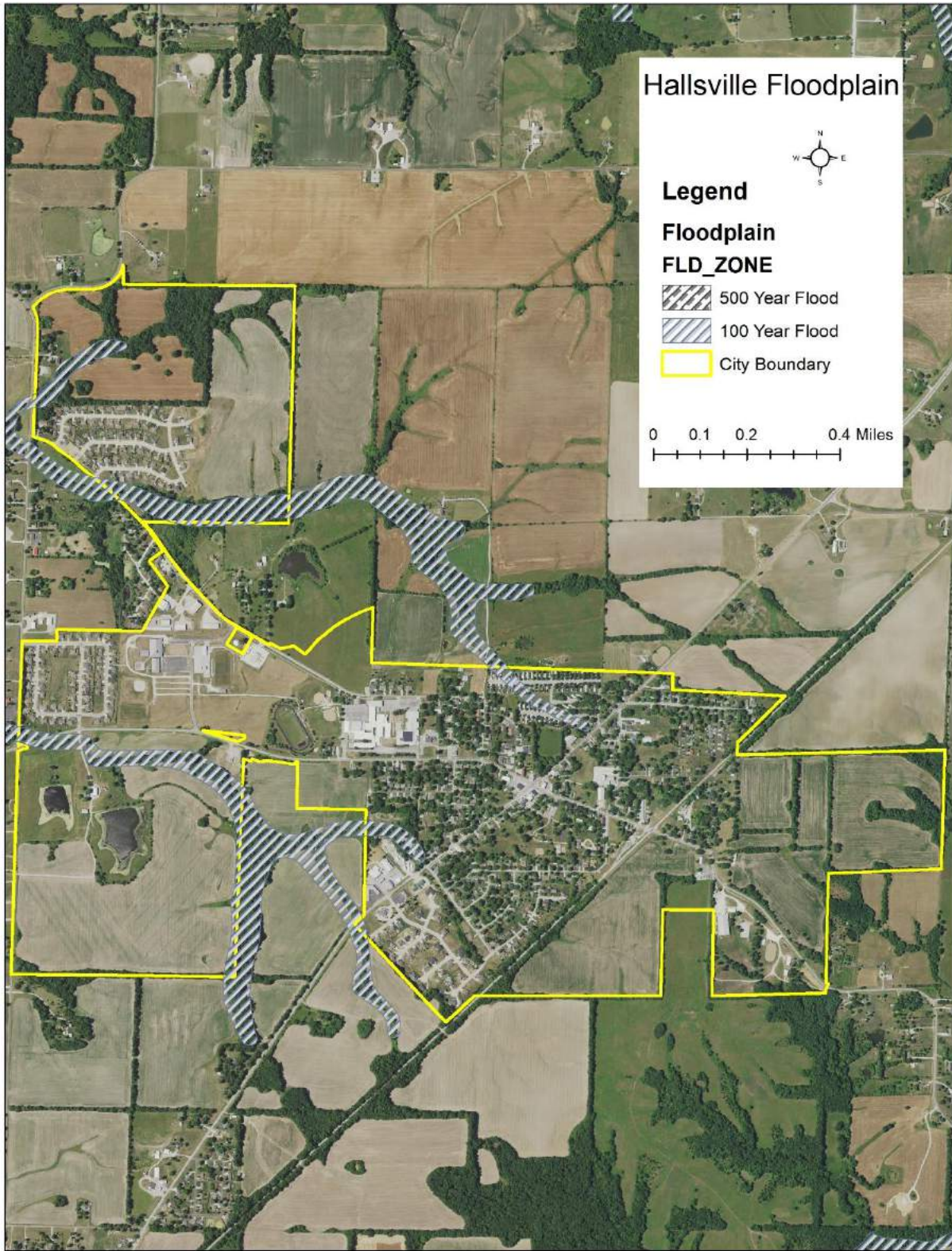


Figure 3.12: Hartsburg

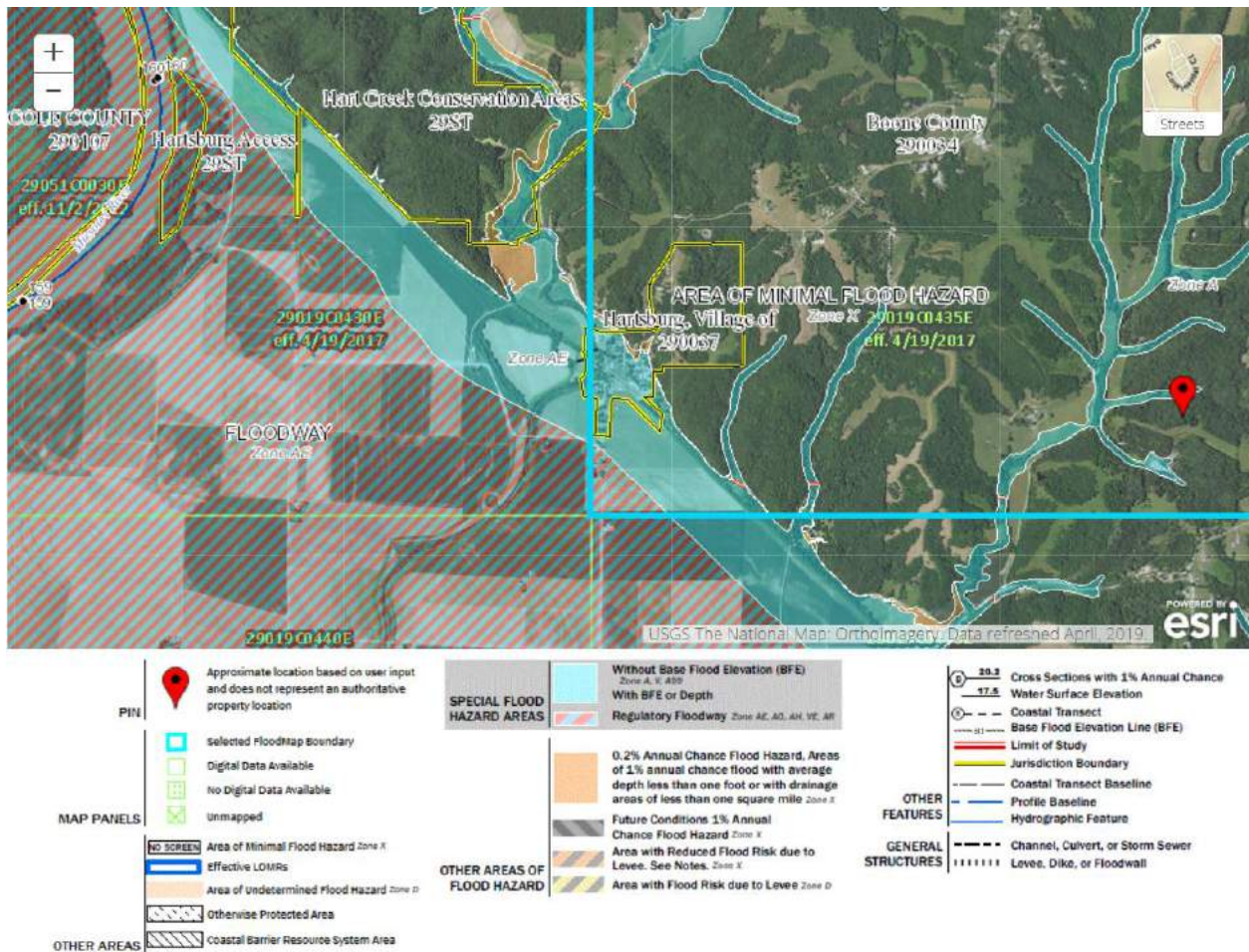


Figure 3.13: Huntsdale

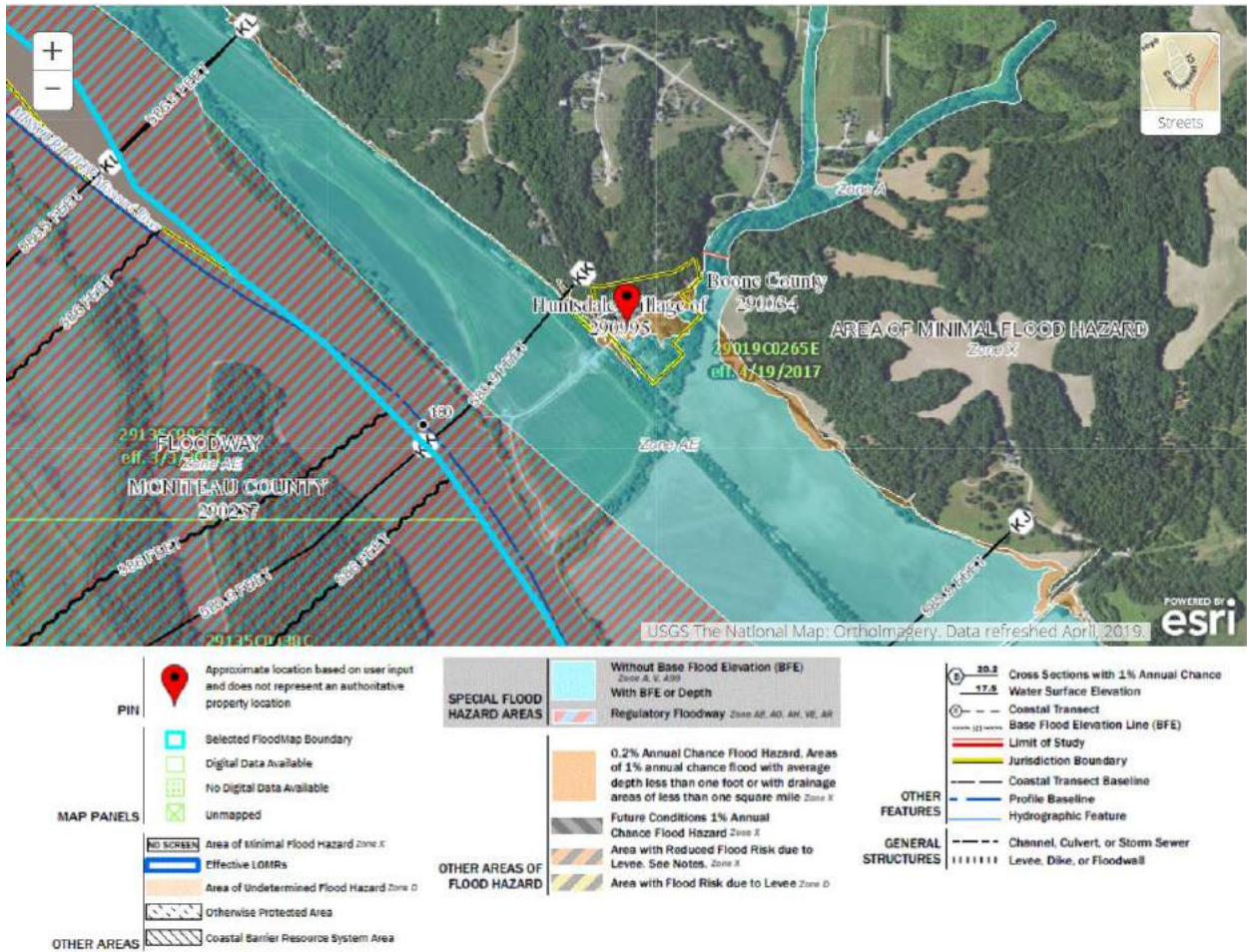


Figure 3.14: Rocheport

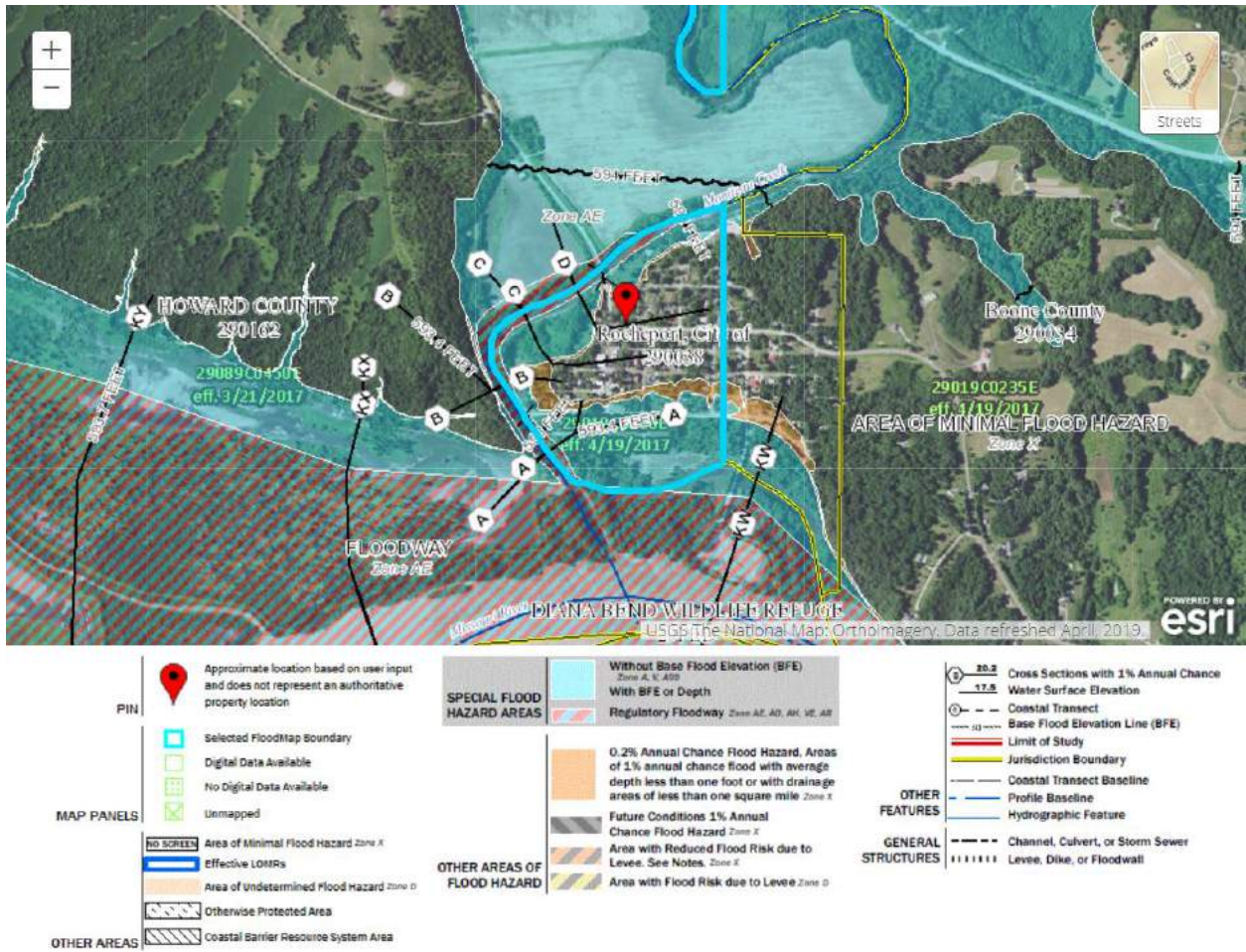
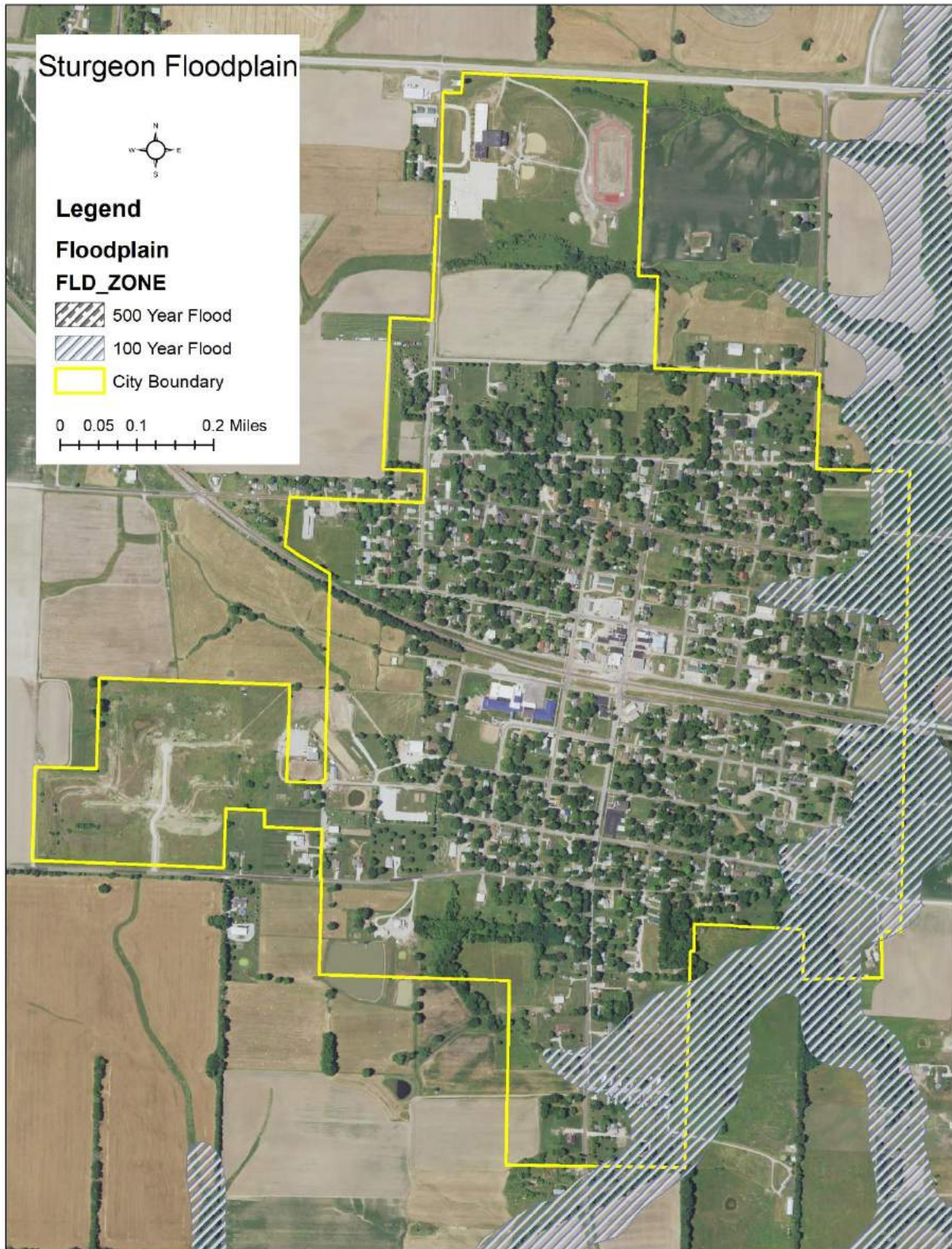


Figure 3.15: Sturgeon Floodplain



Road closures due to high water or flash flooding are common throughout the planning area. The map below indicates areas that are common to close due to flooding and flash floods.

Figure 3.16

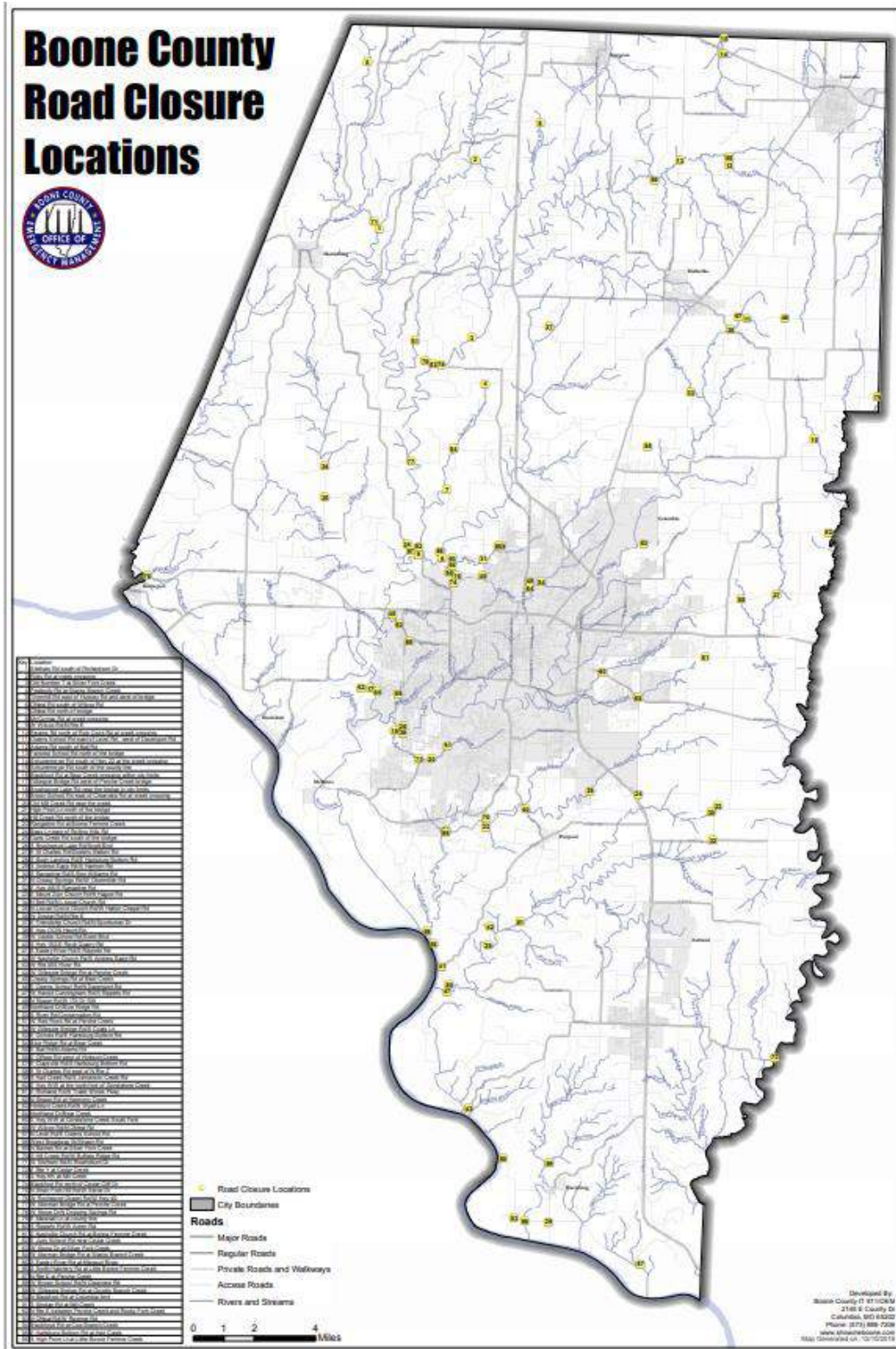


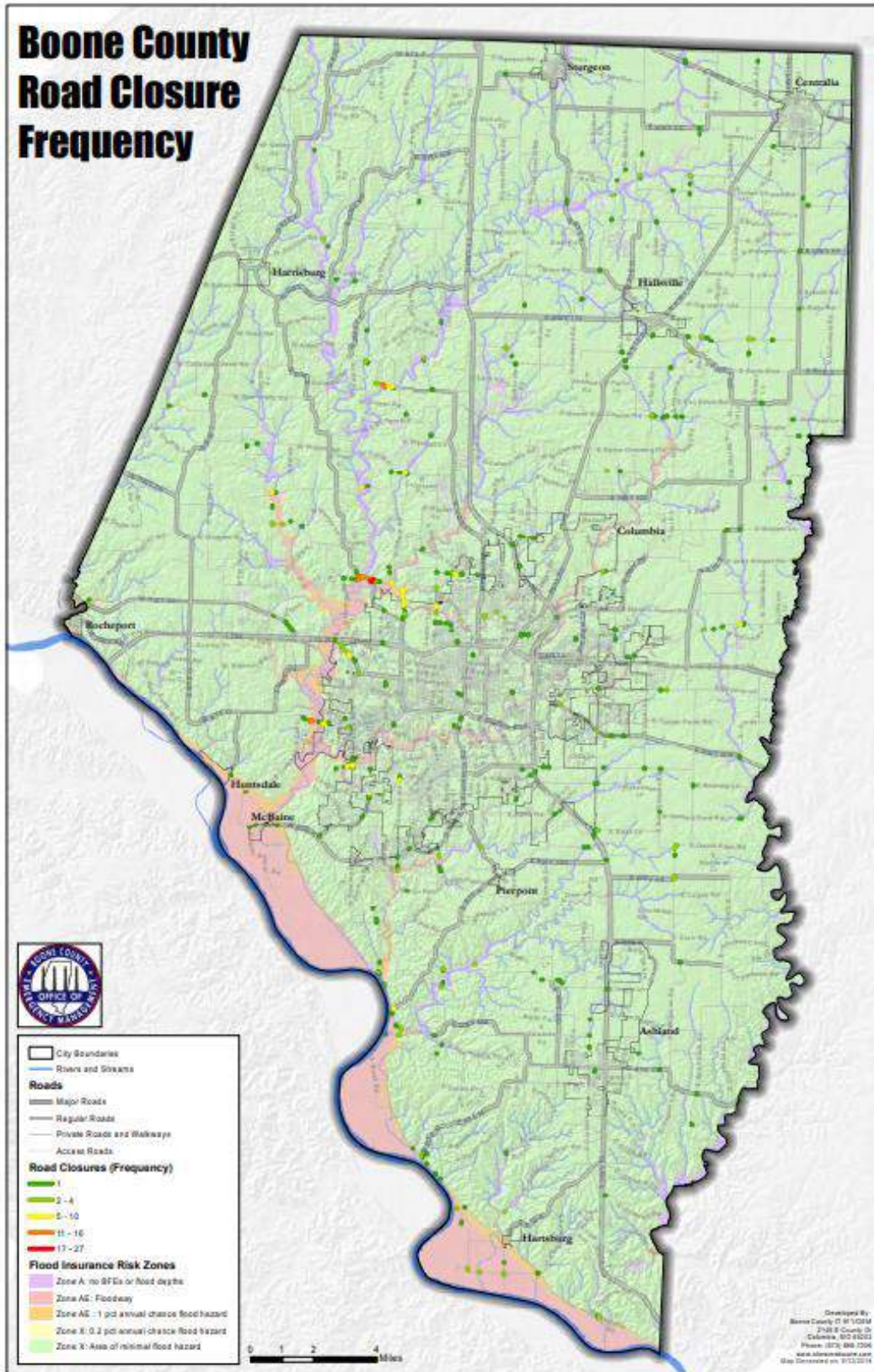
Table 3.15: Road Closure Locations

Key	Location
1	Stidham Rd south of Richardson Dr
2	Riley Rd at creek crossing
3	Old Number 7 at Silver Fork Creek
4	Peabody Rd at Slacks Branch Creek
5	Thornhill Rd east of Hussey Rd and west of bridge
6	ONeal Rd south of Wilcox Rd
7	ONeal Rd north of bridge
8	McComas Rd at creek crossing
9	W Wilcox Rd/N Rte E
10	Reams Rd north of Rob cook Rd at creek crossing
11	Owens School Rd east of Level Rd, west of Davenport Rd
12	Adams Rd south of Ball Rd
13	Farwest School Rd north of the bridge
14	Schunemeyer Rd south of Hwy 22 at the creek crossing
15	Schunemeyer Rd south of the county line
16	Blackfoot Rd at Bear Creek crossing within city limits
17	Gillespie Bridge Rd west of Perche Creek bridge
18	Brushwood Lake Rd near the bridge in city limits
19	Brown School Rd east of Clearview Rd at creek crossing
20	Old Mill Creek Rd near the creek
21	High Point Ln north of the bridge
22	Hill Creek Rd north of the bridge
23	Rangeline Rd at Bonne Femme Creek
24	Bass Ln east of Rolling Hills Rd
25	Gans Creek Rd south of the bridge
26	S Brushwood Lake Rd/Scott Blvd
27	E St Charles Rd/Doziers Station Rd
28	S Bush Landing Rd/E Hartsburg Bottom Rd
29	S Andrew Sapp Rd/S Harmon Rd
30	S Rangeline Rd/S Ben Williams Rd
31	N Creasy Springs Rd/W Obermiller Rd
32	E Hwy AB/S Rangeline Rd
33	E Mount Zion Church Rd/N Hague Rd
34	N Bell Rd/N Locust Church Rd
35	N Locust Grove Church Rd/W Hatton Chapel Rd
36	W Driskel Rd/N Rte E
37	E Friendship church Rd/N Sportsman Dr
38	E Hwy OO/N Hecht Rd
39	W Vawter School Rd/Scott Blvd
40	S Hwy 163/S Rock Quarry Rd
41	S Easley River Rd/S Rippetto Rd
42	W Nashville Church Rd/S Andrew Sapp Rd
43	W Rte M/S River Rd

44	W Gillespie Bridge Rd at Perche Creek
45	Creasy Springs Rd at Bear Creek
46	E Owens School Rd/N Davenport Rd
47	W Harold Cunningham Rd/S Rippetto Rd
48	N Strawn Rd/W 170 Dr SW
49	Northland Dr/Blue Ridge Rd
50	S River Rd/Conservation Rd
51	W Red Rock Rd at Perche Creek
52	W Gillespie Bridge Rd/S Coats Ln
53	E Grimes Rd/E Hartsburg Bottom Rd
54	Blue Ridge Rd at Bear Creek
55	E Ball Rd/N Adams Rd
56	E ORear Rd west of Hinkson Creek
57	E Claysville Rd/S Hartsburg Bottom Rd
58	E St Charles Rd east of N Rte Z
59	S Hart Creek Rd/S Jemerson Creek Rd
60	E Hwy WW at the north fork of Grindstone Creek
61	E Richland Rd/N Trade Winds Pkwy
62	N Strawn Rd at Harmony Creek
63	Hinkson Creek Rd/N Wyatt Ln
64	Northland Dr/Bear Creek
65	E Hwy WW at Grindstone Creek South Fork
66	W Wilcox Rd/N ONeal Rd
67	N Level Rd/E Owens School Rd
68	West Broadway St/Strawn Rd
69	N Barnes Rd at Silver Fork Creek
70	S Hill Creek Rd/W Buffalo Ridge Rd
71	W Stidham Rd/N Richardson Dr
72	E Rte Y at Cedar Creek
73	S Hwy KK at Mill Creek
74	Blackfoot Rd north of Cedar Cliff Dr
75	N Silver Fork Hill Rd/W Stone Dr
76	W Rocheport Gravel Rd/W Hwy 40
77	W Akeman Bridge Rd at Perche Creek
78	W Stone Dr/N Dripping Springs Rd
79	E Marshall Ln at county line
80	S Rippetto Rd/W Acton Rd
81	E Nashville Church Rd at Bonne Femme Creek
82	E Judy School Rd near Cedar Creek
83	W Stone Dr at Silver Fork Creek
84	W Akeman Bridge Rd at Slacks Branch Creek
85	S Easley River Rd at Missouri River
86	S Smith Hatcher Rd at Little Bonne Femme Creek
87	N Rte E at Perche Creek
88	W Brown School Rd/N Clearview Rd

89	W Gillespie Bridge Rd at Goodin Branch Creek
90	N Blackfoot Rd at Columbia limit
91	S Sinclair Rd at Mill Creek
92	N Re E between Perche Creek and Rocky Fork Creek
93	N ONeal Rd/W Roemer Rd
94	Blackfoot Td at Cow Branch Creek
95	E Hartsburg Bottom Rd at Hart Creek
96	S High Point Ln at Little Bonne Femme Creek

Figure 3.17: Road Closure Frequency



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 1996-2019 indicates an average duration of Missouri River flooding of over 13 days per event (Table 3.15).

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 (Table 3.15). 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.

Table 3.16		
Boone County Historic Data		
River and Small Stream Flood		
January 1 1996 - December 31, 2019		
Location	Date	Type of Flood
Southern Boone	1996: 5/1/96	Missouri River
Southern Boone	1998: 10/6/1998	Missouri River
Southern Boone	2001: 6/4/01	Missouri River
Southern Boone	2002: 5/8/02	Missouri River
Southern Boone	2007: 5/8/2007	Missouri River
Southern Boone	2010: 6/9/10	Missouri River
Central Boone	1997: 9/8/1997	Urban/Small Stream
Columbia	1998: 8/27/1998	Urban/Small Stream
Countywide	2001: 1/28/01 - 1/29/01	Urban/Small Stream
Countywide	2001: 6/6/2001	Urban/Small Stream
Countywide	2008: 9/13/2008	Urban/Small Stream
Central Boone	2015: 11/17/2015	Urban/Small Stream
Source: http://www.ncdc.noaa.gov/stormevents ; available data as of 12/31/2019		

Data from NOAA indicates 12 river or small stream floods in Boone County since the Missouri River flood of 1995 (Table 3.15). Six of these events were floods of the Missouri River. There have been 8 reported flash flood events since the last plan update (Table 3.16).

Table 3.17			
Boone County Historic Data			
Flash Flood			
January 1 1996 - December 31, 2019			
Location	Date	Location	Date
Eastern Boone	06/22/97	Countywide	09/12/08
Northern Boone	06/29/98	Countywide	09/13/08
Central Boone	07/04/98	Countywide	03/24/09
Countywide	10/05/98	Northern Boone	04/29/09
Northern Boone	06/12/99	Northern Boone	05/15/09
Southern Boone	05/27/00	Southern Boone	07/04/09
Central and Northern Boone	08/07/00	Countywide	10/08/09
Columbia	05/17/01	Countywide	10/22/2009
SW Columbia and North of McBaine	07/19/01	Columbia	4/23/2010
Countywide	05/07/02	Countywide	4/24/2010
Countywide	05/09/02	Columbia area	5/12/2010
Countywide	05/12/02	Columbia/Centralia	5/13/2010
Southern Boone	08/18/02	Countywide	7/7/2010
Columbia	08/20/02	Centralia	7/29/2010
Northern Boone	06/12/03	Columbia	8/20/2010
Northern Boone	06/25/03	Columbia area	5/25/2011
Countywide	03/26/04	Countywide	4/29/2012
Countywide	08/26/04	Midway/Columbia area	5/26/2013
Countywide	01/12/05	Easley	5/31/2013
Columbia	05/11/05	Southern Boone	4/3/2014
Columbia	08/26/05	Central Boone	9/1/2014
Columbia	09/19/05	Sturgeon	6/7/2015
Central Boone	06/11/06	Countywide	6/25/2015
Centralia	05/06/07	Countywide	7/1/2015
Columbia	05/06/07	Southern Boone	12/26/2015
Centralia	03/17/08	Central Boone	7/3/2016
Northern Boone	04/10/08	Southern Boone	8/1/2016
Central to Northern Boone	06/13/08	Centralia	8/2/2016
Central to Southern Boone	07/22/08	Northern Boone	4/29/2017
Northern Boone	07/25/08	Northern Boone	6/26/2018
Hallsville	07/27/08	Southern Boone	6/22/2019
		Countywide	8/12/2019

Source: <http://www.ncdc.noaa.gov/stormevents>; available data as of 12/31/19

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.

Flooded roadways caused minor injuries to two people who were trapped in their car November 11, 2015 after nearly 5 inches of rain fell over a two-day period.

Strength/Magnitude/Extent

According to the 2018 State Hazard Mitigation Plan, Missouri has a long history of flooding. Flooding along Missouri’s major rivers generally results in slow-moving disasters. Since river crest levels are forecast several days in advance communities in these active areas are given time to take protective measures against heightened water levels through means of evacuation and/or sandbagging efforts. Flash-flooding by contrast is a rapid rise of flood waters and has a history of causing a higher number of deaths and property damage.

National Flood Insurance Program (NFIP) Participation

Table 3.18: NFIP Participation in Boone County

Community ID #	Community Name	NFIP Participant (Y/N/Sanctioned)	Current Effective Map Date	Regular- Emergency Program Entry Date
290034B	Boone County	Yes	04/19/17	06/15/83
290752#	Ashland	Yes	03/17/11	08/24/84
290035#	Centralia	Yes	03/17/11	04/15/77
290036B	Columbia	Yes	04/19/17	08/27/71
290712B	Hallsville	Yes	04/19/17	01/01/06
290246#	Harrisburg	Yes	03/17/11	06/08/12
290037B	Hartsburg	Yes	04/17/17	08/16/82
290995B	Huntsdale	Yes	04/19/17	06/11/15
290038B	Rocheport	Yes	04/19/17	08/02/82
290039#	Sturgeon	Yes	03/17/11	05/01/87

Source: NFIP Community Status Book, 09/24/19; BureauNet, <http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book>; M= No elevation determined – all Zone A, C, and X; NSFHA = No Special Flood Hazard Area; E=Emergency Program

Table 3.19: NFIP Policy and Claim Statistics

Community Name	Policies in Force	Insurance in Force	Closed Losses	Total Payments
Uninc. Boone County	57	11,642,300		\$375,303
Centralia	2	420,000		
Columbia	156	38,706,500		\$2,250,809
Hartsburg	22	1,964,100		\$121,572
Rocheport	4	426,500		

Source: NFIP Community Status Book, [09/24/19]; BureauNet, <http://bsa.nfipstat.fema.gov/reports/reports.html>; *Closed Losses are those flood insurance claims that resulted in payment. Loss statistics as of 09/30/19.

Repetitive Loss/Severe Repetitive Loss Properties

Properties with at least two flood insurance payments of \$1,000 or more in a 10-year period are categorized as Repetitive Loss Properties. Properties that have repetitive loss fall within unincorporated Boone County, and the jurisdictions of Columbia and Hartsburg. They combine for a total of 58 losses. Due to federal restrictions on data sharing, the state was unable to provide full Repetitive Loss data or current Severe Repetitive Loss data. This also impacts information on Property Type and whether the properties are mitigated or non-mitigated.

Table 3.20: Repetitive Loss Payments

Jurisdiction	# of Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Average Payment	# of Losses
Uninc. Boone County	5	N/A	N/A	\$366,233	\$9,069	\$375,303	\$16,318	23
Columbia	5	N/A	N/A	\$1,432,160	\$818,648	\$2,250,809	\$83,363	27
Hartsburg	4	N/A	N/A	\$121,572	\$0	\$121,572	\$15,197	8
Total	14	N/A	N/A	\$1,919,966	\$827,718	\$2,747,684	\$47,374	58

Source: Flood Insurance Administration as of 09/30/19

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

Table 3.21: Boone County Severe Repetitive Loss Property

County	Community Name	Number of SRL Properties	Number of Paid NFIP Claims	Total Paid Losses	Average Payment
Boone	Boone County	1	10	\$219,131.36	\$21,913.14

Source: 2018 Missouri State Hazard Mitigation Plan

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.

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.

2019 saw near record flooding. Depths were reported within a couple feet of 1993 flood levels and on par with 1995 levels. Levees upstream and down-stream were breached. Those breaches outside of Boone County led to drops in depths that took pressure off multiple levees in Boone County.

Table 3.22: NCEI Boone County Flash Flood Events Summary 2000-2020

DATE	# of Events	# of Deaths	# of Injuries	Property Damage	Crop Damage
5/27/2000	1	0	0	0	0
8/7/2000	1	0	0	0	0
5/17/2001	1	0	0	0	0
7/19/2001	1	0	0	0	0
5/7/2002	1	0	0	0	0
5/9/2002	1	0	0	0	0
5/12/2002	1	0	0	0	0
8/18/2002	1	0	1	0	0
8/20/2002	1	0	0	0	0
6/12/2003	1	0	0	0	0
6/25/2003	1	0	0	0	0
3/26/2004	1	0	0	500000	0
8/26/2004	1	0	0	0	0
1/12/2005	1	0	0	0	0
5/11/2005	1	0	0	0	0
8/26/2005	1	0	0	0	0
9/19/2005	1	0	0	0	0
6/11/2006	1	0	0	0	0
5/6/2007	1	0	0	45000	0
5/6/2007	1	0	0	0	0
3/17/2008	1	0	0	0	0
4/10/2008	1	0	0	1000	0
6/13/2008	1	0	0	1000	0
7/22/2008	1	0	0	0	0
7/25/2008	1	0	0	0	0
7/27/2008	1	0	0	0	0
9/12/2008	1	0	0	0	0
9/13/2008	1	0	0	0	0
3/24/2009	1	0	0	0	0
4/29/2009	1	0	0	0	0
5/15/2009	1	0	0	0	0

7/4/2009	1	0	0	0	0
10/8/2009	1	0	0	0	0
10/22/2009	1	0	0	0	0
4/23/2010	1	0	0	0	0
4/24/2010	1	0	0	0	0
5/12/2010	1	0	0	0	0
5/13/2010	1	0	0	0	0
7/7/2010	1	0	0	0	0
7/29/2010	1	0	0	0	0
8/20/2010	1	0	0	0	0
5/25/2011	1	0	0	0	0
4/29/2012	1	0	0	0	0
5/26/2013	1	0	0	0	0
5/31/2013	1	0	0	0	0
4/3/2014	1	0	0	0	0
9/1/2014	1	0	0	0	0
6/7/2015	1	0	0	0	0
6/25/2015	1	0	0	0	0
7/1/2015	1	0	0	0	0
12/26/2015	1	0	0	0	0
7/3/2016	1	0	0	0	0
8/1/2016	1	0	0	0	0
8/2/2016	1	0	0	0	0
4/29/2017	1	0	0	0	0
6/26/2018	1	0	0	0	0
6/22/2019	1	0	0	0	0
8/11/2019	1	0	0	0	0
8/12/2019	1	0	0	0	0

Source: NCEI, 02/01/2000-02/29/2020

Table 3.23: NCEI Boon County Riverine Flood Events Summary 2000-2020

Date	# of Events	# of Deaths	# of Injuries	Property Damage	Crop Damage
1/28/2001	1	0	0	0	0
6/4/2001	1	0	0	0	0
6/6/2001	1	0	0	0	0
5/8/2002	1	0	0	0	0
5/8/2007	1	0	0	10000	25000
9/13/2008	1	1	0	0	0
6/9/2010	1	0	0	0	0
11/17/2015	1	0	2	0	0

Source: NCEI, 02/01/2000-02/29/2020

Probability of Future Events

Table: 3.24			
Probability of Future Flooding Events			
EF-Scale	# of years with flood event (2000-2019)	Probability	Probability Rating
Missouri River flood	6	30%	High
Urban/small stream flood	5	25%	High
Flash flood	59	100%	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, there is only a moderate probability of flooding in these three towns.

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

Changing Future Conditions Considerations

As precipitation is projected to increase, and in more extreme events, the risk of flooding could increase. This risk can be exacerbated by more and more construction that adds more impermeable surfaces that give large quantities of water nowhere to go.

Vulnerability

Vulnerability Overview

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

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. Flash flooding events happen at a high frequency and average 2.8 events a year. In a 20-year period there isn't a single year in which flash flooding hasn't happened.

Potential Impact – Life

All types of flooding present a threat to human life and livelihood. 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 Losses to Existing Development

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.

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. There are no critical building facilities in the floodplain for any jurisdictions, however Rocheport, Sturgeon, and Harrisburg have wastewater facilities that are at risk of overtopping if a historic level flood or flash flooding were to occur.

Potential Losses to Previous and 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.

Hazard Summary by Jurisdiction

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 have all helped to mitigate risk associated with riverine flooding in the planning area.

Boone 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.

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 with revisions in 2013. The manual includes the following specifications for road classifications and their respective levels of safety against flooding (Table 3.25).

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

Flash flooding is of particular concern in the City of Columbia; 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.

Rocheport

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.

Huntsdale

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

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.

Ashland, Centralia, Hallsville, Harrisburg, and Sturgeon are not impacted by major Missouri River flooding but do suffer flash flooding in extreme rain events where the rate of rainfall is excessive. This can lead to water backups onto roadways due to not enough runoff capacity. Such backups can put wastewater infrastructure at risk in Sturgeon and Harrisburg.

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.

While none of the school districts have any buildings located in floodplain their bus routes can be severely impacted by flooded and impassible roads during heavy rain events.

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. These factors, plus a high awareness of the threat of potential flooding, all act to help mitigate the vulnerability to this hazard.

Problem Statement

Flooding and flash flooding are frequent occurrences in the planning area that pose a threat to life, livelihood, property, and infrastructure. Risk to these things vary across the planning area with highest risk being to lands and jurisdictions along the Missouri River and creeks and streams that feed it. While all jurisdictions in the planning area are part of the NFIP, portions of Boone County, Columbia, Hartsburg, Huntsdale, and Rocheport have the most risk due to their proximity to the river and how much of their infrastructure is located in flood and flash flood prone areas. As a result of past events ordinances and guidance has been put in place by Boone County and the City of Columbia to help control development in hazard areas. Proper stormwater handling, warning systems, elevated low-water crossings, and river bank restoration are all actions to aid in reduction of flood damage in the planning area.

3.4.2 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.”

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.

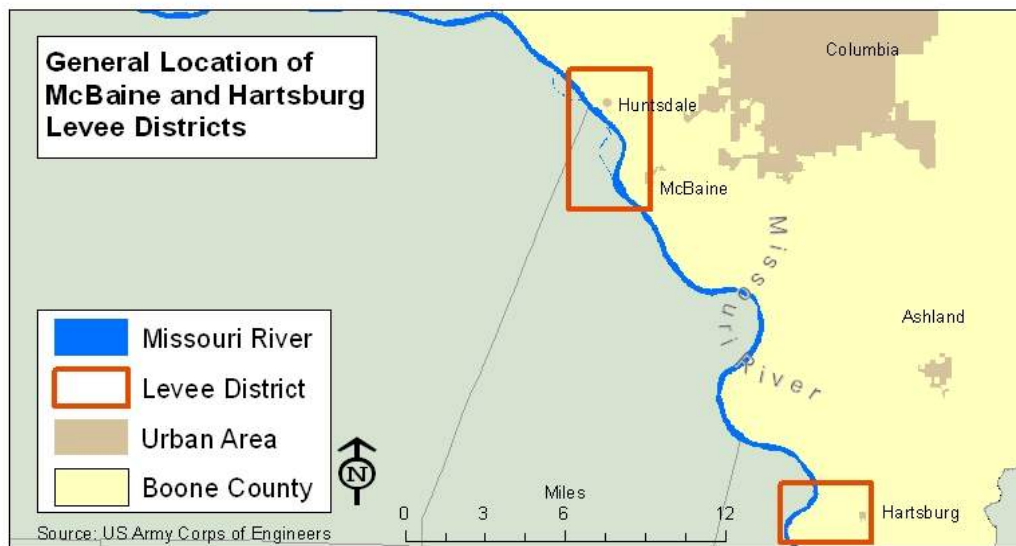
- **Structural Failures** - Lack of regular maintenance is a key reason levees fail.

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. They protect agricultural land, the communities of McBaine, Huntsdale, and Hartsburg, and a water treatment facility for the City of Columbia from Missouri River flooding.

Figure 3.18



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. 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 3.19 and 3.20.

MCBAINE LEVEE

Figure 3.19A



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

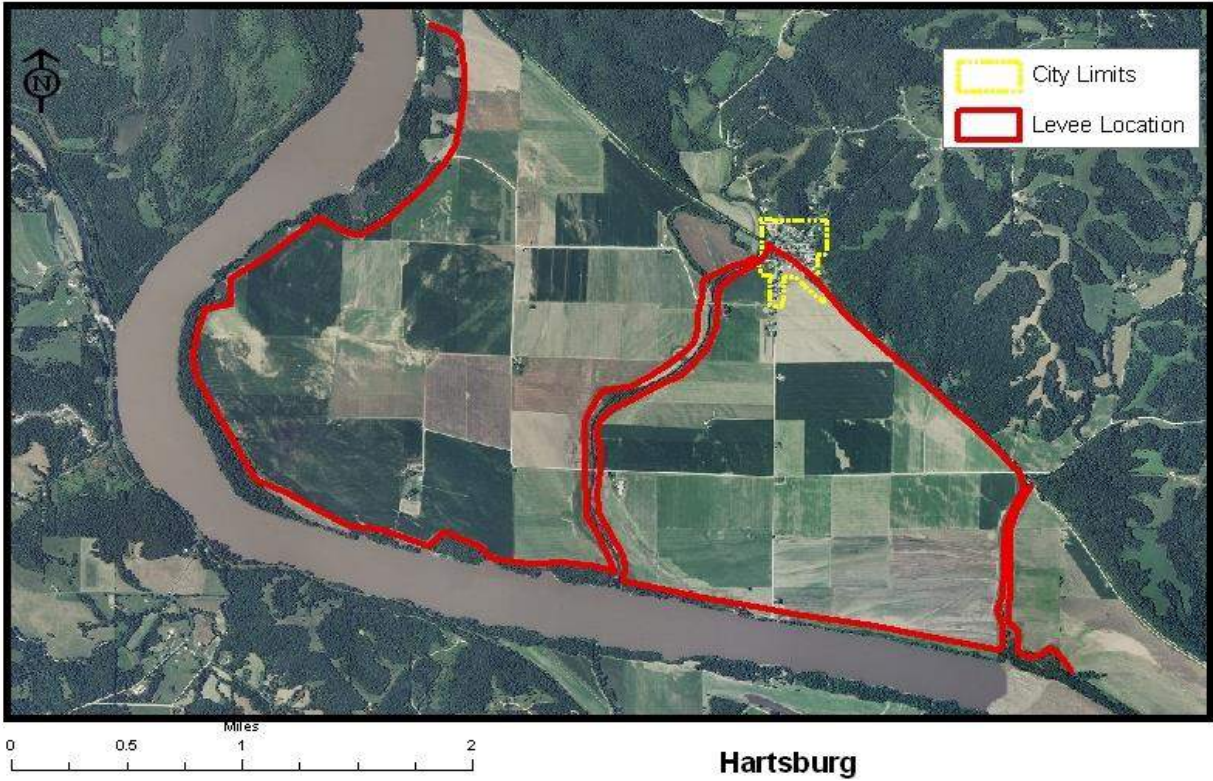
Figure 3.19B



Source: USACE

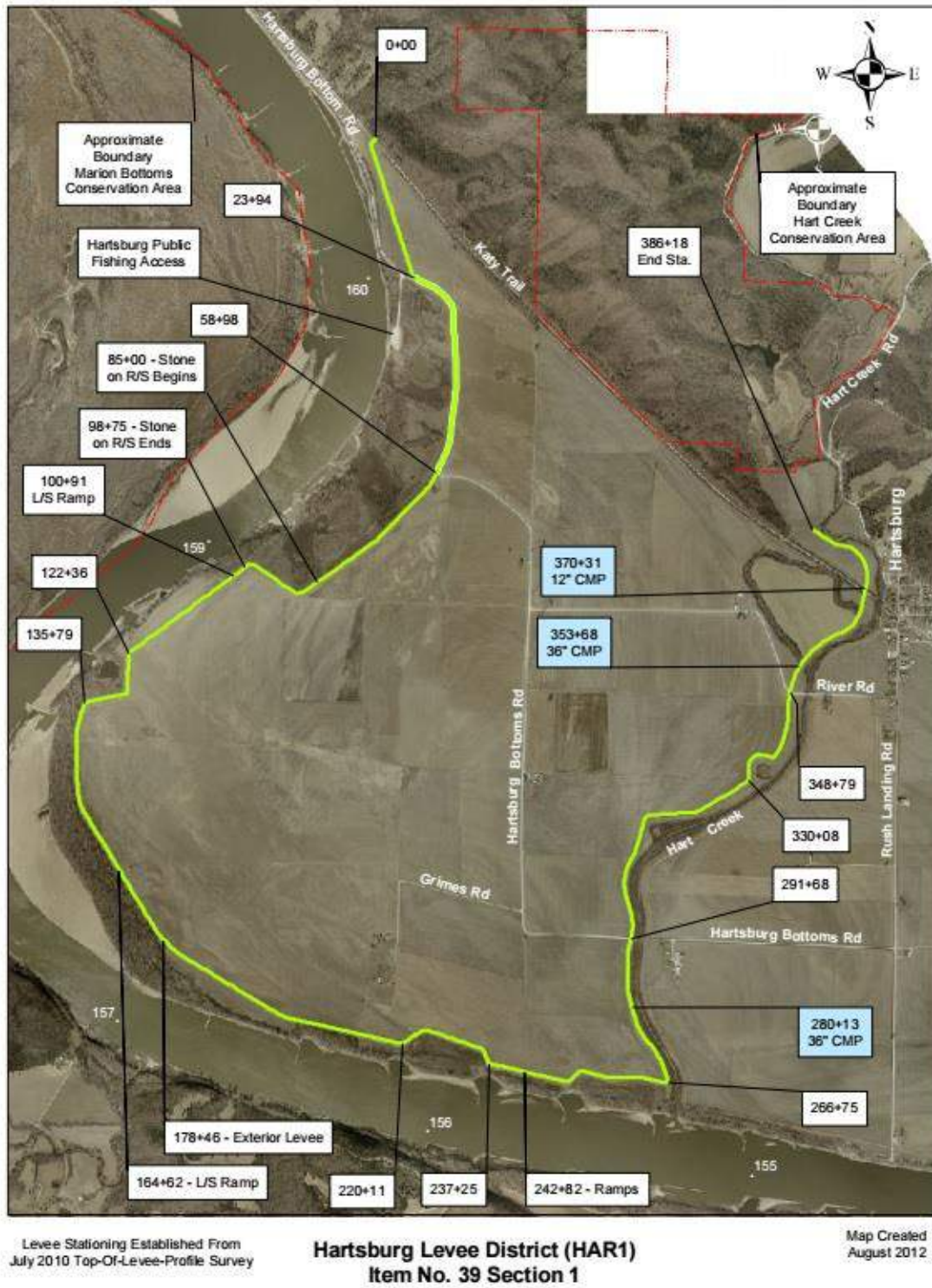
HARTSBURG LEVEES

Figure 3.20A



Source: Hartsburg Floodplain Administrator Mike Rodemeyer

Figure 3.20B



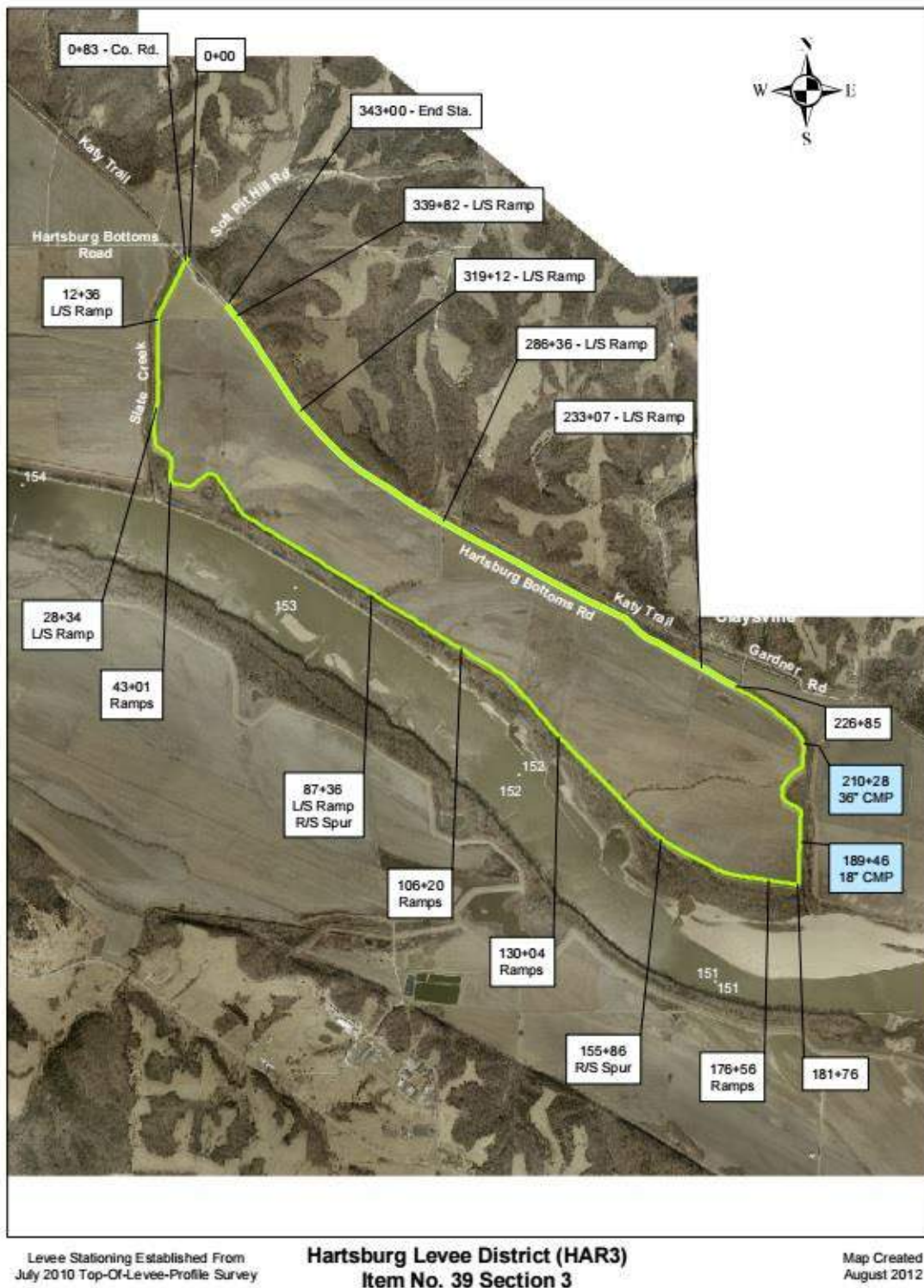
Source: USACE

Figure 3.20C



Source: USACE

Figure 3.20D



Source: USACE

In addition to receiving protection from the Hartsburg Levees, the Village of Hartsburg receives added 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/Magnitude/Severity

Levee failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. Levee failure often occurs during a flood event, causing destruction in addition to what would have been caused by flooding alone. A breach on an agricultural levee can not only cause immediate crop loss but sand and silt brought in from a levee break can impact the growing medium for years to come.

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.

In 2019 levees in Boone County were tested by nearing record level river levels that stayed high for a prolonged period of time. The extended time in which the levees were under pressure caused scouring in places but due to breaks in upstream levees the pressure was reduced to levees in the planning area before they broke.

Probability of Future Occurrence

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

There haven't been any levee breaches in the planning area in the last 20 years. With regular maintenance the probability of a levee break is low but with the high rate of flooding along the Missouri river the potential for a break is never zero.

Changing Future Conditions Considerations

As precipitation is projected to increase, and in more extreme events, the risk of flooding could increase. Prolonged elevated water levels can make maintenance and repairs difficult to accomplish only increasing the risk for a break through scouring and seepage.

VULNERABILITY

Vulnerability Overview

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. Hartsburg, Huntsdale and portions of unincorporated Boone are at risk in the event of a Levee failure, but because the Katy Trail acts as a form of backup levee extreme flood levels of a historic nature would be required to make a substantial impact. Most risk is to crops that are grown directly within the levee protection zone. Failure or overtopping of a levee can damage or kill crops being grown in the fertile lowland areas and also contaminate soil with sand and other things washed in from the Missouri River which can create significant long-term impacts for farmers.

Potential Losses to Existing Development

Structures and infrastructure near the levees are potentially vulnerable to damage from flooding due to failure; many of these structures are protected by levees and sandbagging at times of high river levels but there is the potential for levee failure to lead to sandbag failure. Failure of levees and sandbags leads to the risk of damage to roadways, drainage systems, and culverts.

Impacts to Previous and 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.

Hazard Summary

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.

Problem Statement

Levee failure is not a common occurrence in the planning area. The last instance of levee failure in the planning area was in 1993 when records were set across the state for flooding levels. Levee failure is usually a slow process that gives people time to evacuate areas at risk. Keeping up with maintenance and frequent inspections are actions of mitigation to help prevent such breakages that could lead to property damage and crop loss.

3.4.3 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;

Overtopping – inadequate spillway design, debris blockage of spillways, or settlement of the dam crest.

Piping, erosion, and structural 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 [Table 3.27](#).

Table 3.27				
Dam Hazard Classification Systems				
Federal (NID)		State (MoDNR)		
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, 5,113 dams in Missouri have been classified and only 685 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 126 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 3.17).

State Classification and Regulation of Dams in the planning area					
	State Hazard Classification				Total
	1	2	3	NA	
Regulated	4	10	3	0	17
Non-regulated	34	6	69	0	109
Total dams	47	7	72	0	126

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.

Geographic 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 3.21)
- State Regulated dams (Figures 3.22)
- Non-regulated dams (Figures 3.23)
- Non-regulated dams in the City of Columbia (Figure 3.24)

Figure 3.21

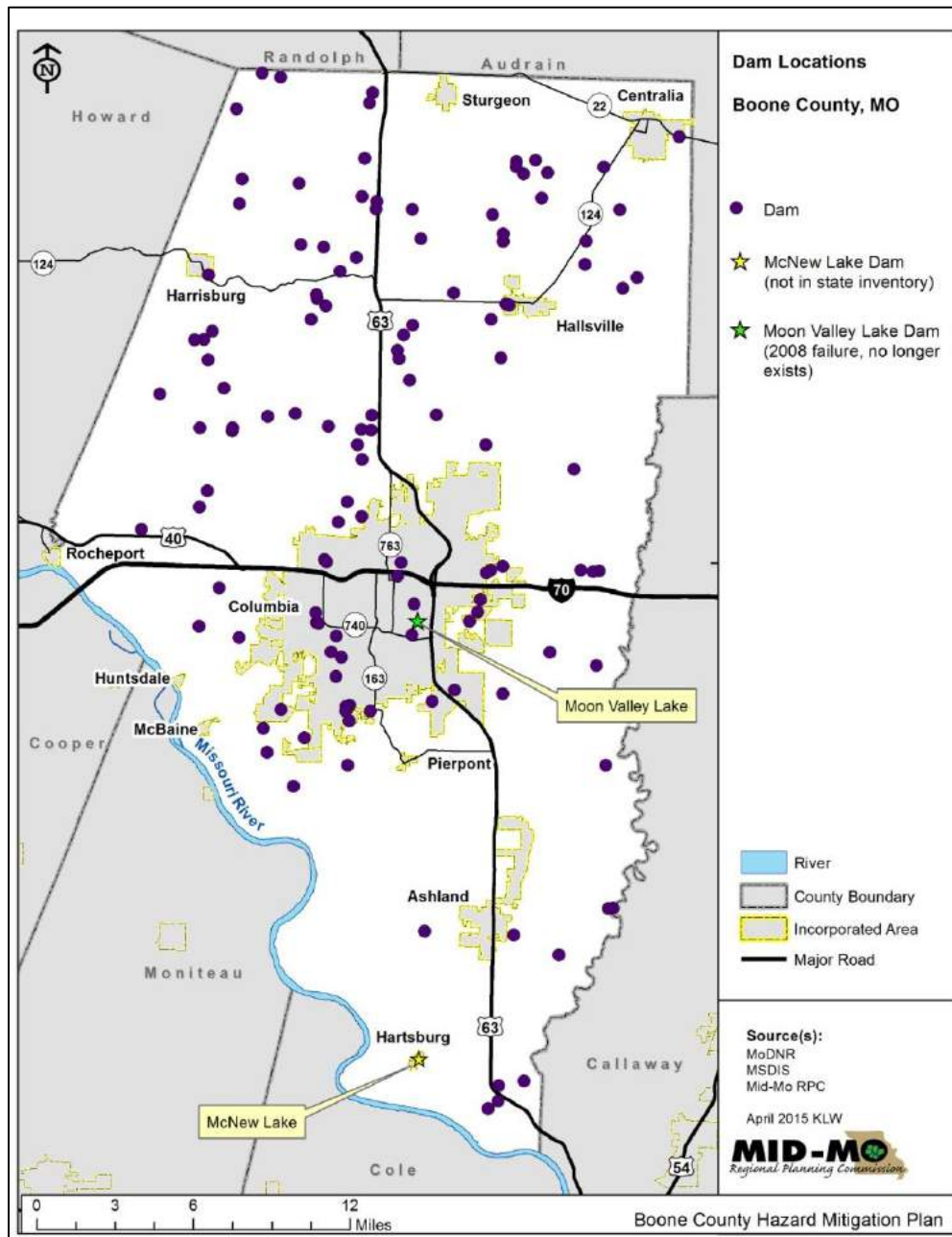


Figure 3.22

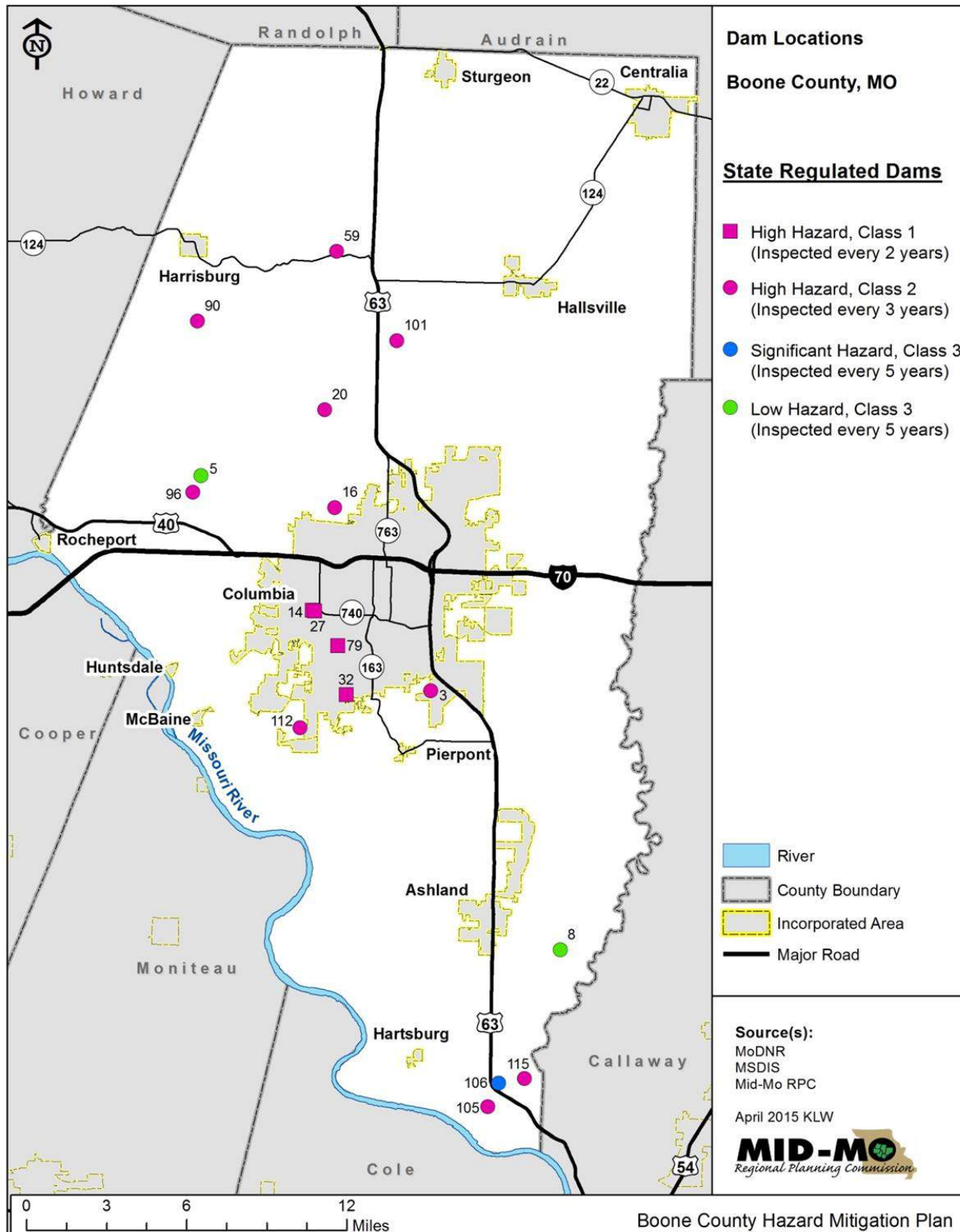


Figure 3.23

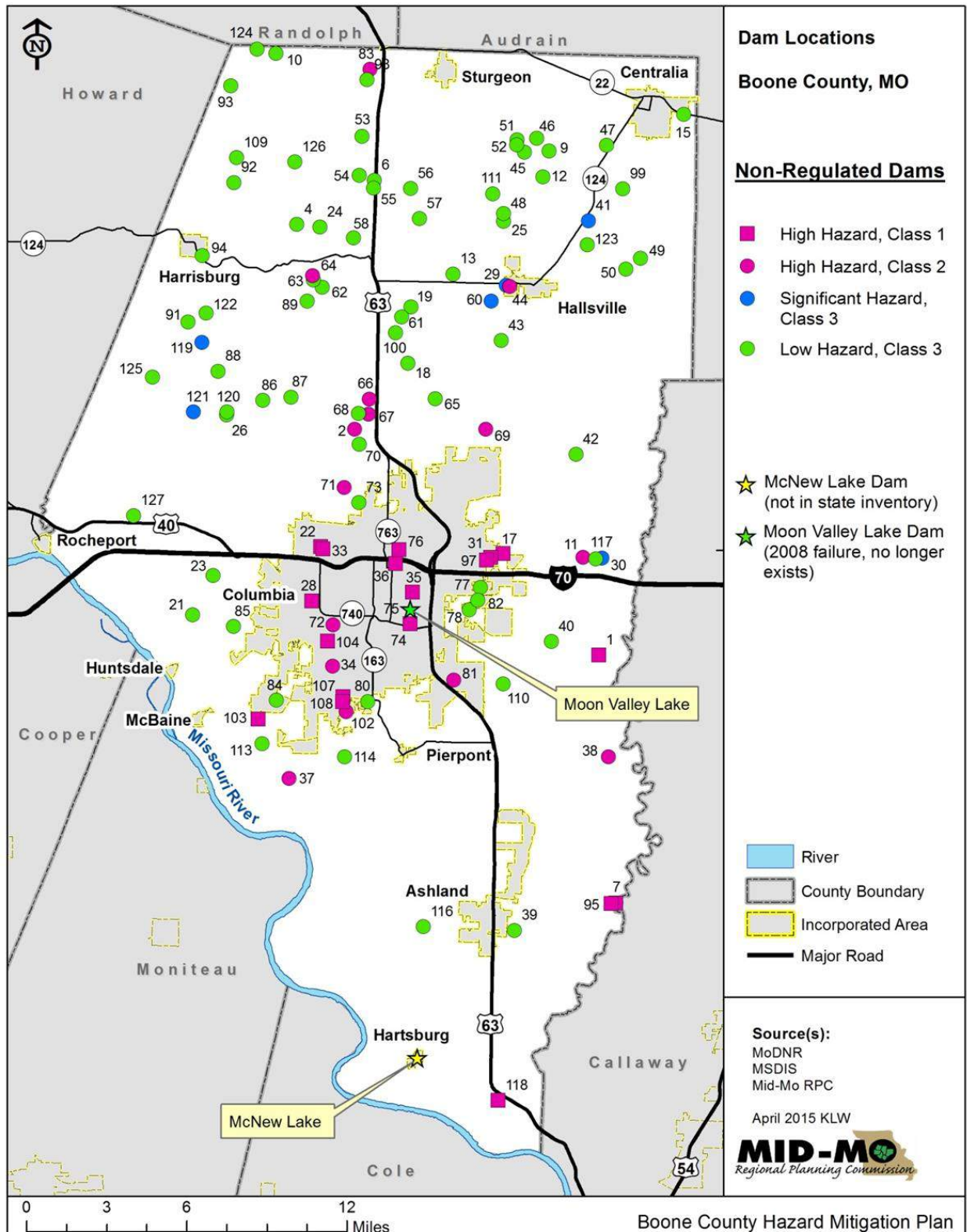


Figure 3.24

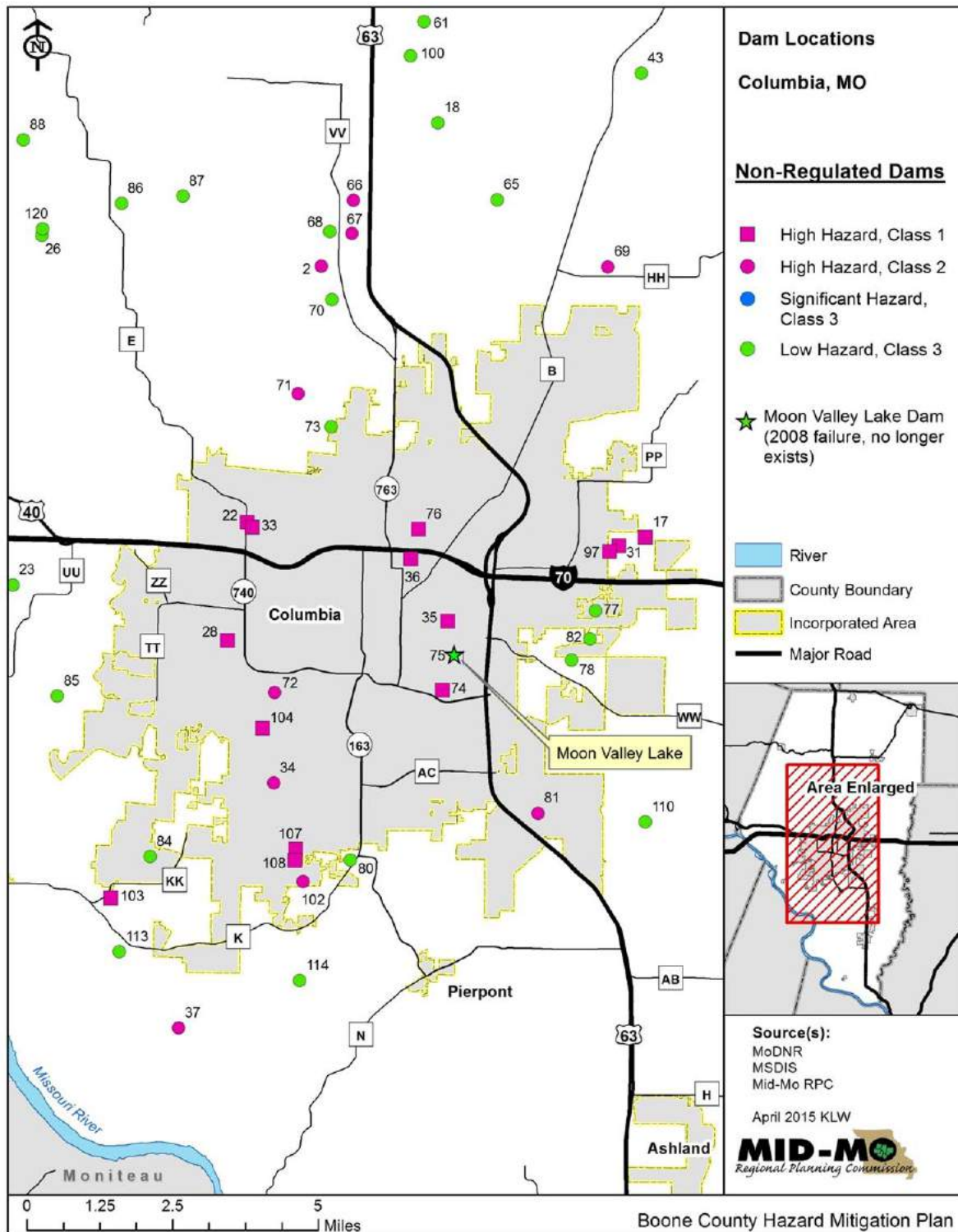


Table 3.29 Dam Summary

DAM NAME	RIVER	Nearest Downstream City	DISTANCE to Nearest City	Dam Owner	Dam Height	Normal Storage (Acre-ft)	Emergency Action Plan (EAP)	Last Inspection Date
LAKE CHATEAU DAM	TR-LITTLE CEDAR CREEK	COLUMBIA	9	LAKE CHATEAU INC	31	183	NR	5/31/1979
COUNTY DOWNES LAKE DAM	TR ROCKY FORK	MCBAINE	13	COUNTY DOWNS HOME.ASSOC.	30	275	NR	
PHILIPS PARK LAKE DAM	TR-CLEAR CREEK	COLUMBIA	5	THE CITY OF COLUMBIA	46	653	Y	4/26/2016
WINDMILLER DAM #1	TR-CEDAR CREEK	CEDAR CITY	20	ELIZABETH WINDMILLER	30	260	NR	5/31/1979
TURKEY FARM LAKE DAM	TR LITTLE CEDAR CREEK	JEFFERSON CITY	28	UNIVERSITY OF MISSOURI	20	78	NR	
HULEN LAKE WEST DAM	TR COUNTY HOUSE BRANCH	COLUMBIA	0	LAKESHORE ESTATES	50	255	Y	4/26/2016
ROEMER'S LAKE DAM	TR COW BRANCH	MCBAINE	10	ROEMER FAMILY LLC	37	277	Y	4/6/2016
WELCH LAKE DAM	HOMINY BRANCH	COLUMBIA	2	EDW,INC.	22	49	NR	3/10/1981
BOCO MO DAM	TR-SLACKS BR CR	COLUMBIA	8		39	759	Y	3/20/2018
COLUMBIA MUN GOLF COURSE LOWER L. DAM	TRIBUTARY TO HARMONY CREEK	MCBAINE	0	CITY OF COLUMBIA	15	9	NR	9/13/1978
HULEN LAKE EAST DAM	TR COUNTY HOUSE BRANCH	COLUMBIA	0	LAKESHORE ESTATES	50	171	Y	4/26/2016
FAIRVIEW LAKE DAM	TR-COUNTY HOUSE BRANCH	COLUMBIA	0	FAIRVIEW LAKE ASSOCIATIO	34	25	NR	4/13/1978
HAGAN LAKE DAM	HOMINY BRANCH	COLUMBIA	0	DAN HAGAN	19	66	NR	6/3/1980
CEDAR LAKE DAM	TR-LITTLE BONNE FEMME CREEK	EASLEY	0	CEDAR LAKE HOA	42	188	Y	7/5/2017
COLUMBIA MUM. GOLF COURSE DAM	TR-HARMONY CREEK	COLUMBIA	0	COLUMBIA PARK & REC DEPT	17	29	NR	9/13/1978
COUNTRY CLUB OF MO LAKE DAM	TR-MILL CREEK	COLUMBIA	0	COUNTRY CLUB OF MISSOURI	30	69	NR	
STEPHENS LAKE DAM	TR HINKSON CREEK	COLUMBIA	0	STEPHENS COLLEGE	23	63	NR	7/11/1980
MOORES LAKE DAM	TR-BEAR CREEK	COLUMBIA	0	CITY OF COLUMBIA	30	51	NR	7/11/1980
SMITH HATCHERY LAKE DAM	TR-MAYHAN BR	EASLEY	0	SMITH HATCHERY	25	40	NR	
GINN LAKE DAM	TR-CEDAR CREEK	JEFFERSON CITY	0	STANLEY GINN	30	80	NR	
COUNTRY BOY ESTATES LAKE DAM 2	TR-SILVER FORK	MCBAINE	0	COUNTRY BOY ESTATES HOA	37	32	Y	3/7/2017
LEWIS LAKE NORTH DAM	TR-REEDER CR	MCBAINE	0	MARY A LEWIS	25	100	NR	
WALNUT CREST LAKE DAM	TR-ROCKY FORK CR	MCBAINE	0	WALNUT CR/M P RINES	25	22	NR	

WEIL LAKE DAM	TR-ROCKY FORK CREEK	MCBAINE	14	GARY WEIL	25	25	NR	
SELTSAM LAKE DAM	TR-HINKSON CREEK	COLUMBIA	2	DARRELL SELTSAM	25	20	NR	
RAYFIELD LAKE DAM	TR-ROCKY FORK CREEK	MCBAINE	0	RAYMOND WIGGINS	25	20	NR	
MILLS LAKE DAM	TR-HINKSON CREEK	COLUMBIA	0	THOMAS L MILLS	30	22	NR	
LAKE CYRENE DAM	TR-HINKSON CREEK	COLUMBIA	0	LAKE CYRENE, INC.	25	50	NR	3/11/1981
MOON VALLEY LAKE DAM	HOMINY BRANCH	COLUMBIA	0	E.L. ROGERS	18	74	NR	3/11/1981
SHADY LAKE DAM	BEAR CREEK	COLUMBIA	0	DOROTHY M. CLARY	26	49	NR	6/2/1980
WOODRAIL LAKE DAM	HINKSON CREEK	HINKSON	7	KYLE E RUSSELL	54	324	Y	6/2/2016
UNIV OF MO-R1 DAM	TR GANS CREEK	WILTON	0	UNIVERSITY OF MISSOURI	18	60	NR	
TINCHER LAKE NORTH DAM	TR-LICK FORK	MCBAINE	0	HUGH TINCHER	25	35	NR	
CALLAHAN CREEK A-1	CALLAHAN CR	MCBAINE		CALLAHAN CR WTRSD SUBDST	35	77	Y	8/12/2015
WINDMILLER DAM #2	TR-CEDAR CREEK	CEDAR CITY	20	ELIZABETH WINDMILLER	20	67	NR	5/31/1979
CALLAHAN CREEK C-2	BARCLAY BR	MCBAINE		CALLAHAN CR WTRSD SUBDST	54	55	Y	5/7/2015
WATERS EDGE ESTATES LAKE DAM	HOMINY BRANCH	COLUMBIA	4	WATERS EDGE ESTATES INC.	25	122	NR	7/12/1980
FINGER LAKES DAM SOUTH	ROCKY FORK CK.	COLUMBIA	17	MO. DNR PARKS	44	398	Y	7/15/2014
HIGHLANDS LAKE DAM	ROCK CREEK	COLUMBIA	0	HIGHLAND PROPERTIES CO.	34	57	NR	7/16/1986
B & C SUBDIVISION DAM	PERCHE CREEK	MCBAINE	2	B & C SUBDIVISION CORP	34	431	NR	
LIMERICK LAKE DAM	TRIBUTARY HINKSON	COLUMBIA	6	LIMERICK HEIGHTS, INC.	31	21	NR	
CLAYSVILLE LAKE DAM	UNNAME TRIB TO MO.RIVER	CLAYSVILLE	1		42	273	Y	1/25/2018
HIGHLANDS LOWER LAKE DAM	TRIB TO CEDAR CREEK	COLUMBIA	7	INNOVATIVE MGT & INVESTM	30	40	NR	
HIGHLANDS SOUTH LAKE DAM	TRIB TI CEDAR CREEK	COLUMBIA	7	INNOVATIVE MGT & INVESTM	30	10	NR	
ARROWHEAD LAKE DAM		COLUMBIA	0	ARROWHEAD LAKE EST H/O	37	382	Y	4/6/2016
LAKE CHAMPETRA DAM	TR,TO CEDAR CREEK	CEDAR CITY	0	LAKE CHAMPETRA HOA	60	1530	Y	6/2/2016
DEMARCO LAKE DAM	TR-MISSOURI RIVER	CLAYSVILLE	2	GUY DEMARCO	31	26	NR	7/1/1980

Sources: Missouri Department of Natural Resources, <https://dnr.mo.gov/geology/wrc/dam-safety/damsinmissouri.htm> and National Inventory of Dams, http://nid.usace.army.mil/cm_apex/f?p=838:12. Contact the MoDNR Dam and Reservoir Safety Program at 800-361-4827 to request the inundation maps for your county to show geographic locations at risk, extent of failure and to perform GIS analysis of those assets at risk to dam failure.

Strength/Magnitude/Extent

The speed of onset of a dam failure can vary considerably. 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.

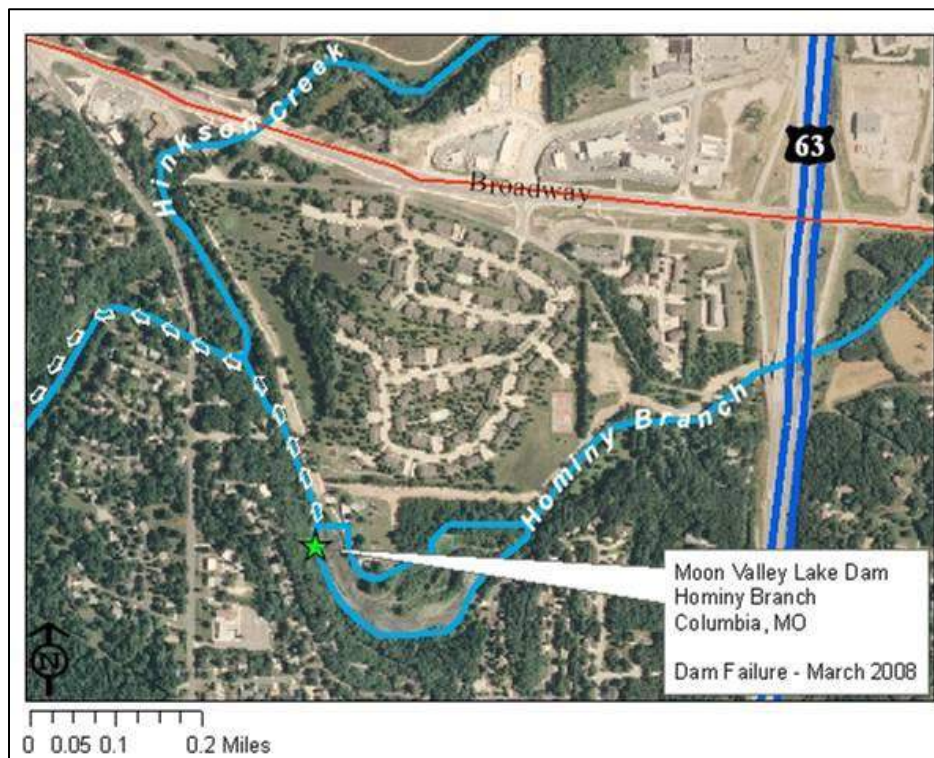
The extent of hazard which a dam failure poses is also influenced by the reservoir size.

Previous Occurrences

Boone County experienced its first widely known dam failure in March 2008 when Moon Valley Lake Dam in Columbia failed. 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. 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 3.25



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 5.5% ($1/18 \times 100$) 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

Changing Future Conditions considerations

The future of climate change on dam failure is largely tied to future precipitation events. Since precipitation is predicted to increase in the future with potential for more vigorous rainfall events, this creates an elevated risk of flooding and pressure on dams and spillways to handle the extra water amounts. This elevated pressure brings about the importance for regular inspections and maintenance, as well as the need for engineering with higher flood levels in mind.

VULNERABILITY

VULNERABILITY OVERVIEW

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)

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 3.26A-K). All figures were created using the same scale.

Table 3.30A		
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	Windmiller Dam #1	B
95	Windmiller Dam #2	B
79	Woodrail Lake Dam	I

Figure 3.26A

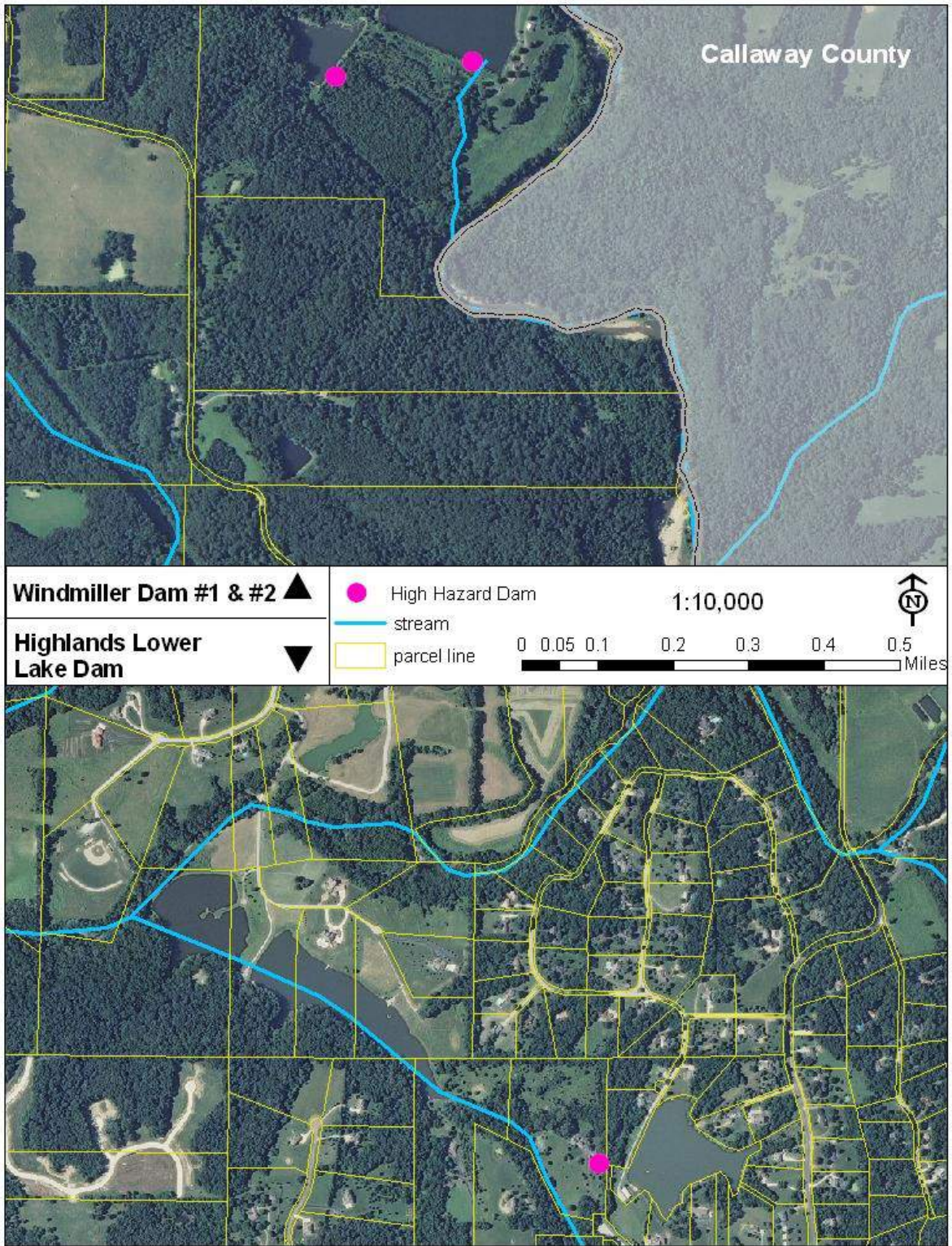


Figure 3.26B

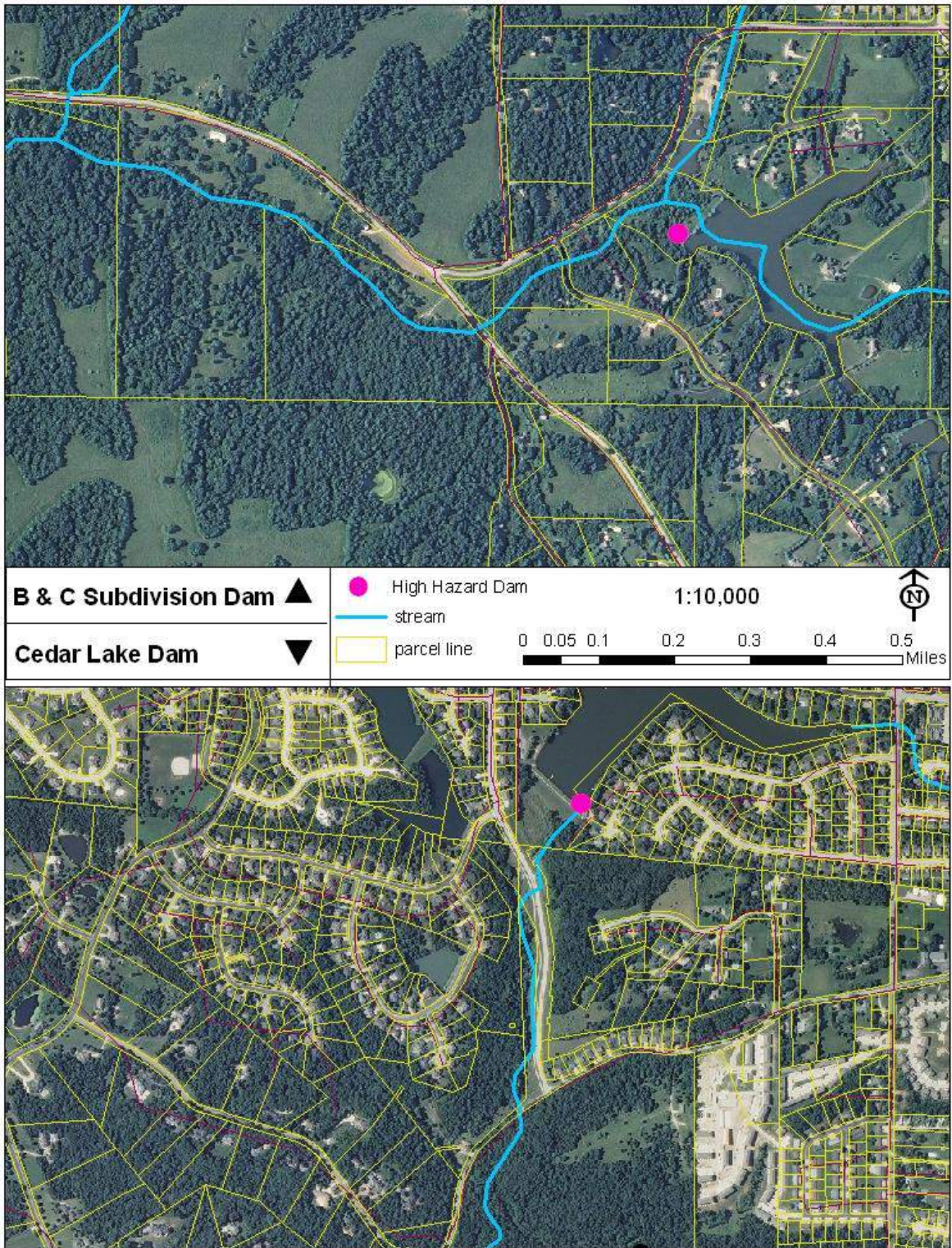


Figure 3.26C

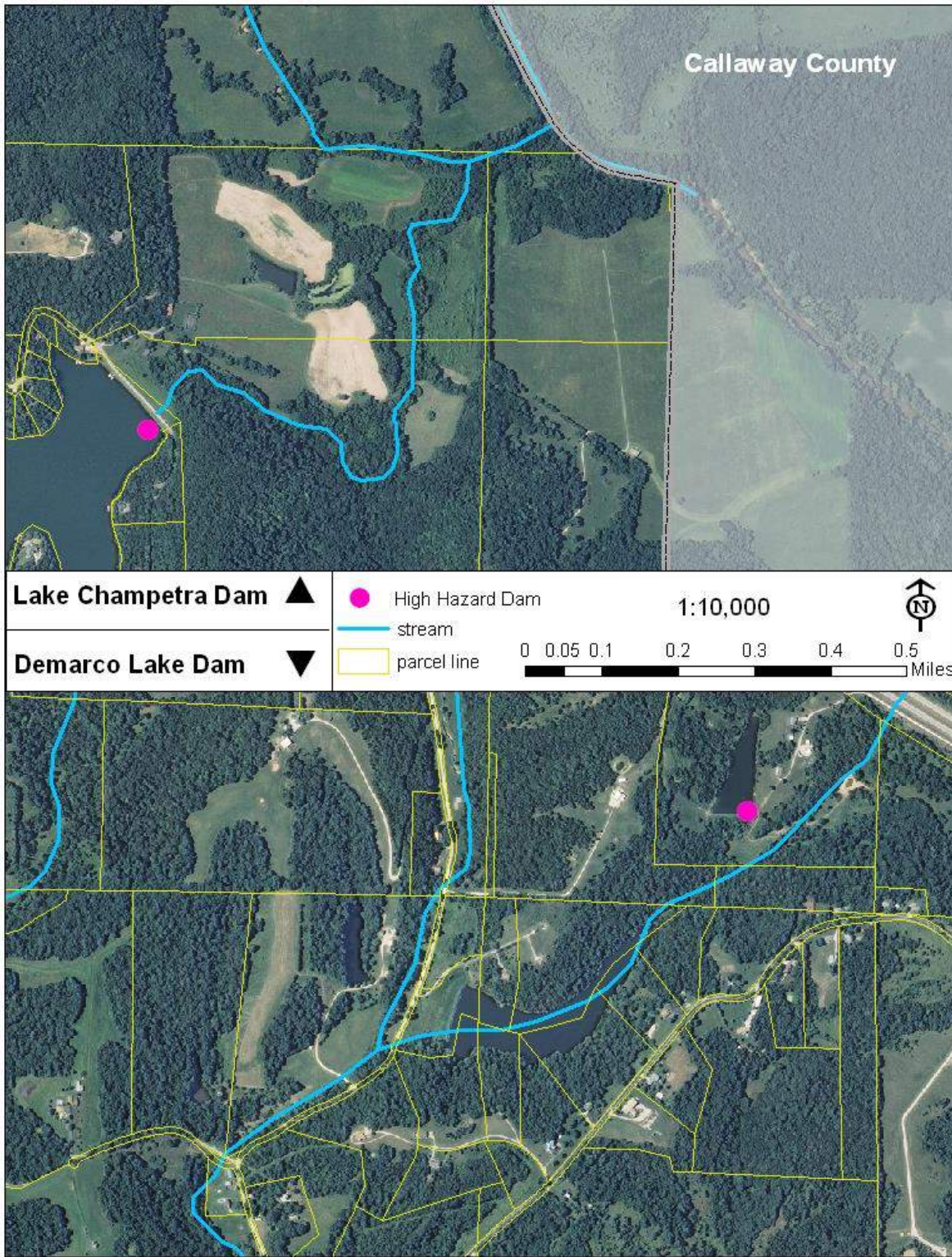


Figure 3.26D

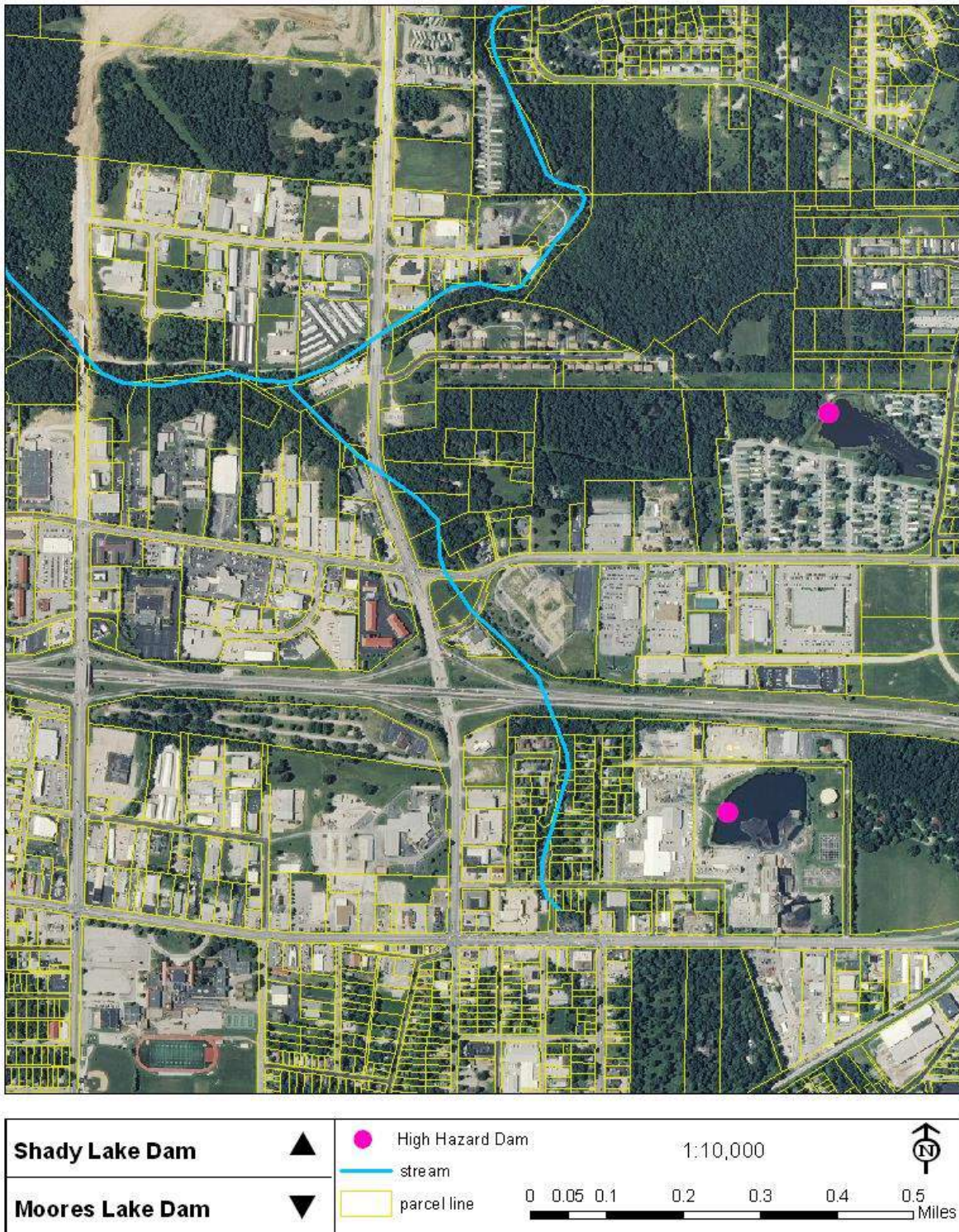


Figure 3.26E



Figure 3.26F

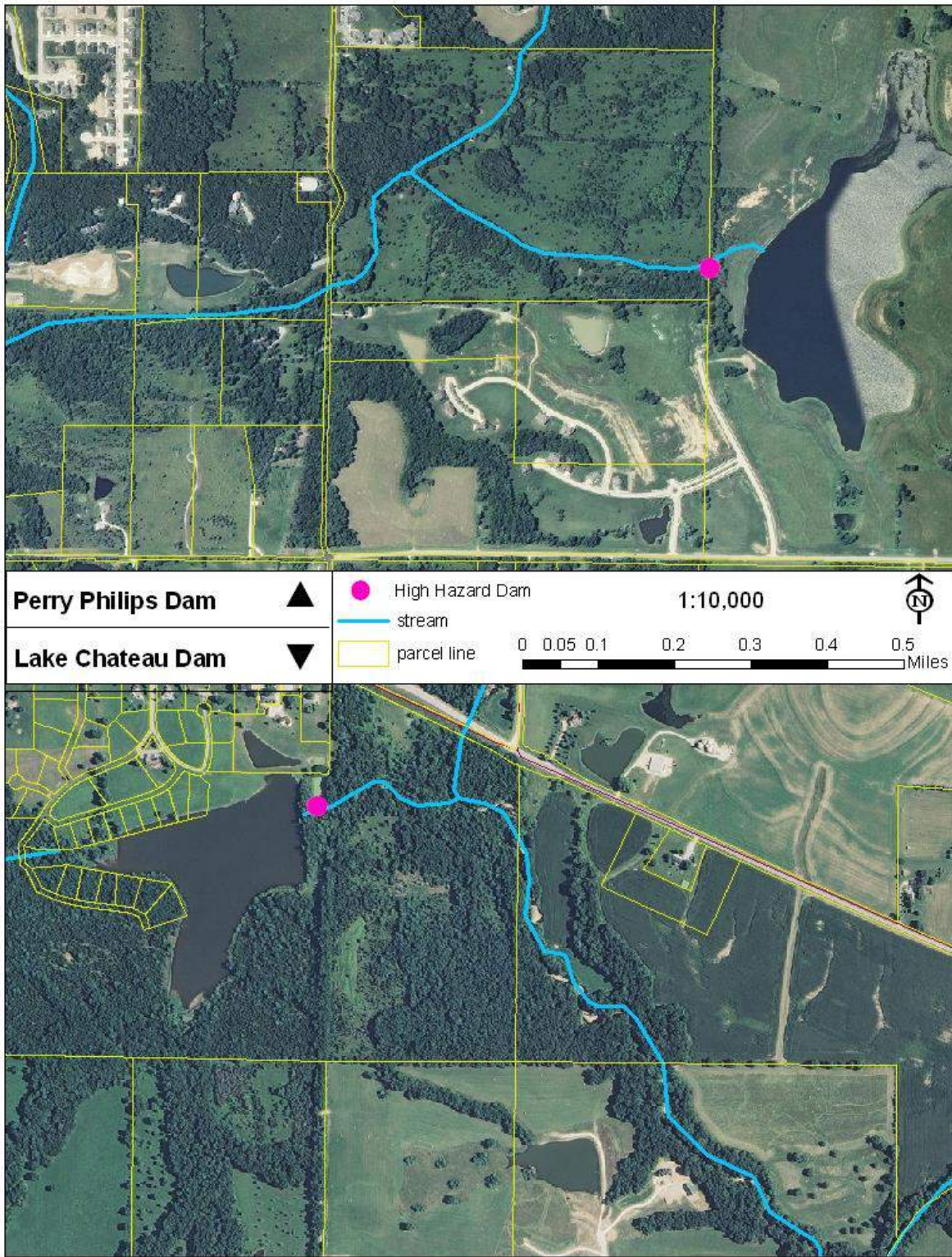


Figure 3.26G

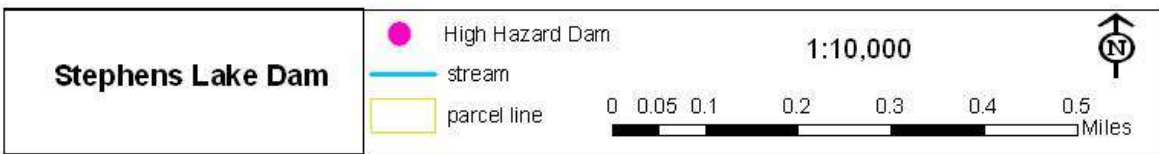
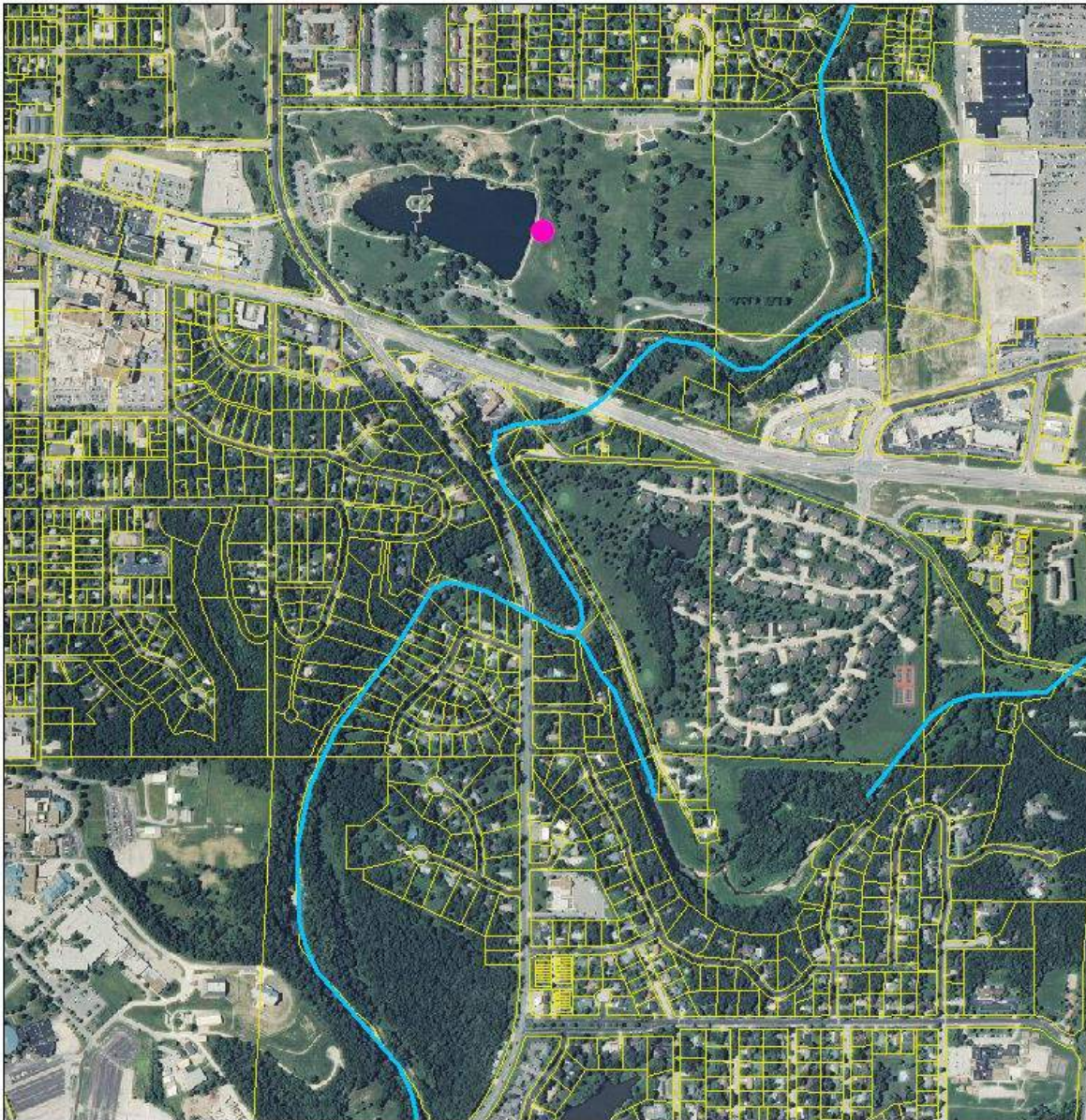


Figure 3.26H

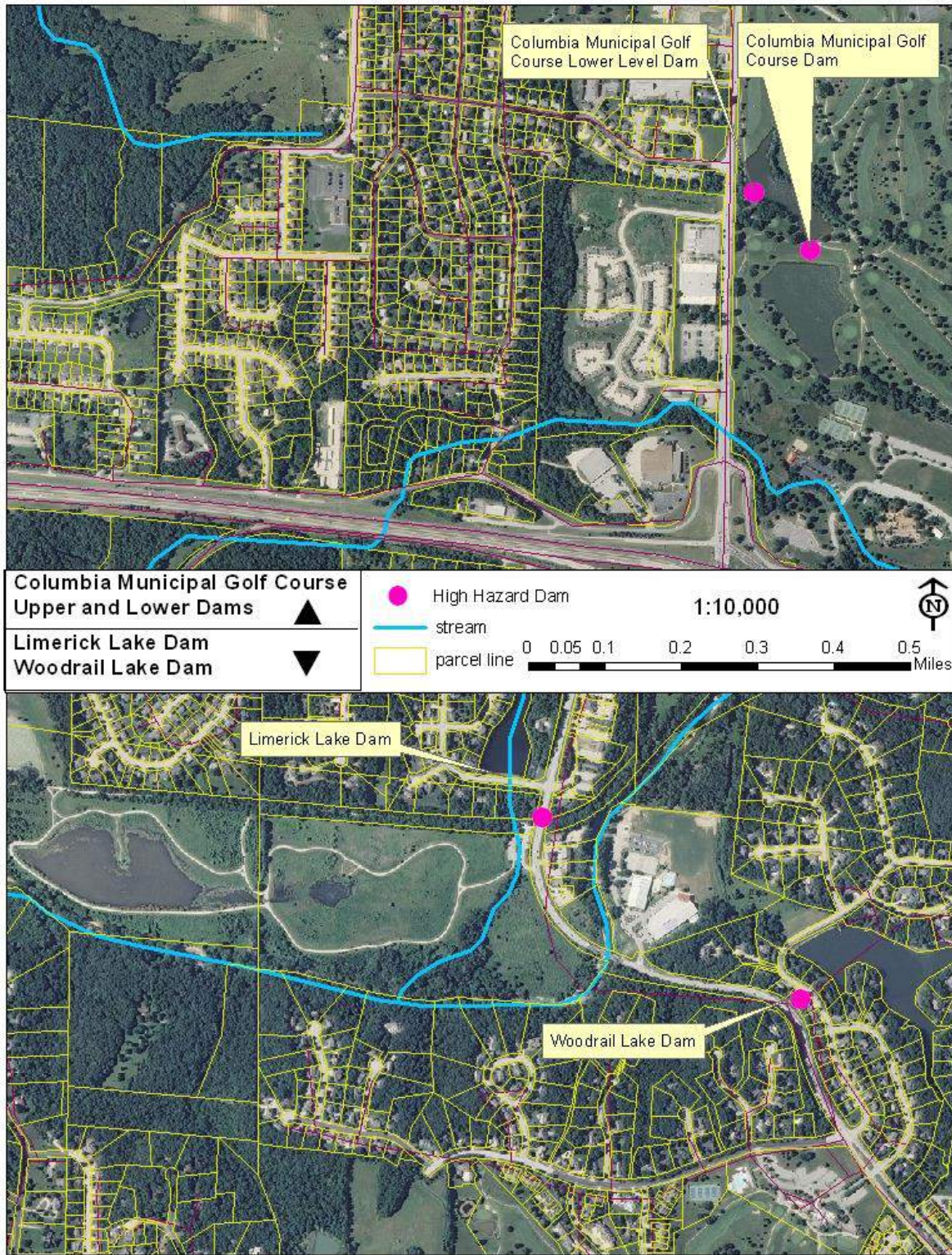


Figure 3.26I

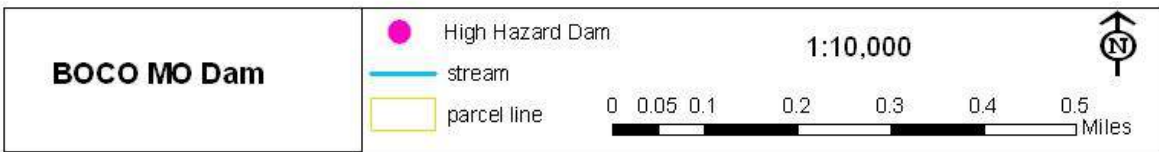
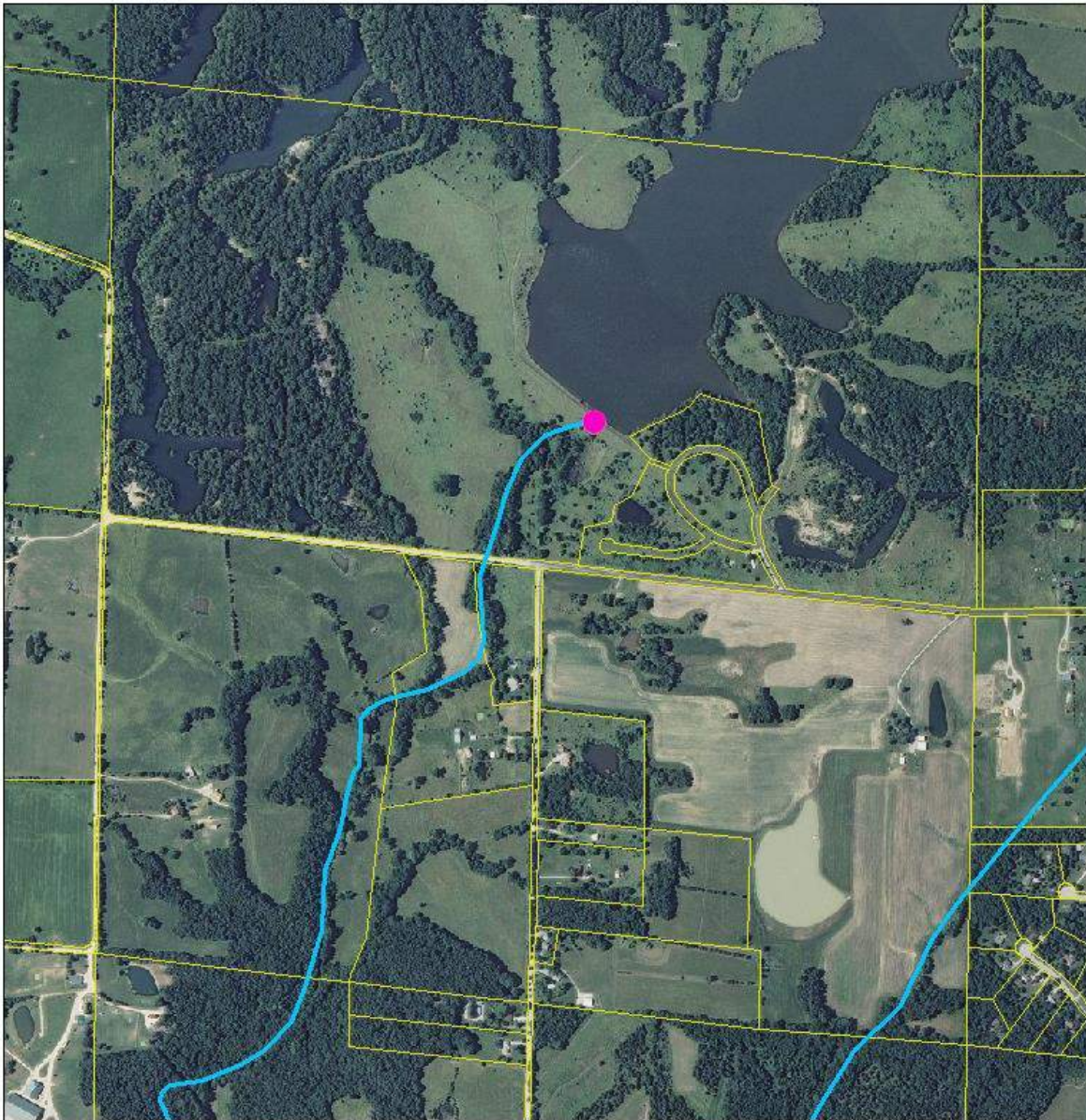


Figure 3.26J

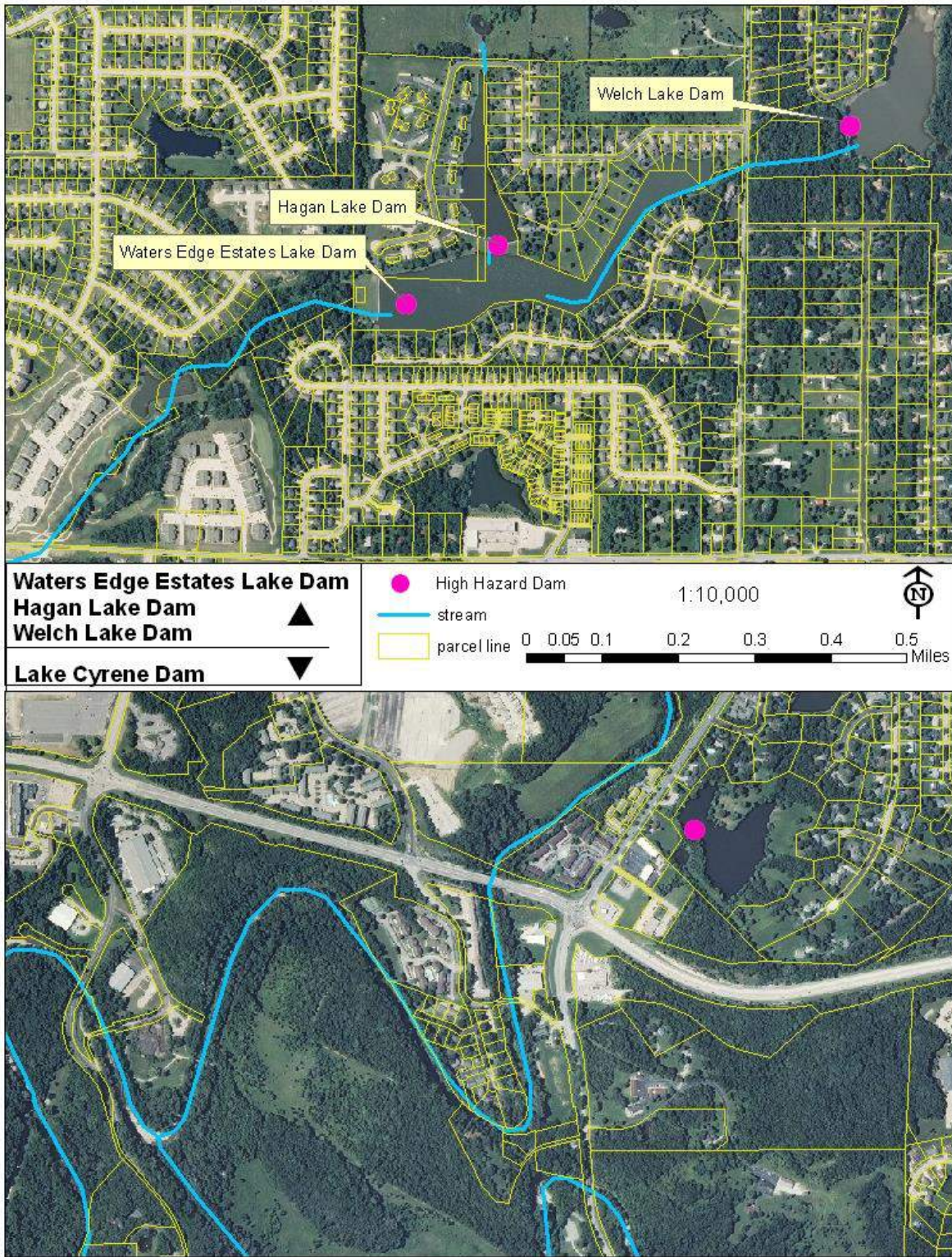
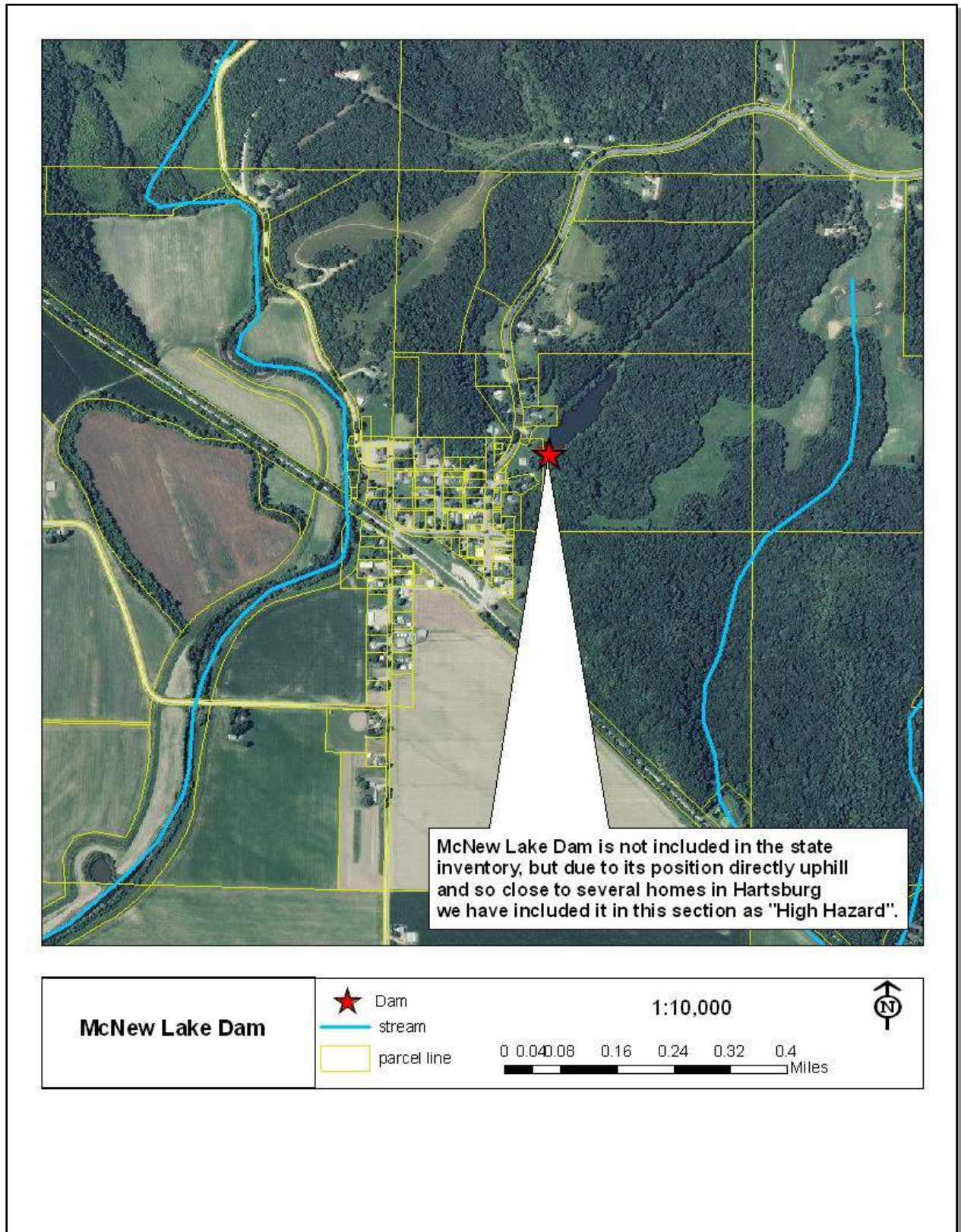


Figure 3.26K



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 this update EAPs have been written for all of the state regulated high hazard dams 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:

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.

HAZARD SUMMARY BY JURISDICTION

The jurisdictions of Boone County, Centralia, Columbia, Hallsville, and Hartsburg are all vulnerable to dam failure. There are 126 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 126 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). These plans are 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.

Problem Statement

Much like flash flooding, the risk in a dam failure to life and property comes from the sudden rush of water downstream. Development in the Columbia area and parts of Boone County pose the highest risk. Dams such as Hulen Lake Dam that have dense subdivisions built up around them threaten several structures and populations if a failure was to occur.

Many dams in the planning area are not regulated and inspections may be infrequent or not at all. Boone County already has regulations in place for new dams over 25 ft. There needs to be continued review of such regulations and making sure that businesses and residents downstream from such dams have access to any emergency plans that maybe available for the particular dam that could affect them. The requirement of inspections on dams with potential affected populations over a certain size could help insure the safety of those downstream.

3.4.4 EARTHQUAKE

Hazard Profile

Hazard Description

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.

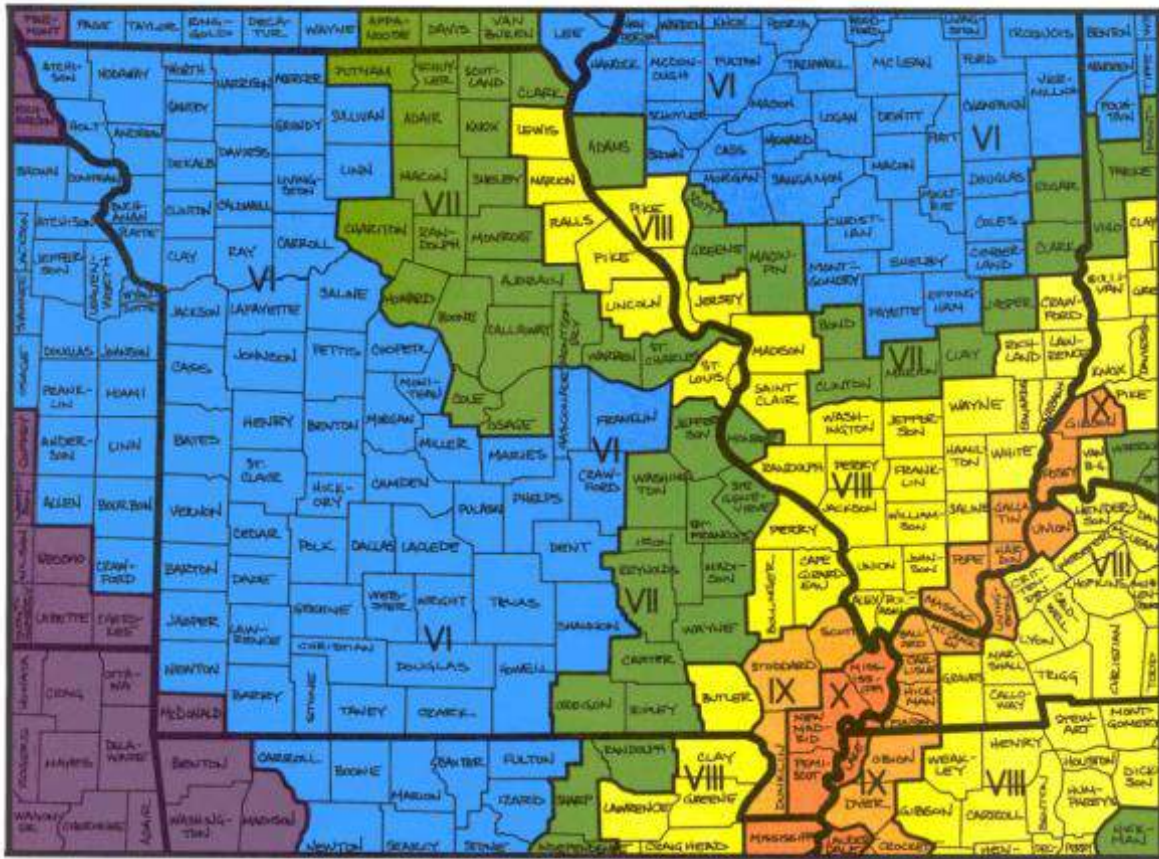
The New Madrid Seismic Zone (NMSZ), which runs through southeastern Missouri, is the most active seismic zone east of the Rocky Mountains. Any hazard mitigation planning in Missouri must, of necessity, take possible earthquakes into account.

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.

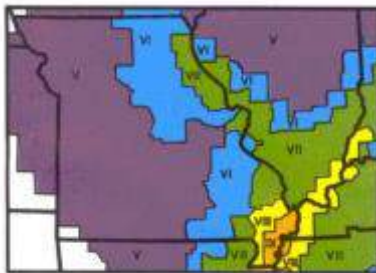
Geographic Location

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. While the Nemaha Ridge runs through Kansas and Oklahoma seismic activity along this ridge does not overly impact the planning area.

Figure 3.27: Seismic Zones

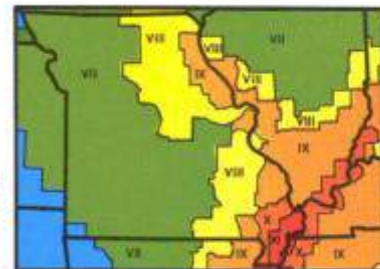


This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude - 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.



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

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



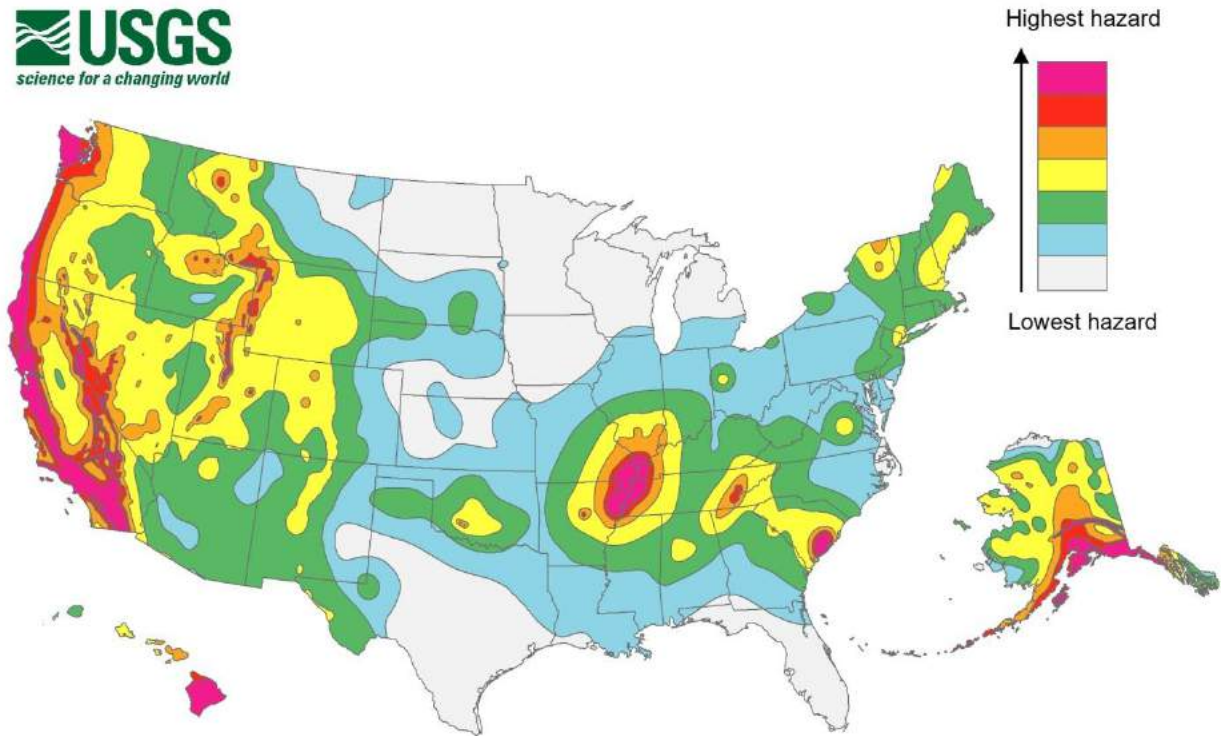
Source: https://sema.dps.mo.gov/docs/EQ_Map.pdf

Figure 3.28: Projected Earthquake Intensities

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	

The below map shows the seismic hazards across the United States. The planning area located in the center of the United States is included in zone VII, which is displayed in green.

Figure 3.29: United States Seismic Hazard Map



Source: United States Geological Survey at https://earthquake.usgs.gov/hazards/hazmaps/conterminous/2014/images/HazardMap2014_1g.jpg

Strength/Magnitude/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.

While there have been no large-scale earthquakes felt in the planning area in more than 200 years there are a multitude of shocks undetectable by anything other than special equipment that emanate from the New Madrid region many times throughout the year, but they are so minor they cannot be felt in the planning 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 209 years in which such earthquakes have occurred. This equals less than 1% probability in any given year ($\text{Probability} = \frac{2}{209} * 100 = 0.95\%$). 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.

Vulnerability

Vulnerability Overview

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 3.23).

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.

The pertinent information for Boone County is summarized in Table 3.31.

Projected Earthquake Hazard for Boone County			
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;

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 (2018)* 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).

Table 3.32 Hazus-MH Earthquake Loss Estimate: Annualized Loss Scenario

County	Total Losses, in \$ Thousands	Loss Per Capita, in \$ Thousands	Loss Ratio, in \$ Per Million
Boone	\$552	\$0.0034	\$30

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.

Table 3.33 HAZUS-MH Earthquake Loss Estimation 2% Probability of Exceedance in 50 Years Scenario Direct Economic Losses

County	Cost Structural Damage	Cost Non-Structural Damage	Cost Content Damage	Inventory Loss	Loss Ratio	Relocation Loss	Capital Related Loss	Wage Losses	Rental Income Loss	Total Loss
Boone	\$47,799	\$129,199	\$44,304	\$679	0.96	\$29,990	\$11,430	\$15,490	\$14,373	\$293,265

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

The potential for loss of life goes up as the magnitude of the earthquake goes up. Areas with a high rate of older or historical structures with construction methods not designed to withstand such an event pose a higher risk for loss of lives that work or live within such buildings.

The potential for “emotional aftershocks” 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.

Hazard Summary by Jurisdiction

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.

Harrisburg and Sturgeon have a number of older structures that could be vulnerable to collapse in the event of strong earthquakes. Hartsburg, Huntsdale, and Rocheport have less dense populations but many of their structures are older making them more likely to be vulnerable to collapse in a strong earthquake. Their proximity to the Missouri River though could also make these communities more vulnerable to the effects of potential liquefaction that can occur in some soil structures as a result of strong tremors.

Columbia has a large quantity of historical buildings and multi-story buildings that could be vulnerable to larger magnitude earthquakes. Infrastructure damage to roads would cause transportation backups that could impact much farther from the planning area.

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.

PROBLEM STATEMENT

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. Encouraging new construction buildings and infrastructure to be rated for earthquakes and taking on hardening efforts on existing structures can help minimize damage.

3.4.5 LAND SUBSIDENCE/SINKHOLES

HAZARD PROFILE

HAZARD DESCRIPTION

“Land subsidence is a geological hazard caused by the sinking of the earth’s surface due to the movement of earth materials below the surface. This sinking can be sudden or gradual and is generally attributed to the removal of subsurface water or the draining of organic soils. In Missouri, subsidence is primarily associated with sinkholes but they can also occur from void space left by mining and natural caves.” (*MO State Hazard Mitigation Plan, 2018*)

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).

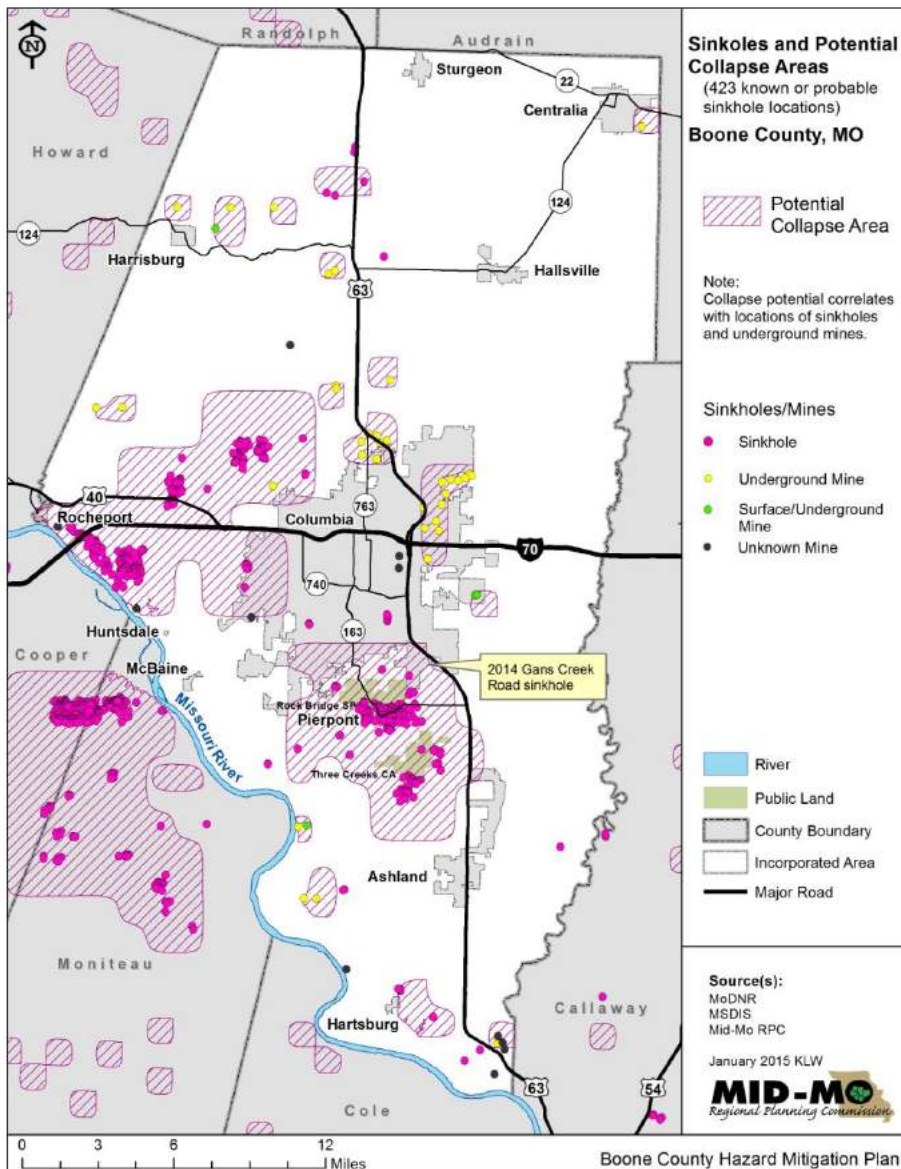
In addition to being at risk for land subsidence and sinkhole collapse associated with karst topography, the planning area is at risk from land subsidence/collapse associated with underground mining and exploratory drilling for petroleum.

Location

There are 397 known sinkholes in the planning area. The karst areas of the Ozark Highlands in the western and southern sections of the planning area are where the majority of sinkholes are located (Figure 3.31). 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.

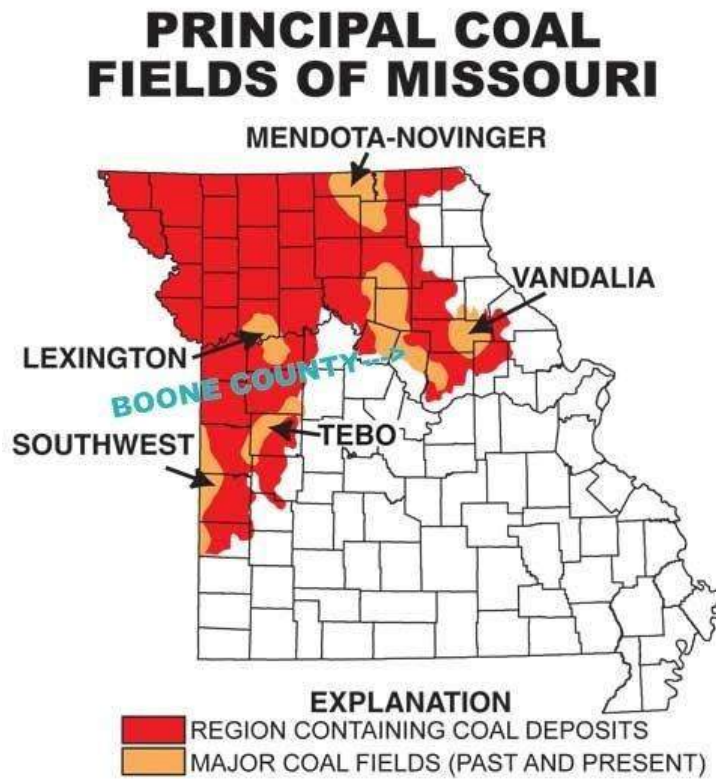
The MO DNR has mapped potential collapse areas around the known sinkholes and underground mines (Figure 3.31). These may not be the only potential sinkhole collapse areas however; further development may bring to light previously unknown sinkhole areas in the karst regions and also more abandoned underground mines.

Figure 3.31



The potential for collapse from underground mining is primarily in the northern part of Boone County and associated with coal fields (Figure 3.27). 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. There are 200 known mining locations in the planning area.

Figure 3.32



Source: MO DNR

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 3.31). 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 and a few underground lead mines in the southern part of Boone County.

Strength/Magnitude/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 15,981 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 sinkhole collapse in the planning area did impact the built environment. On May 12, 2014, a sinkhole collapsed a roadway in southern Columbia. 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 Occurrences

High – Boone County, Columbia

Low – Ashland, Centralia, Hartsburg, Rocheport

Not applicable - All other participating jurisdictions

In the last 20 years there has been one major sinkhole collapse that impacted the planning area. ($1/20 * 100 = 5\%$) If all sinkhole collapses were documented a much higher rate of collapse would be reflected, but many collapses are either minor and go unnoticed or are in areas that are unpopulated and impact little. 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.

CHANGING FUTURE CONDITIONS CONSIDERATIONS

With expected rainfall events to happen more frequently and with higher intensity with climate change, instances of sinkhole collapse could go up in the planning area due to erosion from flooding and severe runoff exposing depressions below. Periods of rain followed by drought also elevate potential for sinkholes to open up with the fluctuating water table.

VULNERABILITY

VULNERABILITY OVERVIEW

Severity: Low to High

The planning area has 397 known sinkholes and 200 known mines dispersed across many jurisdictions. 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.

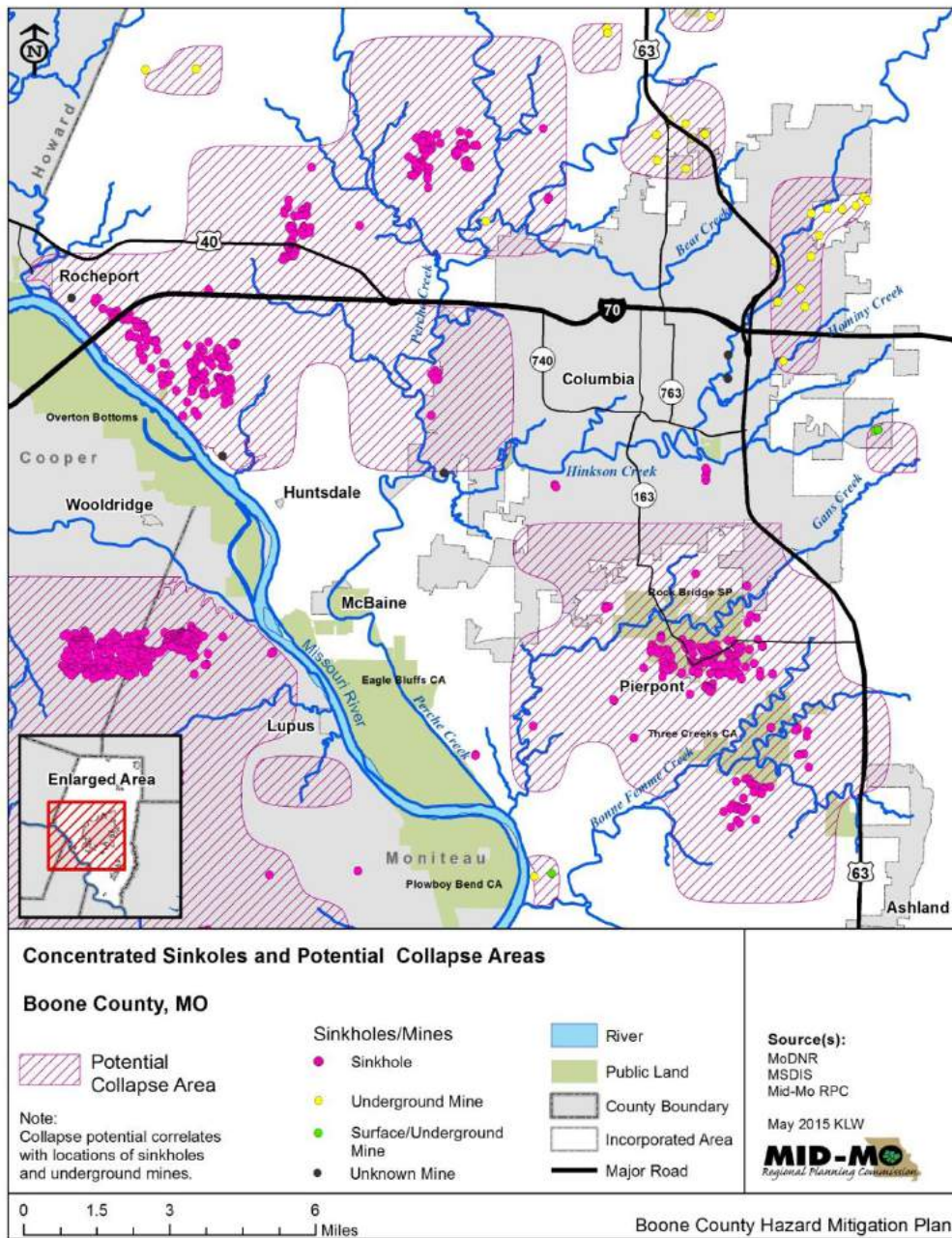
Sinkhole collapse potentially poses a threat to public health via contamination of the water supply. According to information from the Missouri DNR, a 1978 sinkhole collapse in southern Missouri drained the West Plains lagoon, resulting in sewage draining directly into underground water sources. More 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 3.33.

Figure 3.33



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. Much of this area is considered to have sinkhole collapse potential (Figure 3.33) 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.

Hazard by Jurisdiction

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. 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.

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.

PROBLEM STATEMENT

Boone County, Columbia, Ashland, Centralia, Hartsburg, and Rocheport are all vulnerable to land subsidence/sinkholes.

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. By tracking new collapse occurrences jurisdictions can more easily discourage land disturbance near potential problem areas.

3.4.6 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 (Table 3.34) The most common type of drought in Mid-Missouri is the agricultural drought.

Table 3.34	
Drought Categories	
Agricultural	Defined by soil moisture deficiencies
Hydrological	Defined by declining surface and groundwater supplies
Meteorological	Defined by precipitation deficiencies
Socioeconomic	Defined as drought impacting supply and demand of some economic commodity

Source: *Missouri Drought Plan, 2002* (Mo DNR)

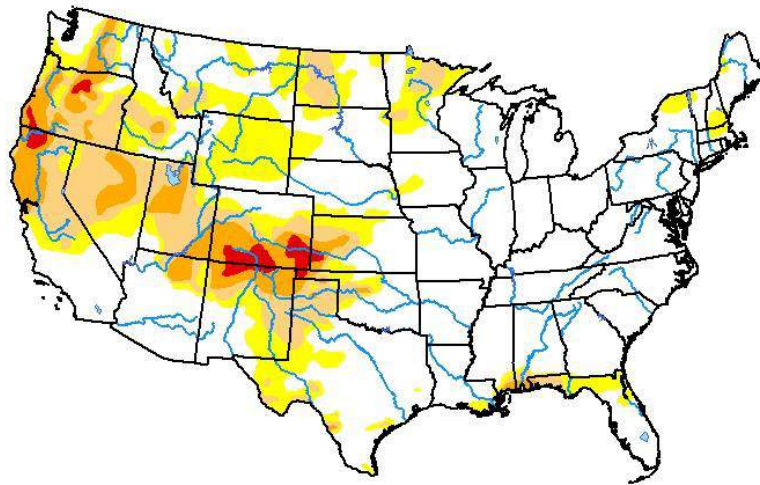
Geographic Location

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.

Figure 3.34 U.S. Drought Monitor Map

U.S. Drought Monitor
Continental U.S. (CONUS)

June 2, 2020
 (Released Thursday, Jun. 4, 2020)
 Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>.

Author:

Curtis Riganti
 National Drought Mitigation Center



droughtmonitor.unl.edu

Source: <https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?conus>

Strength/Magnitude/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).

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 D0 Abnormally Dry to D4 Exceptional Drought for reports on the U.S. Drought Monitor (Table 3.36).

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.

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 (2018)*.

While short periods of drought have been recorded in localized areas in the past few years the last reported crop loss was in 2019. According to USDA’s Risk Management section there was a single insurance claim for \$5,328 that was due to drought in August.

Probability of Future Occurrences

In the 20-year period 2000-2019, there were 8 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: $1 - (8/20) = .60$)

The probability of occurrence of the different drought severities in any given year, based on the 2000-2019 data, has also been calculated (Figure 3.37).

Table 3.37				
Probability of Future Drought Events				
Severity Scale	Drought Description	# of years with drought event (2000-2020)	Probability	Probability Rating
D1	Moderate	8	40%	High
D2	Severe	4	20%	High
D3	Extreme	3	15%	High
D4	Exceptional	2	10%	High

Changing Future Conditions Considerations

Droughts are naturally occurring events in the planning area. While overall precipitation is predicted to rise with climate change the intensity of rainfall events at a given time could mean less rainfall at other times throughout the season leading to more frequent droughts and crop failures. Raising global temperatures could lead to more severe droughts.

VULNERABILITY

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 *2017 US Census of Agriculture*, 48.8% of Boone County land use is tied to farming activities. In 2017 the market value of Boone County farm products was estimated at \$105,007,000 Million.

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.

Hazard Summary by Jurisdiction

All jurisdictions in the planning area can be impacted by drought. Incorporated cities may see a drain on their water supply in times of extreme drought and wear on roads under cracking and shrinking dry ground can become damaged. The largest impact to drought though comes to unincorporated Boone County due to the agriculture-based nature of its economy and land usage. Crop losses deal large economic blows and the potential for wildfire pose a risk to those living nearby.

PROBLEM STATEMENT

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 (2000-2020), 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. The agriculture industry is usually the worst hit by drought. Having crop insurance and practicing good water management in growing methods can help mitigate losses.

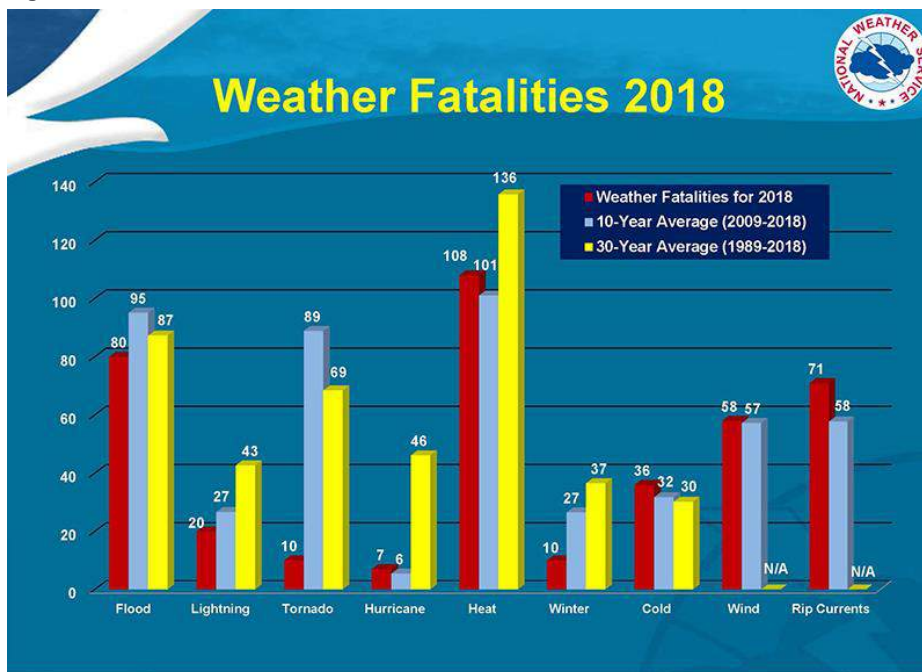
3.4.7 EXTREME TEMPERATURES

HAZARD PROFILE

DESCRIPTION OF HAZARD

Extreme temperature events, both hot and cold, can impact human health and mortality, natural ecosystems, agriculture, and other economic sector. Extreme heat is the number one weather-related killer in the United States, according to the National Weather Service (Figure 3.30). In contrast to the visible, destructive, and violent nature of floods, hurricanes, and tornadoes, extreme heat is a silent killer.

Figure 3.35



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 101

deaths per year when looked at over a 10-year period; this is 6 more deaths per year than the number cause by flood, the next most frequent cause of death.

Extreme cold often accompanies severe winter storms and can lead to hypothermia and frostbite in people without adequate clothing protection. Cold can also cause issues with power sources by freezing fuel lines and overwhelming heating systems. It can also freeze and bust pipes in homes and businesses.

Geographic Location

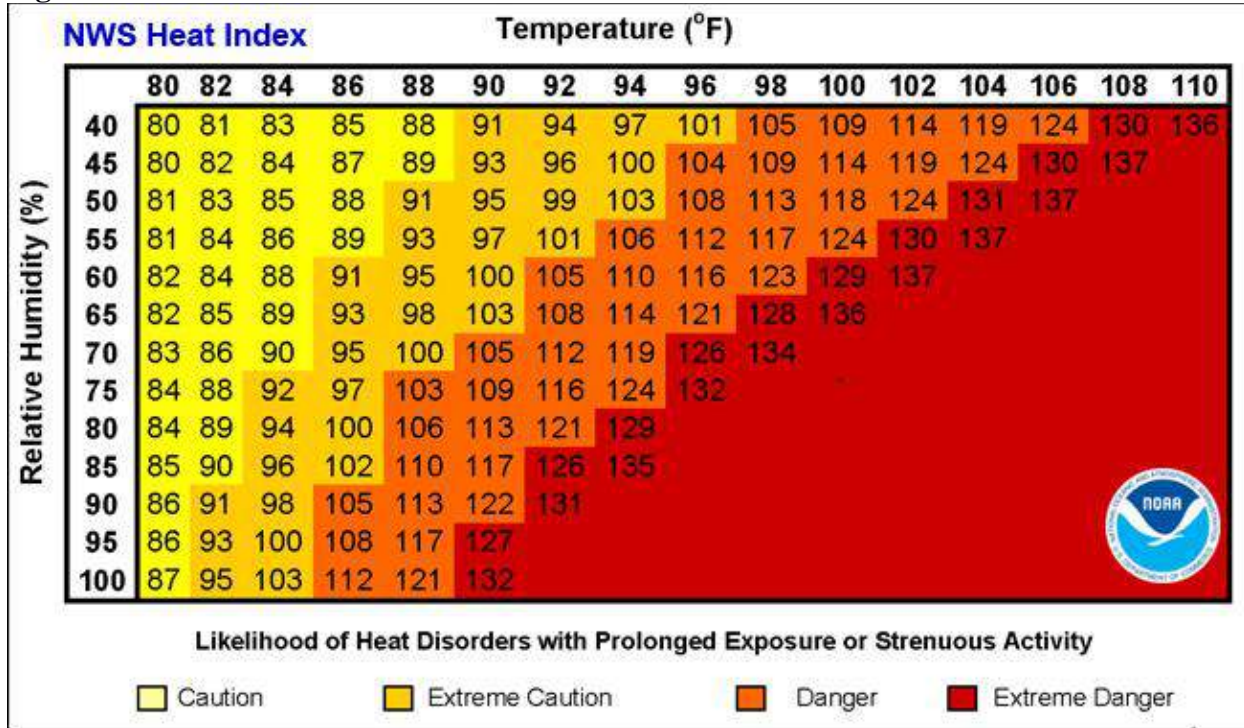
The entire planning area is at risk from extreme temperature events.

Strength/Magnitude/Extent

The planning area routinely experiences prolonged periods with temperatures in the 90s and 100s (Figure 3.31). The duration of these periods of extreme heat can range from just one day to

weeks. The National Weather Service (NWS) has an alert system in place to alert people when the Heat Index is expected to have a significant impact on public safety. The severity decides whether an advisory or a warning is issued.

Figure 3.36



Source: National Weather Service (NWS) <https://www.weather.gov/safety/heat-index>

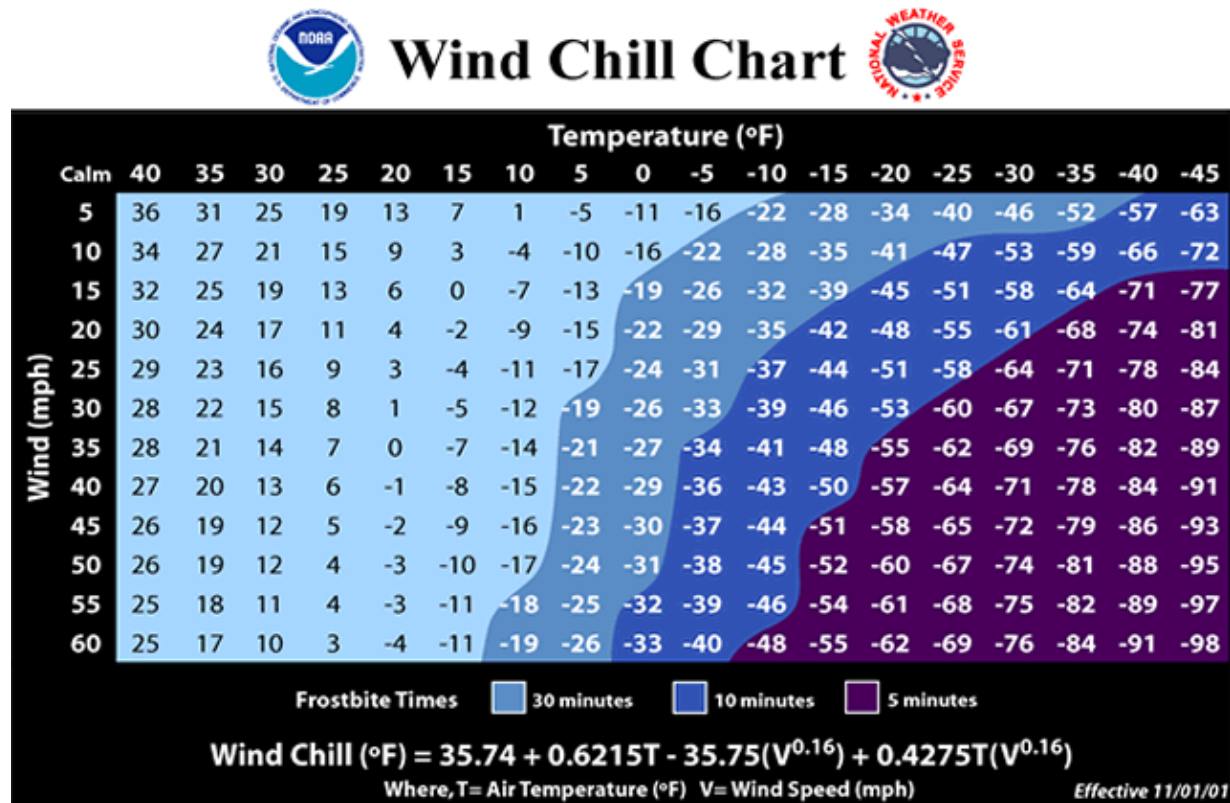
Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Similar to heat index the NWS also has an index for wind chill. It uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. Based on estimated temperatures advisories or warnings maybe issued.

Wind Chill Advisory	Combination of low temperatures and strong winds will result in wind chill readings of -20 degrees F or lower
Wind Chill Warning	Wind chill temperatures of -35 degrees F or lower are expected. This is a life-threatening situation.

The figure below shows wind chill temperatures which are based on the rate of heat loss from exposed skin caused by wind and cold. When wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 3.37



Previous Occurrences

Table 3.38

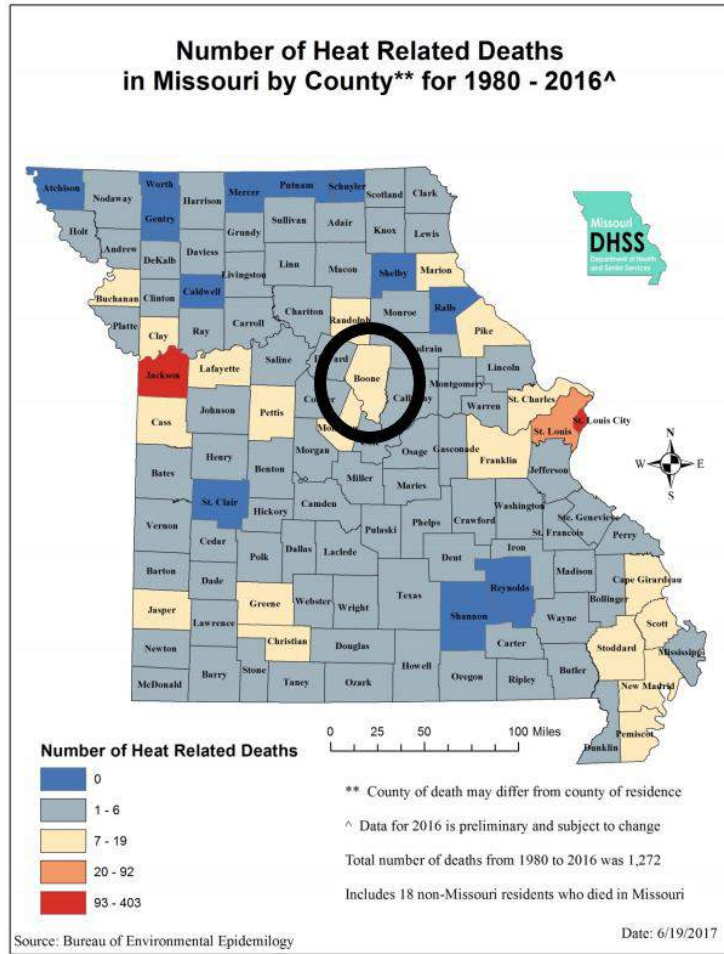
Periods of Extreme Heat in Boone County, 2000-2020				
Date	Air Temp	Deaths*	Injuries*	Length (days)
12/16/00	9	0	0	2
08/05/07	100-103	8	1300+	12
06/21/09	90s	0	0	7
06/18/10	mid 90s	0	0	6
07/14/10	100 - 103	8	941	3
07/17/10	mid-90s	0	13	1
07/22/10	mid-upper 90s	0	23	3
08/02/10	100 -102	0	13	3
08/08/10	upper 90s - 100	2	85	7
07/17/11	lower 90s - 100	8	100+	18

06/27/12	100 -109	19	212	11
07/16/12	100 -106	1	53	4
07/22/12	up to 108	0	75	6
08/01/12	105	0	6	2
08/20/14	Upper 90s	0	56	7
07/12/15	Upper 90s	0	0	2
07/17/15	Mid 90s	0	0	1
07/25/15	Mid 90s	0	0	4
07/18/16	Upper 90s	1	70	5
07/18/17	Upper 90s – 108	0	51	5
Total Deaths/Injuries and Average Length		47	2998+	5.5
* Deaths and injuries are for entire area in MO affected by extreme heat event.				
Source: www.ncdc.noaa.gov/stormevents/ (Available data as of 2/29/2020)				

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)

Figure 3.38



Source: <https://health.mo.gov/living/healthcondiseases/hyperthermia/pdf/stat-report.pdf>

Probability of Future Occurrence

– High for all participating jurisdictions

- NOAA data dating back to 1994 indicates only 6 years without extreme heat events (1996, 1997, 2008, 2013, 2018 and 2019). 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: $1 - (6/26) = 0.76$)
- NOAA data dating back to 1994 indicates that there was only 1 year with an extreme cold event. That event took place in 2000. This makes for a probability of an extreme cold event in any year 1%. (Probability calculation: $1 - (1/26) = 0.96$)

The chances of an extreme heat event are much higher and happen much more frequently than extreme cold but cool snaps that may not bother humans can bother crops. Insurance claims for 2019 show \$234,542 in damages due to cold weather.

VULNERABILITY

VULNERABILITY OVERVIEW

Measure of Severity - Moderate for all participating jurisdictions

Potential Impact – Life

Extreme temperatures kill by overloading a body’s capacity to regulate its internal temperature. 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 body attempts to heat itself through shivering when faced with cold.

The Heat Index devised by the NWS (Table 3.39) 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. 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.

Table 3.39 Typical Health Impacts of Extreme Heat

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

Source: National Weather Service Heat Index Program, www.weather.gov/os/heat/index.shtml

Many factors, such as age, general level of health, outdoor activity level, and availability of adequate shelter and clothing, affect the actual risk level. The elderly in general are vulnerable to the effects of extreme temperatures. Hypothermia sets in when internal body temperatures fall below 95 F. While this is most likely to occur when temperatures outside are extremely cold it is possible to happen slowly at temperatures as high as 40 F if the exposure is prolonged and exacerbated by chill caused by sweat, rain, or submersion into cold water.

Extreme temperature events can also result in livestock deaths and fish kills; drought in conjunction with extreme heat exacerbates the situation. Strenuous outdoor activity in extreme cold can also be life threatening. Frostbite can lead to the loss of limbs and hypothermia can result in death.

Potential Impact - Existing Structures

While illness and loss of life are of the most concern with extreme temperatures, structural impacts may also occur. Structural impacts depend on the length of the period of extreme temperature and exacerbating factors such as concurrent drought or heavy precipitation. Road

damage and electrical infrastructure damage may occur with intense and prolonged heat. Water pipes may break with steep drops in temperature below freezing and cold temperatures can make materials more brittle and prone to failure.

Potential Impact - Future Development

Thoughtful future development has the potential to include mitigation for extreme temperatures 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. Placing utilities below ground under the freeze line can protect them from bitter cold temperature that could cause failure.

Hazard Summary by Jurisdiction

Those at greatest risk for temperature-related illness and deaths include children under 5 years of age and people over the age of 65. To determine jurisdictions within the planning area with populations more vulnerable to extreme temperatures, demographic data was obtained from the 2018 American Community Survey estimates for populations 5-years-old and younger, as well as ages 65 and older. Since students and faculty of school districts are not typically part of the vulnerable age groups they have been left out of the following table.

Table 3.40: Boone County Population by Age

Jurisdiction	Population Under 5 yrs	Population 65 yrs and over
Unincorporated Boone County	10,403	19,080
Ashland	282	520
Centralia	368	845
Columbia	7,053	11,588
Hallsville	65	215
Harrisburg	33	32
Hartsburg	1	21
Huntsdale	0	5
Rocheport	21	64
Sturgeon	28	190

Source: American Community Survey 5-year Estimates 2012-2017

The City of Columbia, the major population center in the planning area, is well equipped with warming/cooling centers to help protect those most vulnerable. Warnings regarding the dangers of extreme temperatures are widely broadcast during times of threat.

The following locations in Columbia are used as cooling/warming 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 extreme weather and/ or issuing alerts when the threat of extreme temperatures is imminent:

The Boone County/City of Columbia Health Department alerts the public on the dangers of extreme temperatures.

The Missouri State High School Activities Association (MSHSAA) provides coaches with educational pamphlets on the dangers of excessive heat. Schools in the planning area have air conditioning in their main buildings and many of their detached buildings, but warnings should be taken into consideration for outdoor sports and practices. Many schools in the planning area are closed for summer session during the more hot portions of the summer season.

The Missouri Department of Health and Senior Services announces statewide hot weather health alerts.

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.)

PROBLEM STATEMENT

All jurisdictions are vulnerable to the effects of extreme temperatures. 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 temperatures; 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. Likewise, frostbite and hypothermia can set in for those who cannot afford to heat their homes or who must be out in extremely cold temperatures. Older structures with less insulation may be at risk for frozen pipes. Outreach to raise awareness amongst the

most vulnerable populations and educating those about where warming and cooling centers are located can help mitigate the potential loss of life that can come with extreme temperatures.

In addition to the human toll, prolonged extreme temperatures can result in livestock deaths, fish kills, and infrastructure damage; drought in conjunction with extreme heat exacerbates the situation. Winter weather can also take a toll on crops in the area. Unseasonable cold snaps and late frosts can kill and damage crops costing thousands of dollars in insurance claims.

3.4.8 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 sections on flooding and tornadoes.

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.

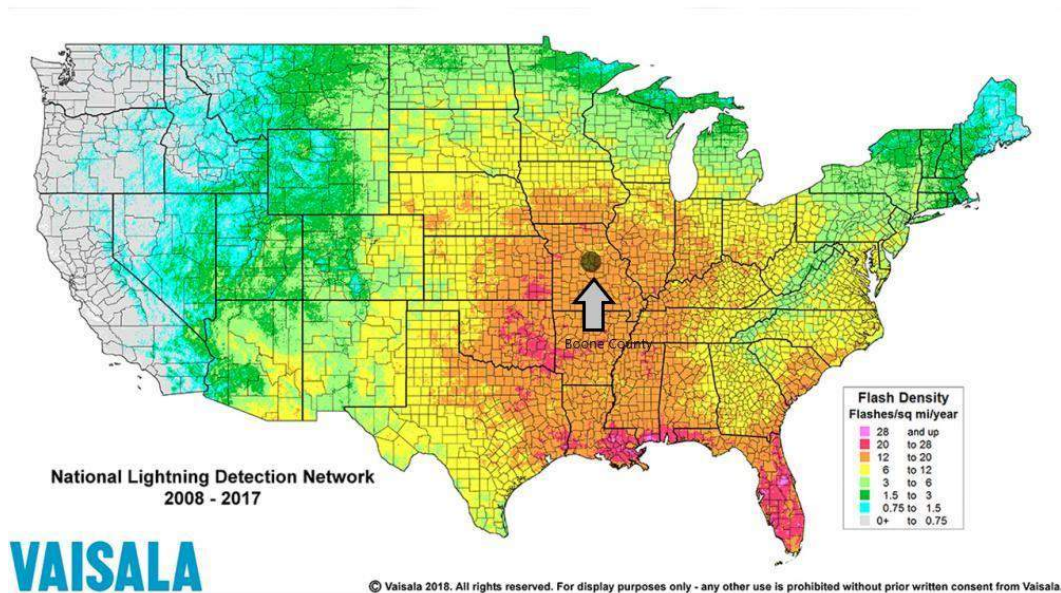
Hail is formed when updrafts in thunderstorms carry raindrops up to very high and cold areas where they freeze into ice. Hail, especially large sized hail, can cause severe damage and presents a threat to automobiles, airplanes, roofs, crops, livestock, and even humans.

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. Although these events occur similarly throughout the planning area damages are more likely to occur in more densely developed areas and areas with older homes. Boone County is located in central Missouri and has a medium flash density of 6-12 Flashes/square mile/year.

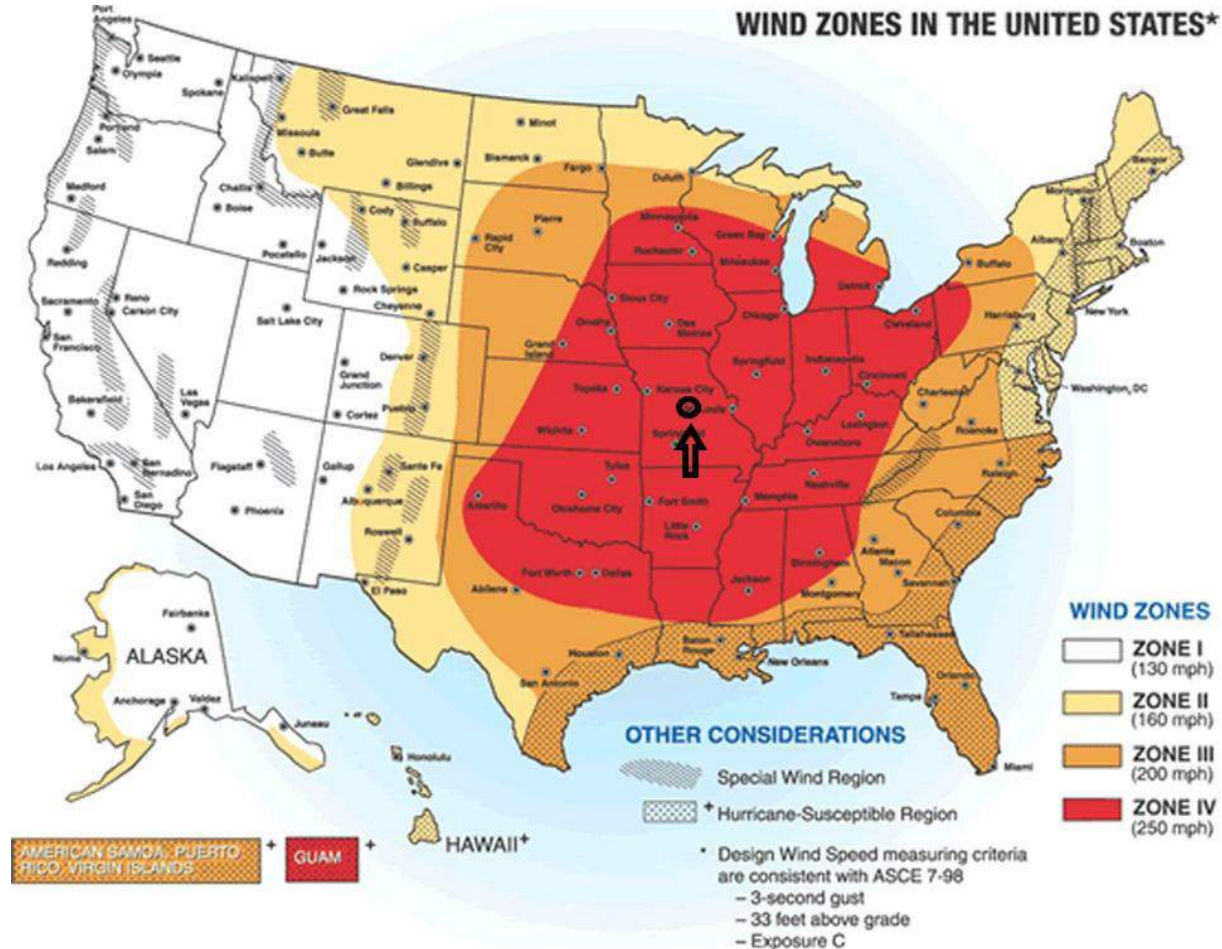
Figure 3.39: Location and Frequency of Lightning in Missouri



Source: National Weather Service, <http://www.vaisala.com/en/products/thunderstormandlightningdetectionsystems/Pages/NLDN.aspx> . Note: indicate location of planning area with a colored square or arrow.

The Planning area is in a high wind zone according to FEMA. All of the planning area is located in Zone IV and can see winds of 250 mph.

Figure 3.40 Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, https://www.fema.gov/pdf/library/ism2_s1.pdf

Strength/Magnitude/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.

Based on information provided by the Tornado and Storm Research Organization (TORRO), Table 3.41 below describes typical damage impacts of the various sizes of hail.

Table 3.41: Hail Damage by Size

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

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

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

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

The NCEI is limited in its reporting of lightning due to the fact that only lightning events that result in fatality, injury and/or property and crop damage are in the NCEI. There were no direct reports of lightning for the review period in the planning area. The tables below summarize past crop damages as indicated by crop insurance claims and give insight into the magnitude of the impact on the planning area's agricultural economy.

Table 3.42 Crop Insurance Claims Paid in Boone County from Thunderstorms, 2009-2019

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2016	Corn	Other, storms	58,485
2014	Wheat	Other, storms	1,983
Total			60,468

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

Table 3.43 Crop Insurance Claims Paid in Boone County from High Winds, 2009-2019

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2016	Corn	Wind	185
2011	Corn	Hot Wind	112
Total			297

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

Table 3.44 Crop Insurance Claims Paid in Boone County from Hail, 2009-2019

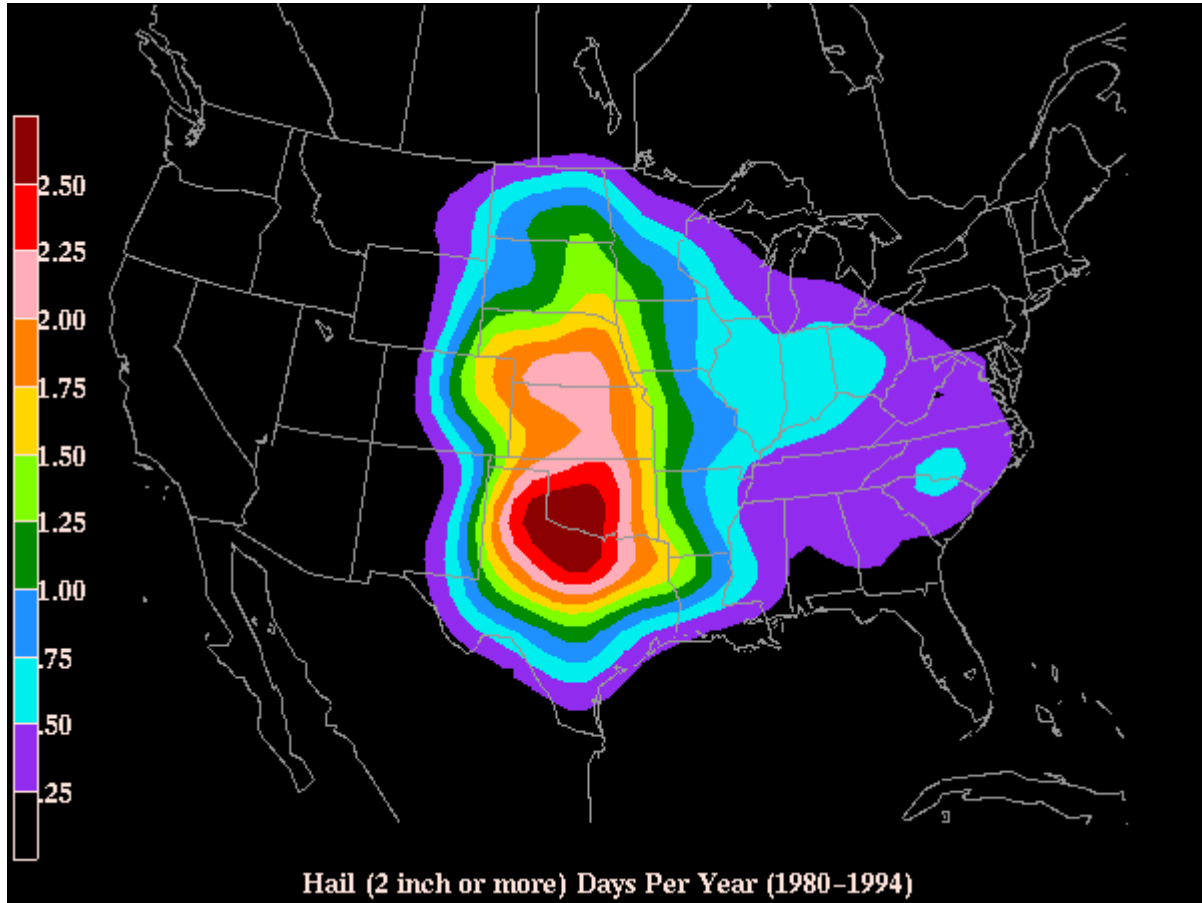
Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2016	Corn	Hail	926
2011	Wheat	Hail	387
2009	Corn	Hail	317
Total			1,630

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

Probability of Future Occurrences

High for damaging winds, hail, and lightning – All participating jurisdictions

Figure 3.41 Annual Hailstorm Probability (2" diameter or larger) 1980-1994

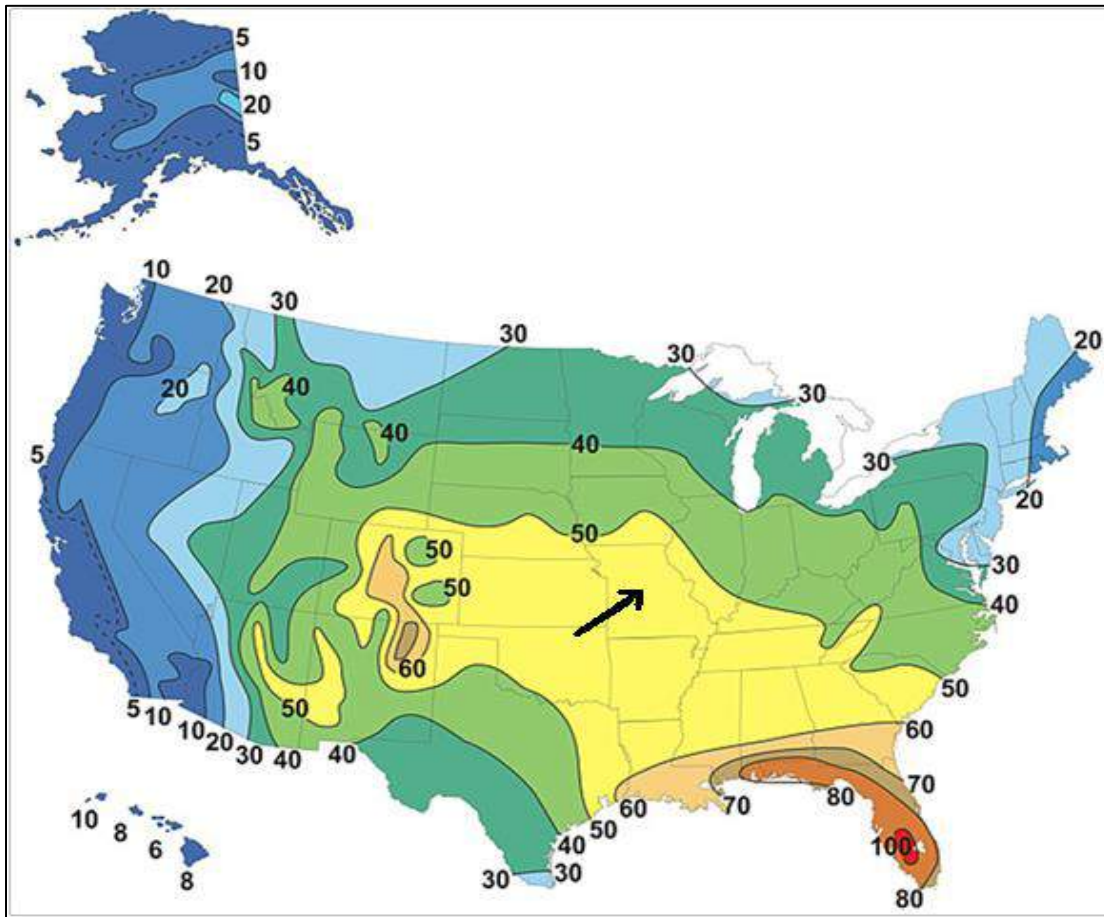


Source: NSSL, http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif

The planning area is indicated to have at least 1 hailstorm event a year according to NOAA.

National Weather Service data indicates an average 50-60 thunderstorm days per year in Missouri (Figure 3.37).

Figure 3.42 Average Number of Thunderstorm Days Annually in U.S.



Source: NOAA

Data from NOAA for the 10-year period (2009-2019) indicates 48 severe thunderstorm wind events in Boone County. 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 10-year period 2009-2019 indicates 42 severe hail events in Boone County. 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 2009-2019 indicates 5 lightning events in Boone County which caused property damage, injury, or death. There were six 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 40%.

CHANGING FUTURE CONDITIONS CONSIDERATIONS

According to the State Hazard Mitigation Plan 2018, “Predicted increases in temperature could help create atmospheric conditions that are fertile breeding grounds for severe thunderstorms and tornadoes in Missouri.” These changing conditions will affect the entire planning area and should be considered when building new structures.

VULNERABILITY

Vulnerability Overview

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, there were 2 recorded injuries due to damaging winds in a 10-year period. One instance occurred in 2011 when a tent was blown down at the fairgrounds injuring one person. The second person was injured in 2015 when a tree was blown over in a storm onto a mobile home. The person inside suffered multiple broken bones.

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 to humans and livestock. 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. There have been no reported hail injuries in the planning area in the last 10 years.

Potential Impact - Existing Structures

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.

Hail events of a large magnitude do not happen every year in the planning area. When they do, they can cause extensive damage to roofs and windows on buildings, and dent and bust glass on vehicles that cost residents and business owners in repairs.

Property damage due to fires and shorts to electrical systems caused by lightning strikes can cost thousands of dollars per incident and affect electronic equipment located inside buildings and damage crops and farm structures.

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.

While the housing growth rate might be expected to be somewhat lower since the last plan update, 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.

Hazard Summary by Jurisdiction

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

Boone County has a large population of 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.

The City of Columbia is a densely populated area that incurs high costs when damaging storm events move through. While the city has done much to help mitigate losses through underground utilities in portions of the city and educating residents about shelter sites its density and number of aging structures make it vulnerable to storm damage.

There is a storm siren located in or near each jurisdiction in the planning area that can be sounded remotely from the EOC if a storm of damaging proportions is coming.

PROBLEM STATEMENT

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.

3.4.9 SEVERE WINTER WEATHER

HAZARD PROFILE

Hazard Description

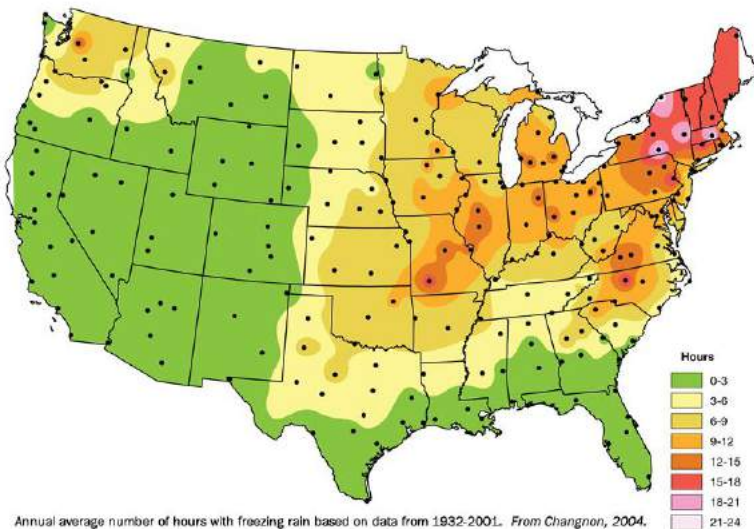
Winter storms in central Missouri contain ice, snow, sleet, and wind; each of these associated factors has the potential to disrupt life in the region by making normal activity difficult and/or dangerous. The National Weather Service describes different types of winter storm events as follows:

- **Blizzard** – Winds of 35 miles per hour or more with snow and blowing snow reducing visibility to less than ¼ mile for at least three hours.
- **Blowing Snow** – Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls** – Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers** – Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain** – Measurable rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet** – Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

Geographic Location

The entire planning area is at risk from severe winter weather. This includes heavy snow, ice, and freezing rain. The planning area falls in the 9-12 hours a year average for freezing rain.

Figure 3.43 Average Hours of Freezing Rain a Year



Source: https://mrcc.illinois.edu/living_wx/icestorms/

Strength/Magnitude/Extent

The entire planning area is at risk for a variety of winter weather. There are various levels of alerts for various conditions of winter weather. The National Weather Service may issue any of the following as conditions warrant.

Table 3.45	
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.
Ice storm Warning	Dangerous accumulations of ice are expected with generally over one quarter inch of ice on exposed surfaces. Travel is impacted, and widespread downed trees and power lines often result.

As the duration of a winter weather event goes longer, the potential for increased severity also rises. Prolonged events tax resources for residents and businesses.

Previous Occurrences

Table 3.46 NCEI Boone County Winter Weather Events Summary, 2009-2019

Date	Event Type	Injuries
01/01/2010	Cold/Wind Chill	0
01/06/2010	Winter Weather	0
01/19/2011	Heavy Snow	0
01/31/2011	Winter Storm	0
02/01/2011	Winter Storm	0
02/01/2011	Blizzard	0
02/21/2013	Heavy Snow	0
02/25/2013	Heavy Snow	0
03/24/2013	Heavy Snow	0
12/21/2013	Winter Storm	0
01/05/2014	Winter Storm	0
01/06/2014	Cold/Wind Chill	0
02/04/2014	Winter Storm	0
11/25/2018	Blizzard	0

01/11/2019	Heavy Snow	0
02/06/2019	Ice Storm	0
12/15/2019	Winter Storm	0

Source: <https://www.ncdc.noaa.gov/stormevents/listevents>

2019 was an active winter weather season. In January 2019 the planning area saw several rounds of snowfall leading to a depth recording at the Columbia Regional Airport of 16.9 inches. Numerous traffic incidents were reported during and after the round of heavy snow. In February of the same year the northern half of the planning area saw a quarter inch of ice that downed power lines and tree limbs in the Centralia area.

Winter weather can also take a toll on crops in the area. Unseasonable cold snaps and late frosts can kill and damage crops costing thousands of dollars in insurance claims.

Table 3.47 Crop Insurance Claims Paid in Boone County as a Result of Cold Conditions and Snow 2009-2019

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid (\$)
2009	Wheat	Cold/Wet	14,095
2010	Wheat	Cold/Winter	355
2010	Wheat	Cold/Winter	2,222
2010	Wheat	Cold/Wet	11,598
2010	Wheat	Cold/Wet	28599
2010	Wheat	Cold/Wet	-
2010	Corn	Cold/Wet	495
2011	Wheat	Cold/Winter	20,791
2011	Wheat	Cold/Winter	6,206
2011	Wheat	Cold/Wet	7,751
2011	Wheat	Cold/Wet	1,265
2011	Corn	Cold/Wet	2,212
2011	Corn	Cold/Wet	7,395
2011	Soybeans	Cold/Wet	1,477
2012	Corn	Cold/Wet	2,272
2012	Corn	Cold/Wet	1,818
2013	Wheat	Cold/Winter	2,627
2013	Wheat	Cold/Winter	94
2013	Wheat	Cold/Winter	1,255
2013	Wheat	Cold/Winter	3,616
2013	Wheat	Cold/Winter	15,313
2013	Wheat	Cold/Wet	216
2013	Corn	Cold/Wet	904
2014	Wheat	Cold/Winter	1,434
2014	Wheat	Cold/Winter	10,108
2014	Wheat	Cold/Winter	196
2014	Wheat	Cold/Winter	23,558
2014	Wheat	Cold/Winter	214
2014	Wheat	Cold/Wet	6,271

2014	Wheat	Cold/Wet	1,113
2014	Soybeans	Cold/Wet	546
2015	Wheat	Cold/Wet	35,778
2015	Soybeans	Cold/Wet	1,385
2017	Corn	Cold/Wet	6,168
2017	Soybeans	Cold/Wet	5,295
2018	Wheat	Cold/Wet	4,095
2018	Wheat	Cold/Wet	493
2018	Corn	Cold/Wet	7,824
2018	Corn	Cold/Wet	83,377
2018	Grain Sorgham	Cold/Wet	11,364
2018	Soybeans	Cold/Wet	6,845
2019	Wheat	Cold/Wet	128,876
2019	Wheat	Cold/Wet	19,130
2019	Corn	Cold/Wet	47,077
2019	Corn	Cold/Wet	33,792
2019	Soybeans	Cold/Wet	5,667

Source: <https://www.ncdc.noaa.gov/stormevents/listevents>

Probability of Future Occurrence

– High for all participating jurisdictions

The historical data indicates there were 5 years (2009, 2012, 2015, 2016, 2017) without a severe winter weather event in the period 2009-2018, a 10-year period; most years witnessed multiple events. Based on this historical data, the calculated probability of a severe winter weather event in any year is 50%. (Probability calculation: $1 - (5/10) = 0.5$)

Changing Future Conditions Considerations

As temperatures rise and shorten the winter season there could be ecological impacts to plant and animal species that could cause them to shift their native territory. An increase in precipitation events throughout the winter months and a general saturation of the ground could increase the likelihood of flooding events and freezing rain or ice storm events in the planning area.

VULNERABILITY

Vulnerability Overview

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.

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. 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.

In March 1998, an 84-year old woman in Columbia died of a heart attack while shoveling snow. The elderly are especially vulnerable to excessive and/or prolonged cold or heat.

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.

Potential Losses to 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.

Previous and Future Development

Measure have been taken by some jurisdictions to help mitigate future impacts on community growth. 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. Such jurisdictions, including Ashland and Hallsville, also have policies in place regarding moving electrical lines underground when possible.

Hazard Summary by Jurisdiction

Unincorporated Boone County is at high risk for winter weather impacts. It has miles of above ground utility lines that can be brought down by heavy snow or ice and even more miles of road network to clear for travelers and first responders. A large portion of Boone County is dedicated to agriculture leaving tender crops susceptible to late season frosts.

The City of Columbia's dense nature leaves a large population vulnerable in the event of a power outage from winter weather. Both Columbia and Ashland have experienced rapid growth opening them up for vulnerability, but also the opportunity to build in resiliency through building codes and the requirement to underground new utilities.

Lack of growth and aging systems in smaller jurisdictions such as Huntsdale, Hartsburg, and Harrisburg leaves them vulnerable to power outages. Older homes can have trouble carrying snow loads during heavier storms.

PROBLEM STATEMENT

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. The further encouragement and effort toward moving utility lines underground will help limit damage to essential utilities during severe winter weather.

3.4.10 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. All of Missouri is located in the zone known as Tornado Alley where the occurrence of tornadoes of varying intensities are common.

Strength/Magnitude/Extent

The Enhanced Fujita or EF-Scale (Table 3.46) 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.

Table 3.48 Enhanced F Scale for Tornado Damage

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest ¼-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust	EF Number	3 Second Gust
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135

3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Source: The National Weather Service, www.spc.noaa.gov/faq/tornado/ef-scale.html

The EF-Scale has been in use since February 1, 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. The table below list damage summaries for their respective EF rating.

Table 3.49 Enhanced Fujita Scale with Potential Damage

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

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

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 3.48). This includes five “significant” F2 tornadoes and three “severe” F3 tornadoes.

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.”

Table 3.50

Historical Tornado Occurrences

Location	Date	Length (miles)	Width (Yard)	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
Boone County	04/30/54	89.6	100	F2	0	0	50K	0
Boone County	12/04/56	11.1	400	F2	0	0	250K	0
Boone County	09/27/59	6.4	50	F2	0	0	50k	0
Boone County	09/28/59	0.1	10	F1	0	0	3K	0
Boone County	10/04/59	0.2	17	F0	0	0	3K	0
Boone County	10/04/59	0.2	10	F0	0	0	3K	0
Boone County	01/25/65	0.1	10	F0	0	0	0K	0
Boone County	12/08/66	2.5	73	F1	0	0	25K	0
Boone County	09/07/72	0.1	33	F1	0	0	25K	0
Boone County	03/13/73	6.1	50	F1	0	0	25K	0
Boone County	05/26/73	3	50	F2	0	1	250K	0
Boone County	12/04/73	0.1	10	F0	0	0	25K	0
Boone County	05/12/80	42.7	50	F2	0	0	25K	0
Boone County	04/16/82	0.3	50	F0	0	0	0K	0
Boone County	05/29/82	0.1	20	F1	0	0	3K	0
Boone County	04/03/84	0.3	27	F1	0	0	0K	0
Boone County	04/29/84	0.3	10	F1	0	0	25K	0
Boone County	10/16/84	4	50	F1	0	0	25K	0
Boone County	06/17/85	1	100	F1	0	0	2.5M	0
Boone County	06/02/87	1	20	F0	0	1	0K	0
Boone County	11/27/90	1	50	F3	0	0	250K	0
Boone County	11/27/90	12	50	F3	0	3	25.0M	0
Boone County	07/02/92	0.5	50	F1	0	0	250K	0
Boone County	07/02/92	0.2	23	F0	0	0	0K	0
Columbia	07/08/95	0.2	80	F0	0	0	0	0
Columbia	11/10/98	2	70	F3	0	16	6.0M	0
Midway	04/08/99	4	120	F2	0	5	0	0
Hinton	04/08/99	10	120	F2	0	0	0	0

Ashland	02/25/00	0.2	50	F0	0	0	0	0
Centralia	03/26/00	0.3	150	F1	0	0	50K	0
Midway	05/17/01	0.1	50	F0	0	0	0	0
Harrisburg	07/07/16	0.34	50	EF0	0	0	0	0
TOTALS:					0	26	34.81M	0

Figure 3.44 Boone County Map of Historic Tornado Events



Crop losses from 2009-2019 total around \$60,765 for storm and wind damage. While USDA’s Risk Management division doesn’t list tornado as the cause for any of those damages high winds and thunderstorm-like conditions often accompany systems that can produce tornados.

Probability of Future Occurrences

High - all participating jurisdictions

For the period 1954-2019, a 66-year period, the NOAA database reports 20 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 (Table 3.51). 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.

EF-Scale	# of years with tornado event (1954-2019)	Probability	Probability Rating
All	20	30%	High
EF0	8	12%	High
EF1	10	15%	High
EF2	6	9%	Moderate
EF3	2	3%	Moderate
EF4	0	0%	Low
EF5	0	0%	Low

Changing Future Conditions Considerations

It is not confidently known how the change in climate could impact the frequency or severity of future tornadic activity. While the activity zone has not expanded according to the State Hazard Mitigation Plan 2018 the number of tornados has gone up since the 1950s. More studies will be needed to know the true impact over time.

Vulnerability

Vulnerability Overview

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. The whole planning area is located in “Tornado Alley” where historically dangerous and destructive tornados occur frequently.

Figure 3.45 Tornado Alley in the U.S.



Potential Losses to Existing Development

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 \$34.81 million in reported property damages associated with recorded tornadoes in the planning area.

Missouri State Hazard Mitigation Plan (2018) 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 Density
- Social vulnerability
- Percent mobile home

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 rated as medium vulnerability.

The State Plan set the Total Building Exposure in the planning area at \$18,473,209,000.

Previous and 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.

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.

Hazard Summary by Jurisdiction

There are a variety of strategies in place in the planning area by which the public can be informed of the threat of tornadoes. Each jurisdiction has a storm siren inside or near their city limits to warn residents of incoming inclement weather. All jurisdictions have a designated shelter place. There is a lack of FEMA rated saferooms in the planning area though.

The risks to school districts and colleges in the planning area is high. A direct hit from a large tornado could prove catastrophic to an education center and the community that relies on it for education, jobs, and even shelter during storms. The destruction of a school has regional implications as students would have to be bussed or transfer elsewhere during rebuild and employees would be left without work.

3.9% of homes in Boone County are listed as 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.

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.

PROBLEM STATEMENT

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

3.4.11 WILDFIRE

HAZARD PROFILE

HAZARD DESCRIPTION

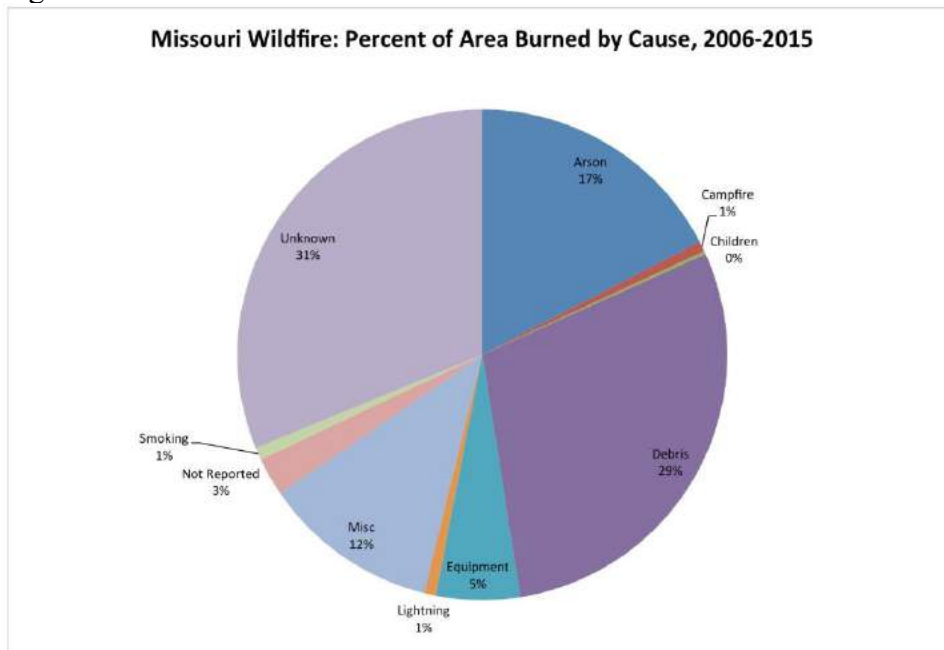
Large and widespread wildfires, such as occur in the western United States, have not been a problem in Boone County in recent history. However, smaller wildfires/natural cover fires occur every year.

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 3.46).

Figure 3.46: Missouri Wildfire Source



Source: Missouri Department of Conservation

Geographic 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 3.42. Columbia, Harrisburg, Hartsburg, and Rocheport all incorporate significant areas of medium or high-density wildland interface and/or intermix (Figures 3.47-3.52). Huntsdale incorporates only a small portion of medium density intermix (Figure 3.52).

Figure 3.47

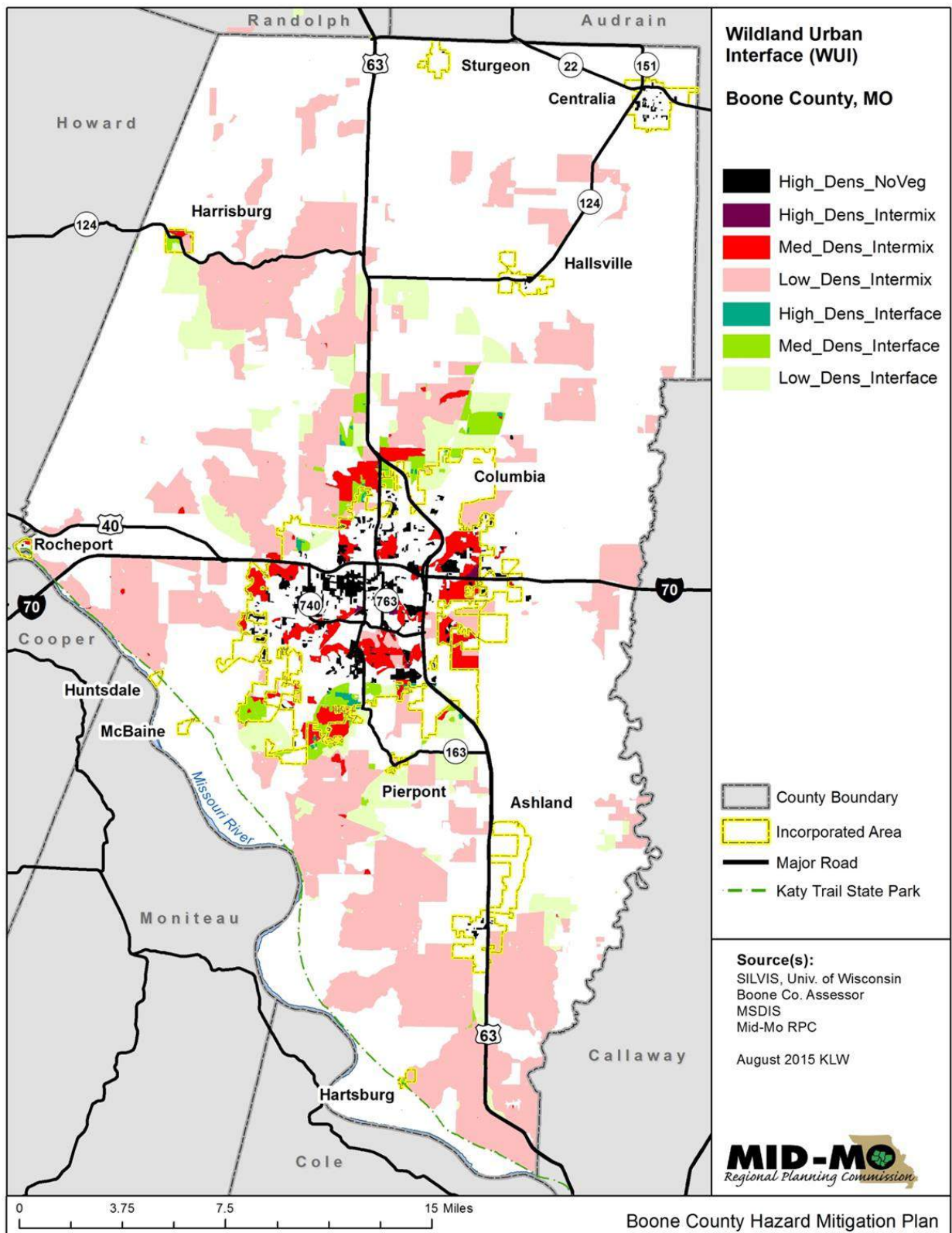


Figure 3.48

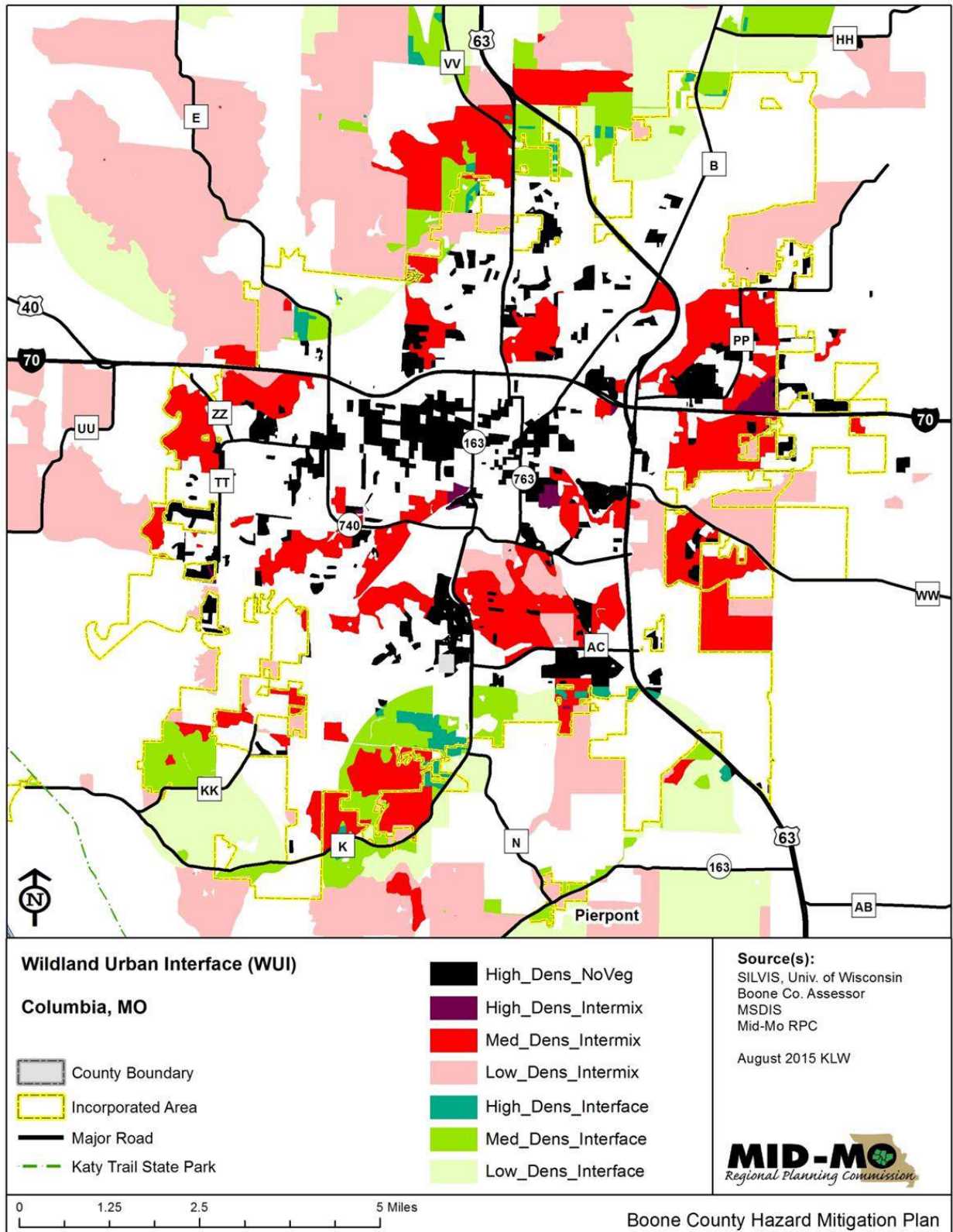


Figure 3.49

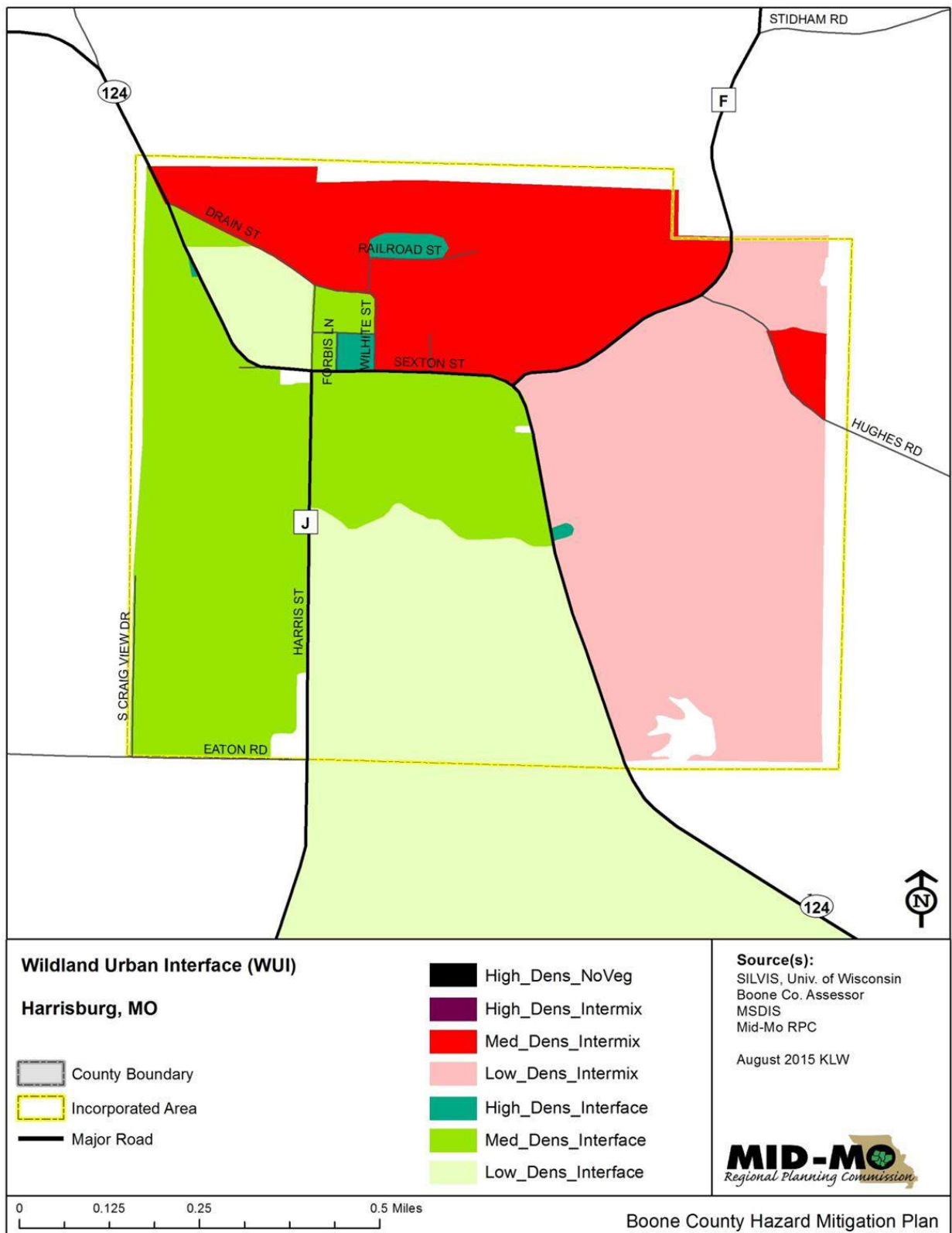


Figure 3.50

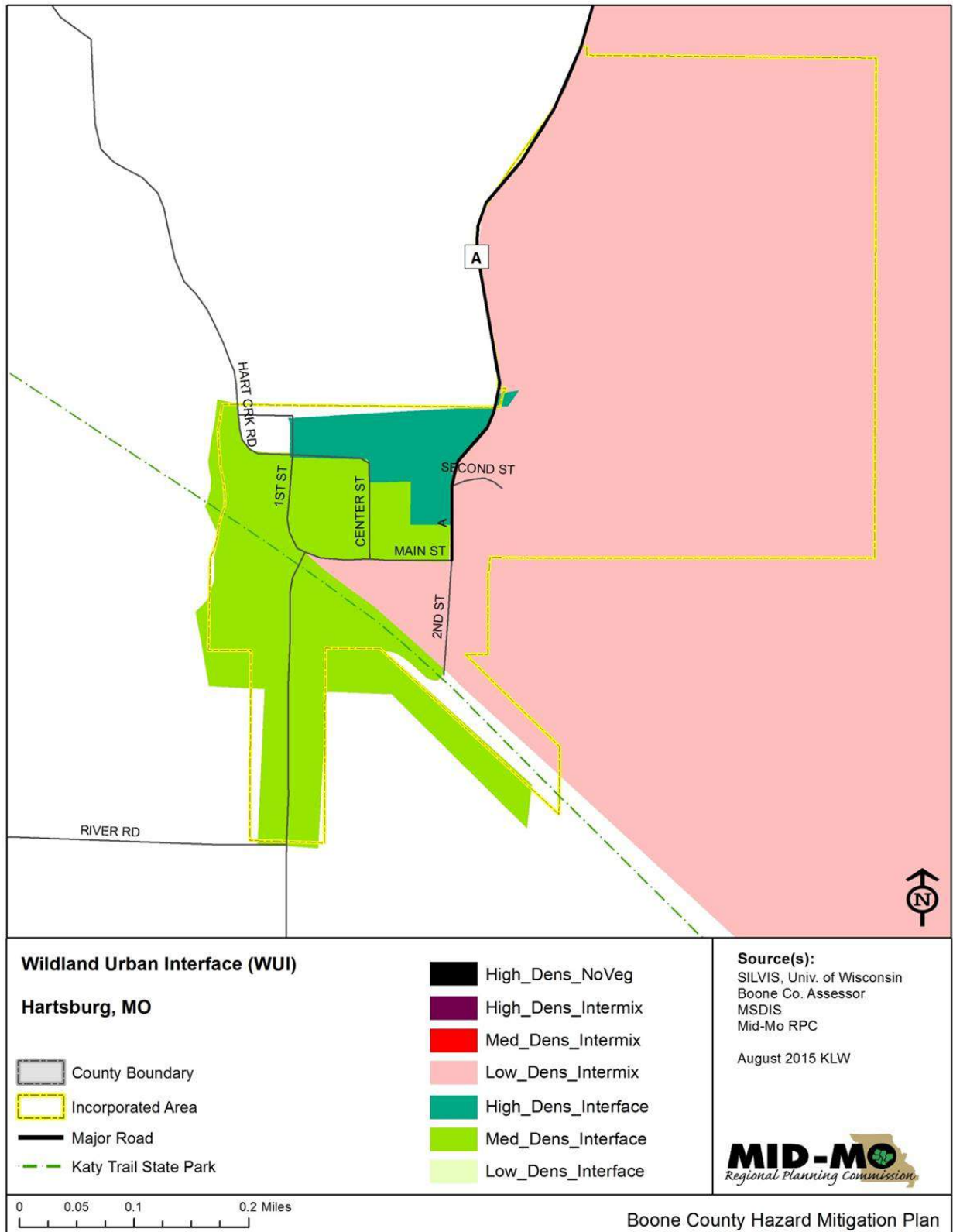


Figure 3.51

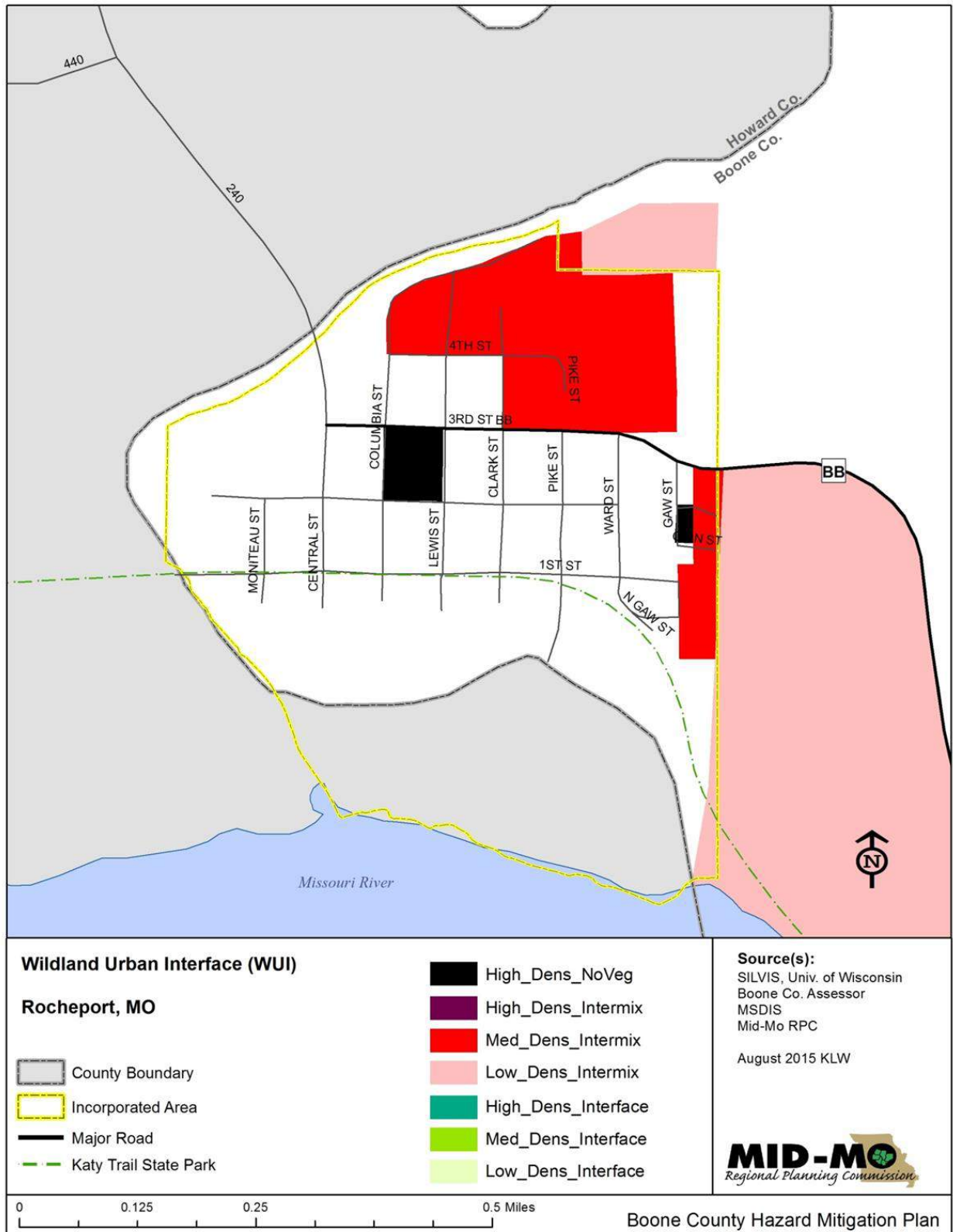
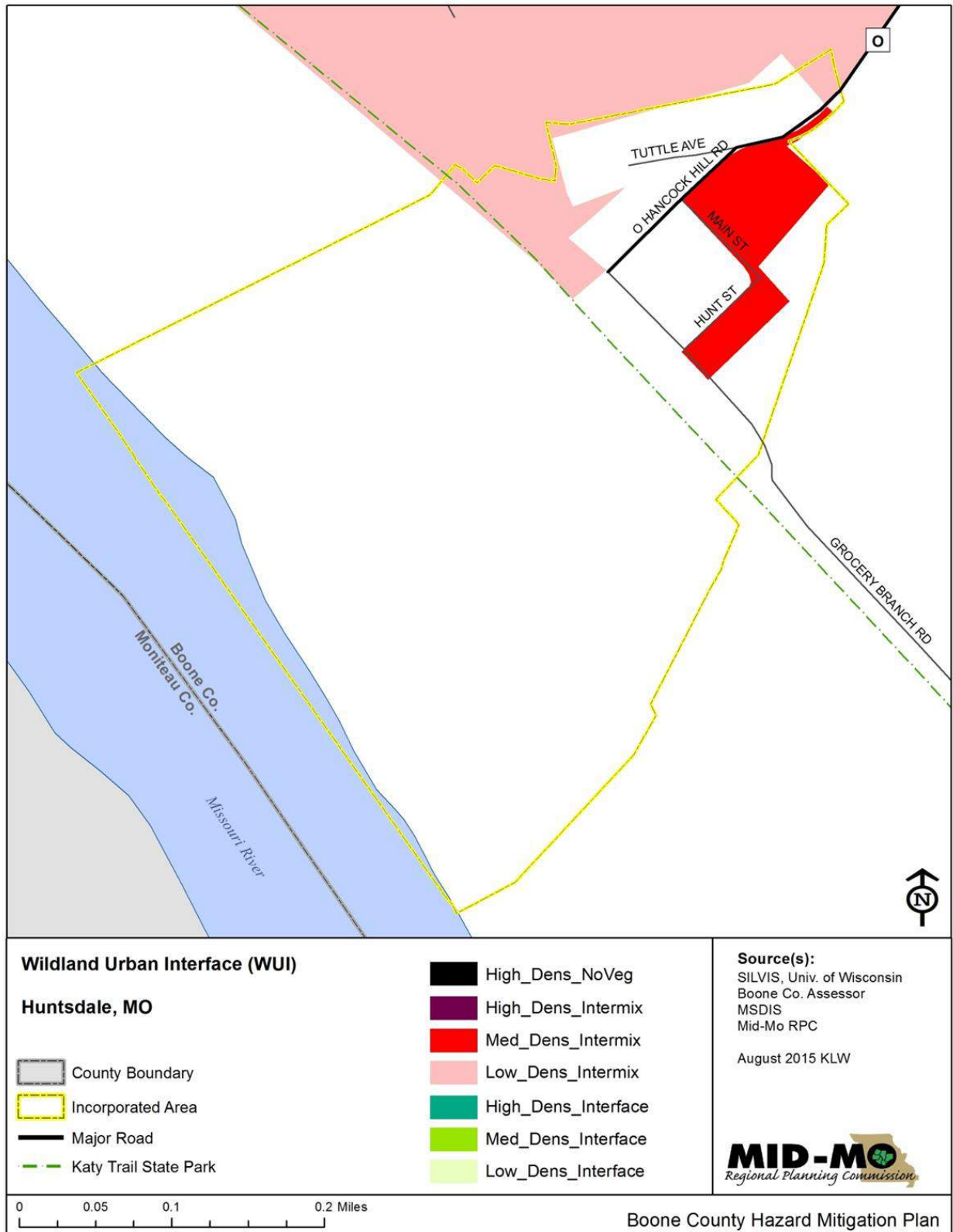


Figure 3.52



Strength/Magnitude/Extent

Most wildfires in the planning area are of limited duration due to the quick response of the fire districts. Wildfires in the area still damage the environment by killing some plants and occasionally animals. Damage to plants can heighten the risk of soil erosion and landslides. Wildfires in the planning area could also impact recreation and tourism, or reduce visibility on roadways with heavy smoke making it dangerous to drive too close to a blaze.

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.

Previous Occurrences

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 Occurrences

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. There's only been 1 reported structure fire caused by a grass fire in the last 20 years for a probability of 5% on any given year.

Changing Future Conditions Considerations

Raising temperatures and more sporadic rains with longer periods of dry between rain events could affect vegetation and the number of days prescribed burns can safely be performed. With increased rainfall can be expected to come an abundance of plant growth that won't be able to be renewed with less prescribed burns making more fuel for fires that potentially get out of control. An increase in droughts and dry vegetation not only in the forest but around homes in the form of depleted landscaping material creates heightened risk for structures to overtaken by wildfires.

VULNERABILITY

Vulnerability Overview

Severity: Moderate – Boone County, Columbia, Harrisburg, Hartsburg, Rocheport
Low – All other participating jurisdictions

There are limitations to the data concerning wildfires. Current presentations utilize data from the National Fire Incident Reporting System (NFIRS) from 2004 to 2008 to determine vulnerability for the State Plan. With only 61 percent of fire departments in Missouri reporting to NFIRS it is hard to get a thorough overview of the rate at which fires happen and how much damage they truly cause.

Potential Losses to 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 Losses to 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.

Hazard Summary by Jurisdiction

Columbia, Harrisburg, Hartsburg, and Rocheport all incorporate significant areas of medium or high-density wildland interface and/or intermix. This makes them more susceptible to damages from out of control burning. Huntsdale incorporates only a small portion of medium density intermix and is slightly less susceptible. Columbia has a burning ordinance in place to help control when, where, and what is being burnt in an effort to promote smart burning practices and good communication to responders if a controlled burn were to become less under control.

Many wildfires in the planning area take place in unincorporated Boone County where burning has less oversight in general. The 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.

Emergency response systems, well trained fire departments, and numerous county roads improve response times to fire events, thus decreasing the chances of fire spread.

PROBLEM STATEMENT

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. Good forestry management, burn ordinances, and burn bans during dry and windy conditions can help limit or prevent possible wildfire situations.

3.5 Technical and Human-Made Risk Assessment

TECHNOLOGICAL AND HUMAN-MADE HAZARDS AFFECTING THE PLANNING AREA

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 3.5:

- 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

A summary of the Probability and Severity ratings for technological/human-made hazards in each of the participating jurisdictions is shown in Figure 4.1.

3.5.1 PUBLIC HEALTH EMERGENCY

HAZARD PROFILE

HAZARD DESCRIPTION

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.

Geographic 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.

Strength/Magnitude/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

There have been contained outbreaks of communicable diseases, such as shigella, and food poisoning incidents in the planning area. Larger public health emergencies have been separated by a number of years.

Historically, 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 (2018)*; the death rate dropped by half in the subsequent year.

In December 2019 Chinese Health officials reported the first cases of what we would come to know as Covid-19. This new form of Coronavirus would swiftly move into a worldwide pandemic. March 13, 2020 Governor Mike Parson signed an executive order declaring a state of emergency for Missouri. Only 4 days later, Boone County reported its first case of Covid-19 on March 17, 2020. As of June 18, 2020 there had been 232 recorded cases of Covid-19 in Boone County.

Probability of Future Events

Moderate for all participating jurisdictions. The uptick in travel throughout the country as well as worldwide elevates the risk of disease spread to large regions of people very quickly.

VULNERABILITY

Vulnerability Overview

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 Losses to Life

Information modeled for the PHS Pandemic Flu Plan in 2006 gives an indication of the potential impact of varying levels of flu pandemic on the planning area (Table 3.52). It should be noted that the population of the planning area has increased by over 20,000 since this modeling was done.

Table 3.52

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	98,166	21,817	4,165

¹FluSurge 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 Losses to Existing Development

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.

Following a large pandemic that has forced businesses to close and people to shelter in place the potential for a recession is heightened which can slow or even halt growth.

Hazard Summary by Jurisdiction

The population density of Columbia and the rapid growth of the Ashland area make it vulnerable to the spread of disease. As Columbia is the center for employment in the region anyone who works in Columbia or does their shopping their run the risk of catching and spreading illnesses out of the city center and into unincorporated Boone and surrounding areas. The City of Columbia is also the source for medical attention in the region which draws people with illnesses and ailments from all over to the planning area. Boone County and Columbia have several plans in place to help mitigate and control the spread of diseases and illnesses in the planning area.

Centralia, Hartsburg, and Huntsdale have 20% or more of their population that is 65 or older according to American Community Survey estimates. Illnesses such as the flu tend to be harder on aging populations. Covid-19 was especially hard on those over the age of 65 or anyone with preexisting medical conditions.

All school districts run a special risk for certain diseases and illnesses due to the number of children that come in close contact with each other throughout the school day. Young children can be challenging to get to understand the impacts the spread of germs can have on others. Mandatory vaccination plays a role in school districts efforts to suppress certain diseases as well as diligent teachers and custodial staff.

PROBLEM STATEMENT

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.

3.5.2 HAZARDOUS MATERIALS RELEASE

HAZARD PROFILE

HAZARD DESCRIPTION

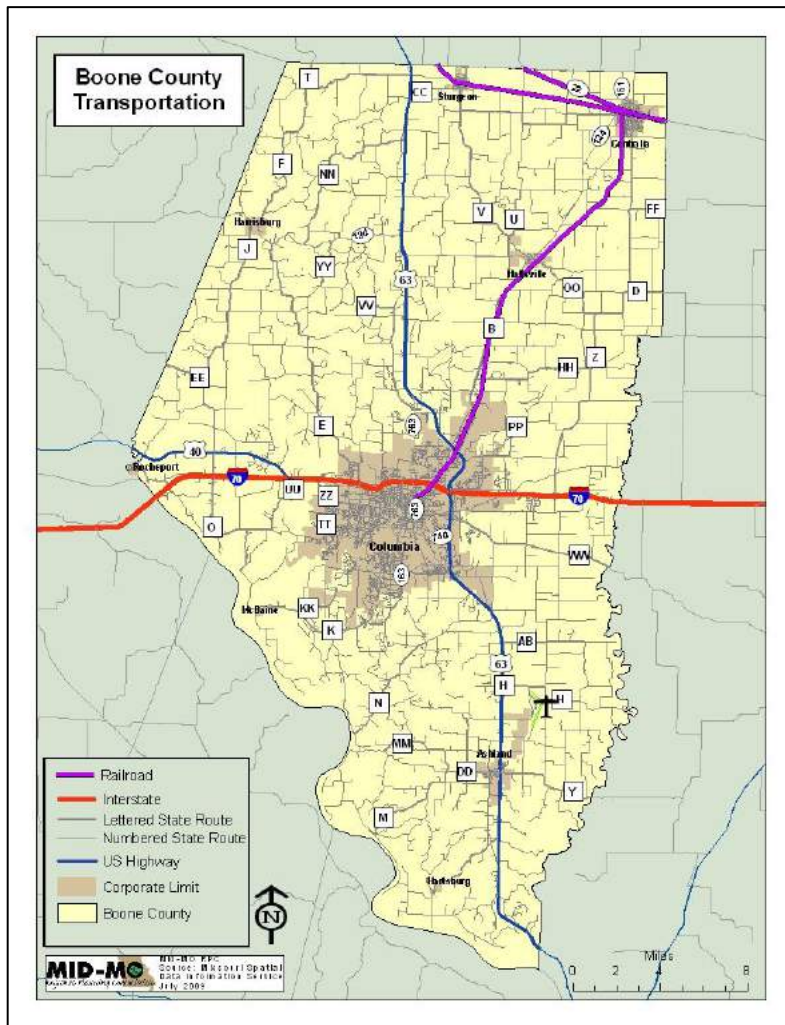
The Department of Homeland Security defines a hazardous materials release as “The improper leak, spillage, discharge, or disposal of hazardous materials or substances (such as explosives, toxic chemicals, and radioactive materials) poses a significant threat to human health and safety, campus property, and the surrounding environment.”

Geographic 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 3.49).

Figure 3.53



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.

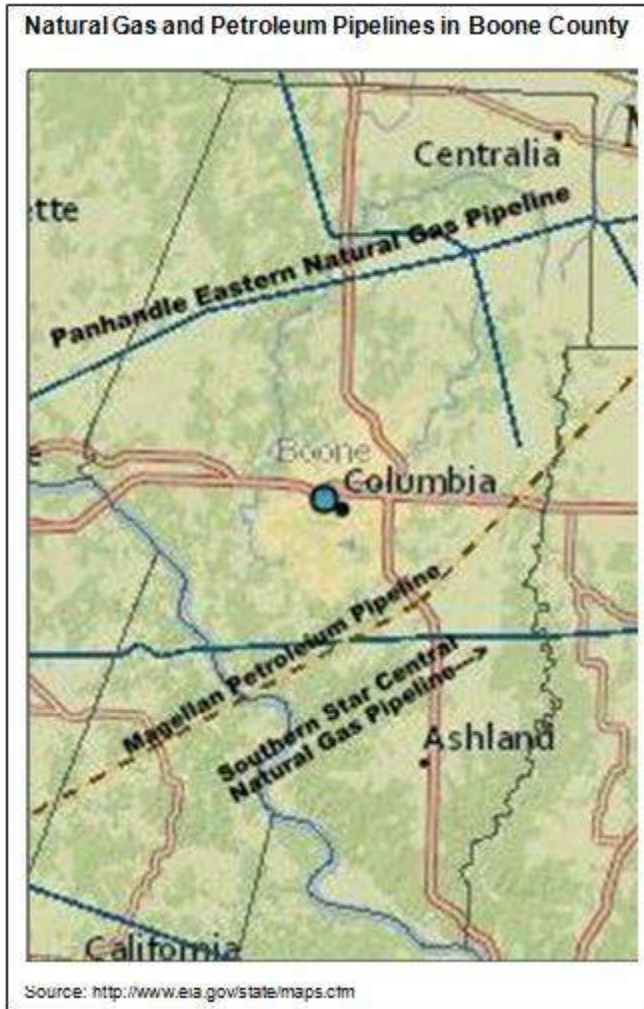
Columbia Regional Airport, located between Columbia and Ashland, serves Boone County and Central Missouri.

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 3.5).

Figure 3.54



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.

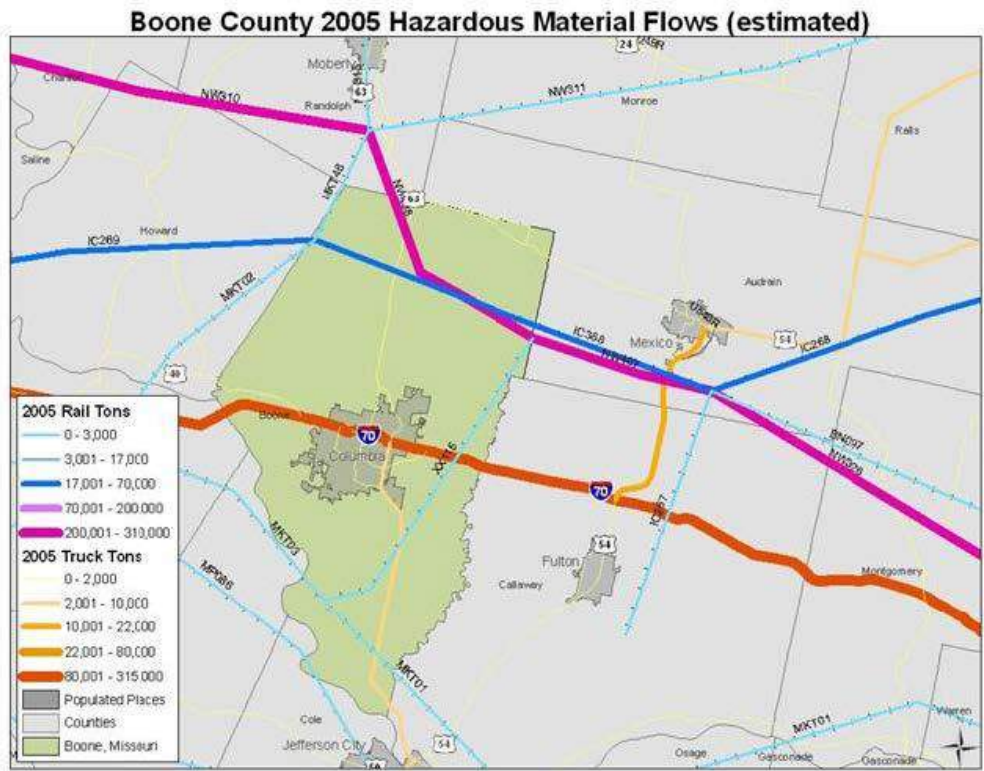
Fixed Facilities: There are a large number of fixed facilities in the planning area that use, produce and/or store hazardous materials. There are a small number of facilities in the planning area that use or store extremely hazardous substances (EHS). The University of Missouri operates the University of Missouri-Columbia Research Reactor (MURR) that produces and stores nuclear waste until it can be shipped off for regulated disposal.

Strength/Magnitude/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 3.51) 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 3.55



Previous Occurrences

Information from the Missouri State Hazard Mitigation Plan (2018) shows release incidents from 2007-2016 Boone County had:

- 15- fixed facility
- 1- airplane/airport
- 1- railroad/railyard
- 129- roadway
- 23- waterway
- 18- pipeline/pump station

Probability of Future Events – Low for all participating jurisdictions

The online MEERTS search rendered 819 incidents in Boone County between 2000-2020. This averages to ~41 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.

Vulnerability

Vulnerability Overview

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 Losses to 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 Losses to Existing Development

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 Losses to 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 break ground in the summer of 2020. 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.

Hazard Summary by Jurisdiction

All jurisdictions in the planning area experience some risk of a spill due to the various transportation networks that run throughout the planning area. Columbia has the most roads and intersections that are used to transport hazardous materials. Busy intersections and a high density of traffic brings opportunity for crashes that can cause hazardous materials being transported through the region to leak or spill.

Columbia is also home to major medical centers that produce hazardous medical waste and the University of Missouri that has the University of Missouri Research Reactor (MURR). With the convenient location of Columbia located centrally to areas of interest and the road network making it quick to transport goods from the area Columbia will continue to draw new business that may create or transport hazardous materials.

Centralia has several rail lines that run through town that can carry various loads, some potentially hazardous that makes them vulnerable to railway accidents.

All jurisdictions with gas stations can have underground tank leaks that can form over time or from poor maintenance.

PROBLEM STATEMENT

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.

3.5.3 TRANSPORTATION INCIDENT

HAZARD PROFILE

HAZARD DESCRIPTION

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 the section on Hazardous Materials Release.

Columbia Regional Airport is located between Columbia and Ashland, to the east of U.S. Highway 63. The airport is served by American Airline and United, with daily flights to and from Chicago, Dallas/Fort Worth, and Denver. In addition, there are numerous charter flights associated with athletics and other activities at the University of Missouri. 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.

Geographic 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.

Strength/Magnitude/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.

In January of 2019 a flight from Dallas/Fort Worth slid off the runway as it was taxiing off the main runway back to its terminal. There were no injuries or fuel/fluid leaks reported with the incident.

Probability of Future Occurrences

Low – Boone County and City of Columbia

Not applicable – all other participating jurisdictions

VULNERABILITY

VULNERABILITY OVERVIEW

By the definition established for this plan, a transportation incident is a passenger rail or air accident which results in injury or death.

Potential Losses of Life

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. As the airport expands to take on larger flights the risk for loss of life in larger quantities in the event of a accident goes up.

Potential Losses of 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 Losses of 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.

Hazard Summary by Jurisdiction

The Columbia Regional Airport is located within the jurisdiction of Columbia, but resides close to Ashland. 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.

No other jurisdictions are located near a commercial airport.

Problem Statement

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.

3.5.4 NUCLEAR INCIDENT

HAZARD PROFILE

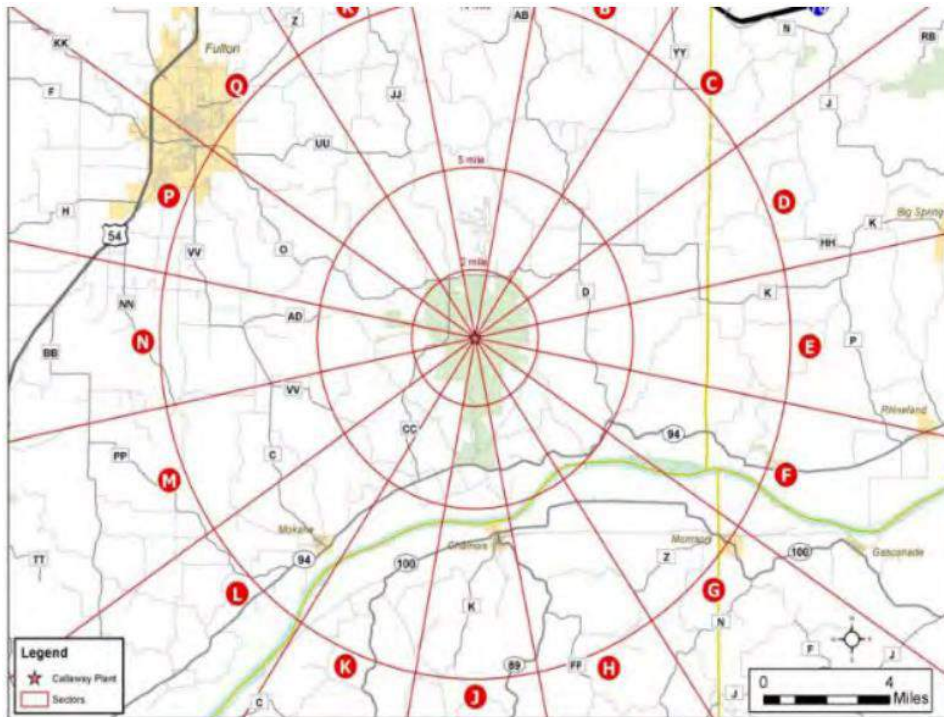
HAZARD DESCRIPTION

This section will deal specifically with the risks posed by a nuclear incident at a nuclear reactor.

Geographic 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 3.52).

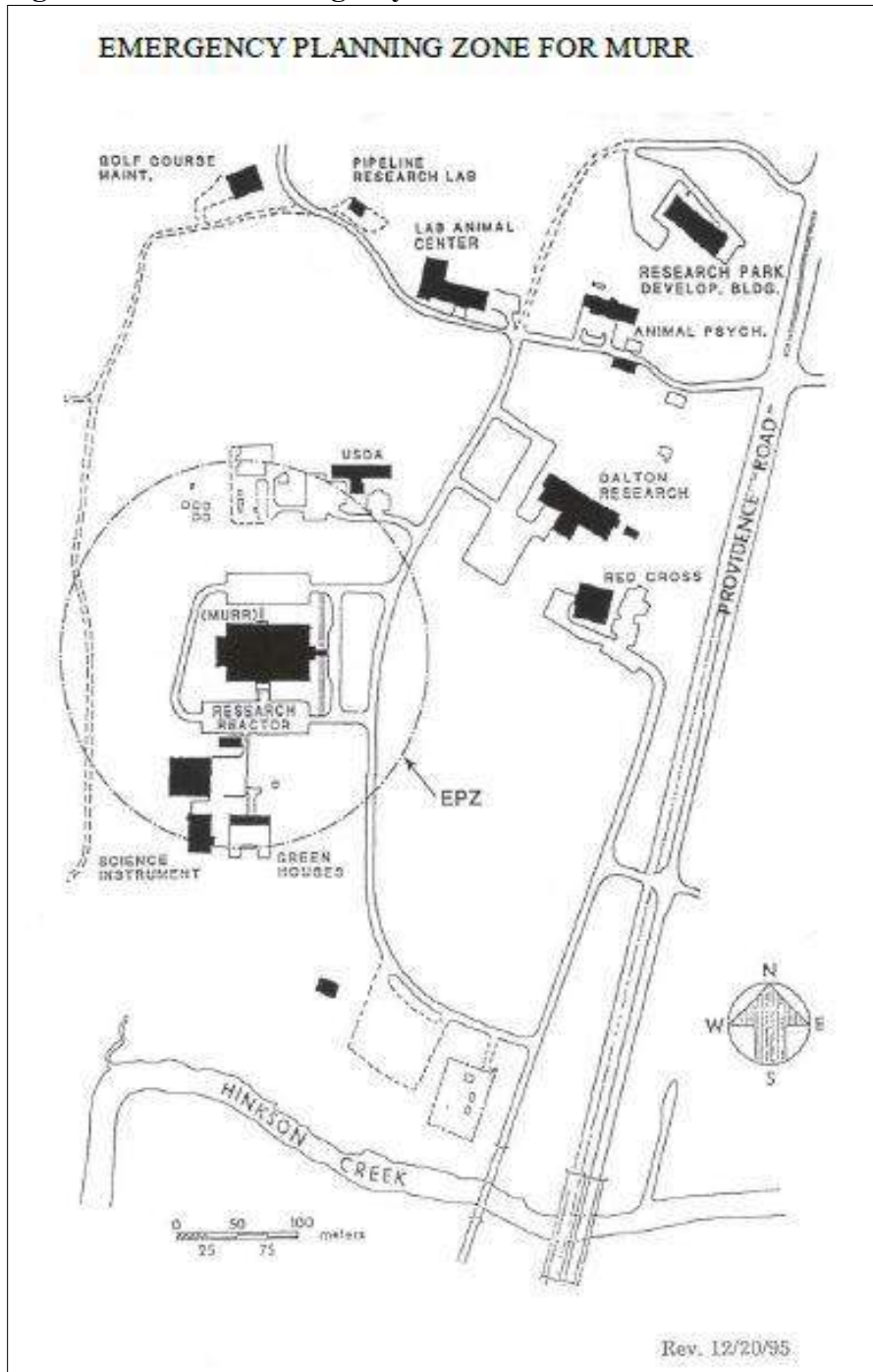
Figure 3.56



Source: Missouri Nuclear Power Plant Accident Plan, 2015

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 3.57 below shows this zone.

Figure 3.57: Murr Emergency Zone



Source: Missouri Hazard Analysis 2013

Strength/Magnitude/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) has extended its license to 2044.

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.

VULNERABILITY

VULNERABILITY OVERVIEW

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 Losses to 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.

Potential Losses to 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 Losses to 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.

Hazard Summary by Jurisdiction

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. Should an event occur at the Callaway plant Columbia would likely feel the most impact from evacuees from the fallout zone coming to their medical centers or seeking shelter.

PROBLEM STATEMENT

While there is one research nuclear reactor 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.

3.5.5 UTILITY SERVICE DISRUPTION

HAZARD PROFILE

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 4.6.

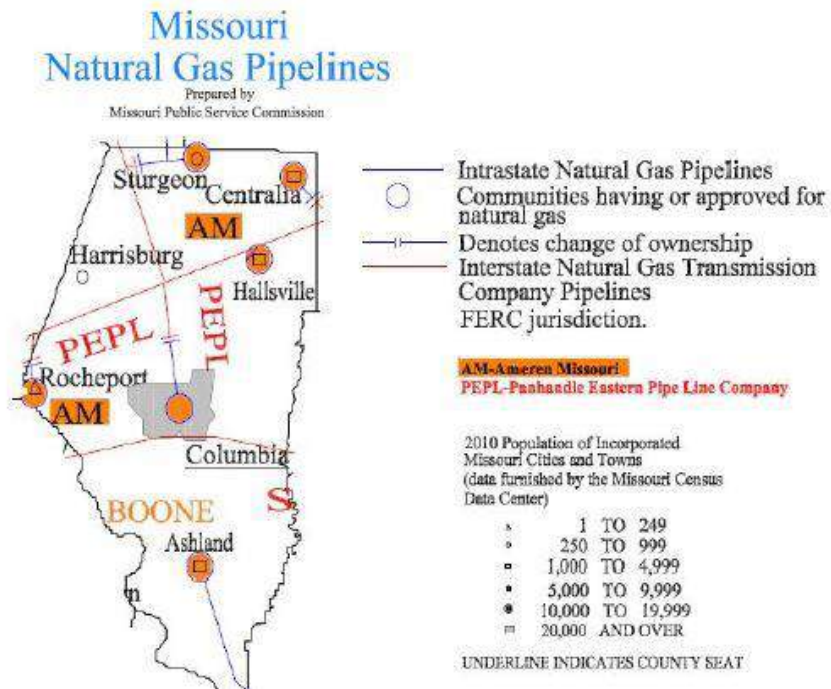
Electrical: A number of the natural hazards profiled in this plan, especially severe winter weather (heavy snow and ice), thunderstorms (wind, hail, lightning), and tornadoes, pose threats to above ground electric utilities. Solar flares are increasingly being recognized as a threat to the power grid. 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,

Figure 3.58

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 3.54).

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.

Geographic Location

The entire planning area is at risk from all types of utility service disruptions.

Strength/Magnitude/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.

VULNERABILITY

Vulnerability Overview

Impacts from utility disruptions are moderate for all participating jurisdictions. Above ground utilities are vulnerable to weather impacts and man-made disruptions either through vandalism, carelessness from homeowners potentially hitting something while digging, or even car accidents that leave the road. Jurisdictions who underground their utilities help lessen the chances for disruption from certain events.

Potential Impacts to 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 Impacts to 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 (Table 3.5).

Table 3.53

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. FEMA estimates the standard value of loss to the economy for every day without electric service is \$126 per person per day. Large outages for extended periods of time in high density areas such as Columbia has large monetary impacts. Based on numbers in the Missouri State Hazard Mitigation Plan (2018) if 10% of the planning area's population (based on 2015 estimates) were to be out of power for one day it would have an impact of \$2,204,672.

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 (Table 3.51-3.52).

Table 3.54

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

Table 3.55

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

Potential Impacts to 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.

Hazard Summary by Jurisdiction

Unincorporated Boone County has several miles of overhead power lines vulnerable to outages. They also have public water supply districts they manage and maintain. Many rural residents are on private wastewater systems so mass outages are less concerning.

Many jurisdictions in the planning area have their own water and wastewater facilities to care for. The City of Columbia is vulnerable to all forms of utility outages due to their population density. Any outage has potential to impact a large number of people.

PROBLEM STATEMENT

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.

3.5.6 TELECOMMUNICATIONS DISRUPTION

HAZARD PROFILE

HAZARD DESCRIPTION

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.

Geographic 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 were 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). Some users saw impacts to cell and data usage at the start of the 2020 Covid-19 Pandemic in the US as people began working from home on their data plans and using the network more to keep in contact with relatives and employers they would usually see in-person.

Probability of Future Events

As technology changes outages are expected intermittently. 5G now looms on the horizon with a massive expansion of the network needed for it to work by adding towers more frequently and at higher densities. As more towers are added in more locations, many in heavily populated areas, the risk of towers being vulnerable to vandalism and accidents increases which can increase the instances of localized outages. It should however reduce large outages.

VULNERABILITY

Vulnerability Overview

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 to 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 to 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 to 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 was highlighted at the start of the Covid-19 Pandemic in the US when students and teachers were forced to go to classes online and students across the planning area had little or no cellular or internet access to continue their learning.

Hazard Summary by Jurisdiction

Areas outside major growth zones like Columbia and Ashland are vulnerable to gaps in communication as the growth outruns communications expansion.

All of unincorporated Boone is at risk if commercial telecommunication systems were to go down. As the system expands and technology changes rural areas could be at risk for disruptions as current trends in tower blanketing could run into coverage roadblocks in the more rugged rural areas.

PROBLEM STATEMENT

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.

3.5.7 CYBER ATTACK

HAZARD PROFILE

HAZARD DESCRIPTION

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: cybercrime, espionage, political activism (“hactivism”), and “just for fun”. Local governments are probably most vulnerable to hacktivists seeking to make a statement or individuals just set on disruption.

Geographic 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 hackmagedon.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 purplesec.us site indicates that social media faced the largest number of attacks (56%) followed by government (27%), industries (8%), retail (4%), and technology records (4). In addition, the 2014 statistics indicate the motivation behind the attacks as follows: cybercrime (56%), accidental loss (34%), malicious insider (7%), Hactivism (2%), unknown (1%).

Strength/Magnitude/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

As more and more people rely on cloud technology and the internet to house data and even control major components of their homes and businesses the impact of any kind of technological attack becomes greater.

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 continued into 2015 with a wave of DDoS attacks; due to security measures put into place, disruption has been minimal.

In 2017 147.9 million consumers were affected by a breach at Equifax.

106 million records were stolen from Capital One in 2019 that contained personal and financial information.

Probability of Future Events

As more and more information and business is conducted online the more value there will be for hackers to attack and steal that information.

VULNERABILITY

Vulnerability Overview

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 to 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 to 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 to 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.

Hazard Summary by Jurisdiction

All jurisdictions in the planning area are vulnerable to a cyber-attack. While some of the smaller jurisdictions such as Hartsburg, Harrisburg, and Huntsdale may have less cyber infrastructure to attack they still maintain some online presence such as email communications.

The City of Columbia is of interest to cyber-attackers. They maintain a large online presence and technology department. A large attack on the City of Columbia could cause large disruptions to many people living or traveling through the community.

All school districts face vulnerability to cyber-attacks and malware.

PROBLEM STATEMENT

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. Cyber-security risks critical information and physical operations if a hacking attempt is successful.

3.5.8 UNWANTED INTRUDER/ACTIVE SHOOTER

HAZARD PROFILE

HAZARD DESCRIPTION

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.

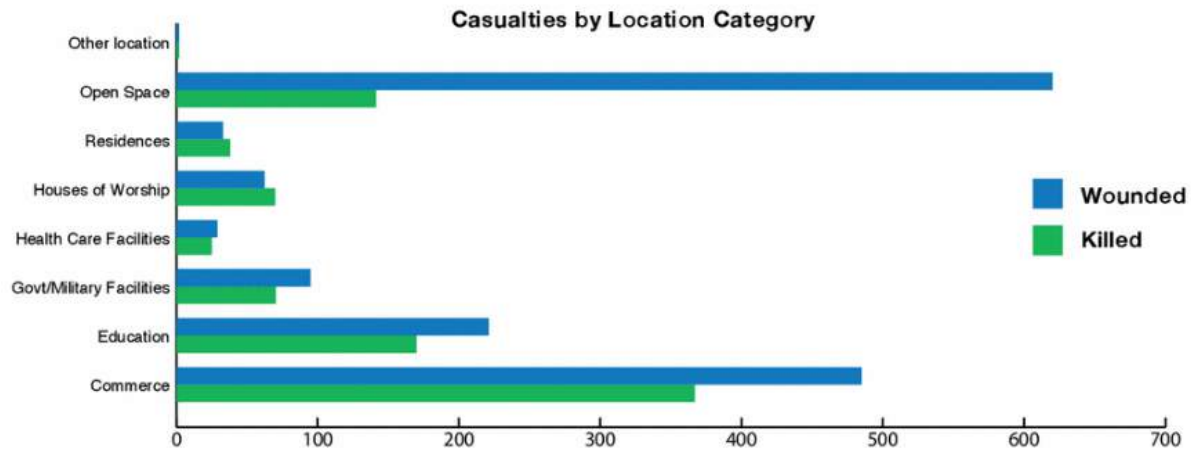
Mitigating for active shooter events is essentially mitigating for unwanted intruders; the intention of intruders cannot always be known at the outset.

Geographic 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. The FBI puts out studies and documents that look at active shooter situations across the U.S. The figure below comes from their “Active Shooter Incidents: Topical One-Pager, 2000-2018”.

Figure 3.59

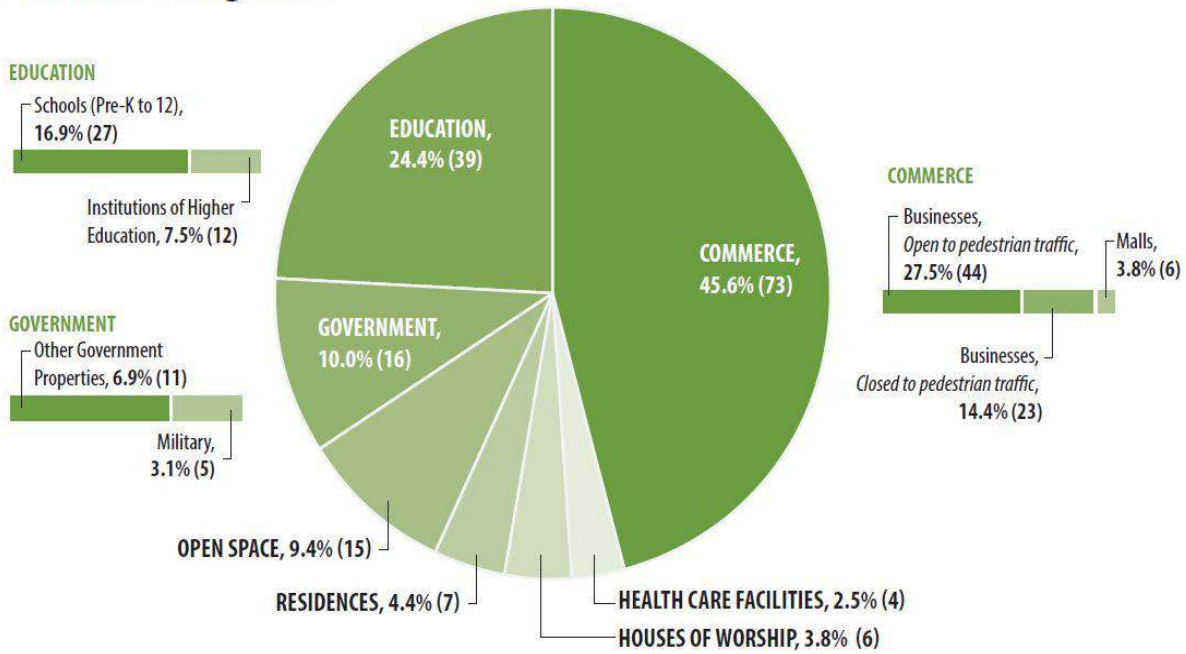
Quick Look:



Other: Wounded-1 Killed-1. Open Space: Wounded-618, Killed-140. Residences: Wounded-37, Killed-40. Houses of Worship: Wounded-60, Killed-71. Health Care Facilities: Wounded-30, Killed-25. Govt/Military Facilities: Wounded-94, Killed-71. Education: Wounded-220, Killed-171. Commerce: Wounded-486, Killed-365.

Figure 3.60

**A Study of 160 Active Shooter Incidents in the United States Between 2000 - 2013:
Location Categories**



Source: <https://www.fbi.gov/file-repository/active-shooter-one-page-summaries-2000-2018.pdf/view>

Source: Federal Bureau of Investigation, 2014

Strength/Magnitude/Extent

The 2013 FBI report “A Study of Active Shooter Incidents in the United States Between 2000 and 2013” 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 277 active shooter events in the nation in the period 2000-2018. This was an average of 15.4 events per year.

Probability of Future Events - High

An 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.

VULNERABILITY

Vulnerability Overview

During the period 2000-2018, 277 active shooter events in the U.S. resulted in 884 deaths and 1,546 injuries, according to the 2000-2018 FBI Topical One-Pager.

Potential Losses to 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 Losses to 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 Losses to 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.

Hazard Summary by Jurisdiction

All jurisdictions in the planning area are vulnerable to an active shooter situation. The City of Columbia is the government seat for the county and hosts large events that can become targets for an active shooter.

All school districts and education facilities are potential targets for attack.

Hartsburg has a pumpkin festival in the fall that draws large crowds to a rural outdoor venue that could be difficult to get additional emergency personnel into if a mass shooting event were to occur.

PROBLEM STATEMENT

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.

3.5.9 TERRORISM

HAZARD PROFILE

HAZARD DESCRIPTION

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.

Geographic 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.

Strength/Magnitude/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.

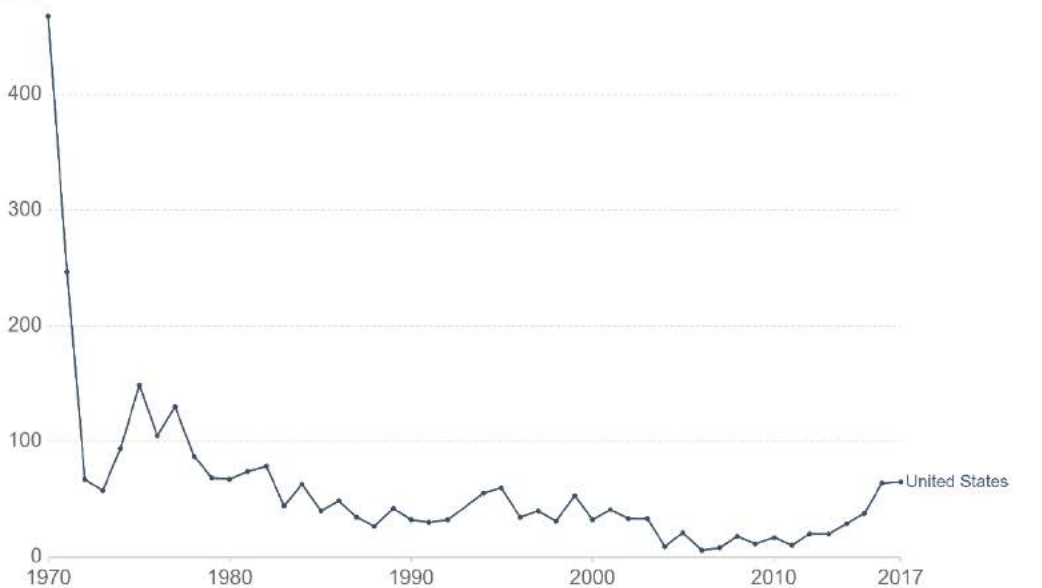
Probability of Future Events

While terrorism has been increasing dramatically worldwide since about 2004 (Figure 3.57), incidents in the U.S. declined since the 1990s, but have started to go back up in recent years 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 1970-2017.

Figure 3.61

Number of terrorist attacks, 1970 to 2017

The source defines a terrorist attack as: "the threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic, religious, or social goal through fear, coercion, or intimidation." The perpetrators of the incidents must be sub-national actors; data does not include acts of state terrorism.



Source: Global Terrorism Database (2018)

OurWorldInData.org/terrorism/ • CC BY

Vulnerability

Vulnerability Overview

While the potential for a terrorist attack is low in the planning area the City of Columbia's location at the crossroads of major transportation avenues make it a possible target. Damage to

the road network running through Columbia could cause large delays in transportation of goods and services, not only in Central Missouri, but across the state and for the Central U.S.

Potential Losses to 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 Losses to 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 Losses to Future Development

Future development could provide new structural targets for terrorism but, overall, does not really impact the threat.

Hazard Summary by Jurisdiction

The City of Columbia is at greatest risk for terrorism since it is the largest urban area in the region and houses the most critical infrastructure. There is little terroristic threat to other jurisdictions within the region.

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.

PROBLEM STATEMENT

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. As political tensions rise within and throughout the country acts of domestic terrorism could become an increasing factor for locals to consider.

3.5.10 CIVIL DISORDER

HAZARD PROFILE

HAZARD DESCRIPTION

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”.

Geographic 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).

Strength/Magnitude/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.
- In 2020, protests across the country over the police killing of a man in Minneapolis brought protests to the streets of Columbia. While protests elsewhere occasionally broke out in looting, riots, and the burning of local business, protest in Columbia remained calm. Minor injuries were reported when a driver hit a couple of protesters who were standing in a road intersection.

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.”

VULNERABILITY

VULNERABILITY OVERVIEW

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 Losses to Life

Civil disorder poses a risk of injury and possibly even death in large scale rioting.

Potential Losses to Existing Structures

There is the potential for significant damage to buildings and property from civil disorder which becomes violent.

Potential Losses to 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.

Hazard Summary by Jurisdiction

The City of Columbia and University Campuses have the highest risk for civil unrest. 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.

Unincorporated Boone and its smaller jurisdictions are low risk for major civil unrest.

PROBLEM STATEMENT

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.

3.5.11 MASS CASUALTY/FATALITY EVENT

HAZARD PROFILE

HAZARD DESCRIPTION

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.

Geographic Location

The entire planning area is vulnerable to a mass casualty/fatality event.

Strength/Magnitude/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.

During the Covid-19 Pandemic MU medical centers prepared for an influx of coronavirus patients from all over the region. Luckily, they did not see the crippling levels of patients that hospitals in other states and regions were subjected to.

Probability of Future Events

Many things can lead to mass casualties ranging from severe weather events, to car accidents, to pandemics and targeted attacks. With the past incidents combined with the high number of opportunities to see fatalities the probability of them is high.

VULNERABILITY

Vulnerability Overview

The entire jurisdiction is vulnerable to mass casualties. A major accident strains emergency personnel in the vicinity of the accident, road crews if a road is shut down or damaged, and the medical professionals who have to triage and help those coming in injured. Jurisdictions where medical and first responder facilities are located and well-traveled roads that run through towns or blind intersections are vulnerable to mass casualties.

Potential Losses to 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 Losses to 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 Losses to 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.

Hazard Summary by Jurisdiction

All jurisdictions are vulnerable to mass casualty events from a variety of sources. Major road accidents, severe weather mentioned in earlier sections, heat exhaustion at sporting events or other large gatherings can pose serious risks to a large number of people at one time.

School districts must take care at sporting events to ensure students and spectators are safe.

PROBLEM STATEMENT

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.

Chapter 4: Mitigation Strategy

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- 4.2 Identification and Analysis of Mitigation Actions.....306
- 4.3 Implementation of Mitigation Actions.....308

Chapter 4: Mitigation Strategy

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

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.

4.1 GOALS

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

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 planning committee chose to not change the goals for this update as they felt they were still feasible and relevant to challenges facing the planning area.

The five goals for the Boone County Hazard Mitigation Plan (2020) 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.

4.2 Identification and Analysis of Mitigation Actions

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

Update of Mitigation Actions

The Planning Committee for the 2020 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 2020 update; some were deleted as unrealistic or inappropriate and some were removed for completion.

For the 2020 update, the actions in the plan were reviewed by the planning committee and categorized as follows:

- Completed with a description of the progress.
- Some uncompleted actions were removed from the strategy action plan for various reasons.
- Many of the 2015 actions were kept in the 2020 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.

Table 4.1 Action Status Summary

Jurisdiction	Completed Actions	Continuing Actions (ongoing or modify)	Deleted Actions
All	4	79	3

Table 4.2 Summary of Completed and Deleted Actions from the previous Plan

Completed Actions	Completion Details
Conduct a phased flow study along major highway routes to help determine quantities of hazardous materials being transported	2017

through Boone County	
Investigate tools for automated notification system to be used collaboratively throughout Boone County and its jurisdictions.	RAVE
Acquire generators and power transfer hookup equipment.	RHSOC funding
Conduct survey of generator needs of critical infrastructure in planning area; include information on sizing, hookup, and fuel storage.	2016
Deleted Actions	Reason for Deletion
Continue to meet Revised Statutes of Missouri concerning earthquake emergency system and earthquake safety in schools.	This is being done since it's required
Evaluate and maintain emergency preparedness plans.	This is being done since it's required
Conduct emergency preparedness exercises periodically throughout the year.	This is being done and is not measurable

4.3 IMPLEMENTATION OF MITIGATION ACTIONS

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

Jurisdictional MPC members were encouraged to meet with members of their community to finalize actions to be submitted for the updated mitigation strategy. The Disaster Mitigation Act requires benefit-cost review as the primary method by which mitigation projects should be prioritized. The committee was asked to take this into account when discussing actions for their jurisdiction. It was decided that projects will be prioritized by when and where damage occurs, available funding, and political will. Details of projects at the planning stage are not in-depth benefit/cost reviews and further details will be refined as there is project development

STAPLEE AND BENEFIT/COST REVIEWS

STAPLEE Review – The process for selecting and prioritizing action items did not change for the update. The Planning Committee conducted a STAPLEE review of the ongoing and possible new mitigation actions using key questions for each of the STAPLEE categories:

Table 4.3: Blank STAPLEE Worksheet

STAPLEE Worksheet		
Name of Jurisdiction:		
Action or Project		
Action/Project Number:	Insert a unique action number for this action for future tracking purposes. This can be a combination of the jurisdiction name, followed by the goal number and action number (i.e. Joplin1.1)	
Name of Action or Project:		
Mitigation Category:	Prevention; Structure and Infrastructure Projects; Natural Systems Protection; Education and Outreach; Emergency Services	
STAPLEE Criteria		Score
Evaluation Rating Definitely YES = 3 Maybe YES = 2 Probably NO = 1 Definitely NO = 0		
S: Is it Socially Acceptable		
T: Is it Technically feasible and potentially successful?		
A: Does the jurisdiction have the Administrative capacity to execute this action?		
P: Is it Politically acceptable?		
L: Is there Legal authority to implement?		
E: Is it Economically beneficial?		
E: Will the project have either a neutral or positive impact on the natural Environment ?		
Will historic structures be saved or protected?		
Could it be implemented quickly?		
STAPLEE SCORE		
Mitigation Effectiveness Criteria	Evaluation Rating	Score
Will the implemented action result in lives saved?	Assign from 5-10 points based on the likelihood that lives will be saved.	
Will the implemented action result in a reduction of disaster damages?	Assign from 5-10 points based on the relative reduction of disaster damages.	
MITIGATION EFFECTIVENESS SCORE		
TOTAL SCORE (STAPLEE + Mitigation Effectiveness)		

<input type="checkbox"/> High Priority (30+ points)	<input type="checkbox"/> Medium Priority (25 - 29 points)	<input type="checkbox"/> Low Priority (<25 points)
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Completed by _____
(Name, Title, Phone Number)

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)

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. 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.

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Information gaps in population location for disaster planning
Action or Project	
Applicable Goal Statement:	5
Action/Project Number:	1.1.1
Name of Action or Project:	GIS data sharing
Mitigation Category:	Preparedness
Action or Project Description:	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Boone County GIS
Supporting Organization/Department:	Boone County Assessor
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	County/City Funds
Local Planning Mechanisms to be Used in Implementation, if any:	The County will be meeting with FEMA staff to work on the next step of their digitization project.
Progress Report	
Action Status:	In Progress
Report of Progress:	GIS data is supplied

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Flooding
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.2
Name of Action or Project:	RISK Map
Mitigation Category:	Preparedness
Action or Project Description:	Continue to participate as a partner in FEMA's RISKMap process.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Boone County Resource Management Dept
Supporting Organization/Department:	FEMA
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal funding
Local Planning Mechanisms to be Used in Implementation, if any:	This is an ongoing activity with the Boone County Resource Management Dept
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Early warning of hazardous events
Action or Project	
Applicable Goal Statement:	4
Action/Project Number:	1.1.3
Name of Action or Project:	Siren Tests
Mitigation Category:	Preparedness
Action or Project Description:	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.
Estimated Cost:	\$0
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	BCJC
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	Ongoing
Report of Progress:	Regular Testing

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Thunderstorms
Problem being Mitigated:	Utility outages and road blocking
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.4
Name of Action or Project:	Brush Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Develop and adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.
Estimated Cost:	\$100,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	County
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Ongoing
Report of Progress:	Schedule has been created

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Planning for Telecommunications Disruption during any event
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.5
Name of Action or Project:	Telecom Risk Assessment
Mitigation Category:	Preparedness
Action or Project Description:	Conduct detailed risk assessments and cost/benefit analyses of telecommunications and networking vulnerabilities in individual municipalities.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	All Jurisdictions
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In Progress
Report of Progress:	Information gathered

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Boone County COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$50,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	All stakeholders
Action/Project Priority:	High
Timeline for Completion:	2020
Potential Fund Sources:	Internal, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In progress
Report of Progress:	Almost finished

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	All that can be funded
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.7
Name of Action or Project:	Revolving Local Hazard Mitigation Fund
Mitigation Category:	Preparedness
Action or Project Description:	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.
Estimated Cost:	Unknown
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	Boone County, jurisdictions, Economic Development Groups, etc
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, EDA
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	Possible sources identified

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather and Thunderstorms
Problem being Mitigated:	Utility outages during winter weather and thunderstorms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.8
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Move current aboveground utilities underground.
Estimated Cost:	\$100 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Resource Management Dept.
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2050 – Ongoing as there’s new development
Potential Fund Sources:	FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	The County and developers work together to underground utilities for new development.
Progress Report	
Action Status:	Ongoing
Report of Progress:	New developments have underground utilities

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Extreme Temperatures
Problem being Mitigated:	Makes sure that people have access to shelter during extreme temperatures
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.9
Name of Action or Project:	Cooling/Warming Center agreements
Mitigation Category:	Preparedness
Action or Project Description:	Review and formalize relationships with cooling and warming centers in each community.
Estimated Cost:	\$0
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	All Jurisdictions
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Review listing of current warming/cooling centers and identify gaps within community. Work with stakeholders to fill gaps.
Progress Report	
Action Status:	In progress
Report of Progress:	Identifying gaps

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Telecommunications Disruption during storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.10
Name of Action or Project:	Cell on Wheels Agreements
Mitigation Category:	Preparedness
Action or Project Description:	Establish agreements with cellular providers for "Cell on Wheels" units to be made available in case of telecommunications disruption.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	Private Vendors
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Work with vendors to establish agreements and request procedures to ensure quick deployment of cellular networks.
Progress Report	
Action Status:	In Progress
Report of Progress:	Have procedures

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Dam Failure/Flooding
Problem being Mitigated:	Planning for Dam Failure
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.11
Name of Action or Project:	Dam EAPs
Mitigation Category:	Preparedness
Action or Project Description:	Develop Emergency Action Plans (EAPs) for dams that are not regulated by the State.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	Dam and Reservoir Safety Program (MO DNR, Rolla)
Action/Project Priority:	Low
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In Progress
Report of Progress:	Unregulated dams identified

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Resource Management Dept.
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	
Local Planning Mechanisms to be Used in Implementation, if any:	This is an ongoing activity within the Planning and Building Department.
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Provide guidance for construction against hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.13
Name of Action or Project:	Building Code Update
Mitigation Category:	Preparedness
Action or Project Description:	Review building codes every three years for possible update.
Estimated Cost:	\$0
Benefits:	IC, PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	County Planning & Building Inspections
Supporting Organization/Department:	County Commission
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	
Local Planning Mechanisms to be Used in Implementation, if any:	Building codes
Progress Report	
Action Status:	In Progress
Report of Progress:	The County is currently in the process of reviewing the most recent code.

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Earthquake, Tornado
Problem being Mitigated:	Ensures essential equipment isn't harmed during earthquakes or tornados
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.14
Name of Action or Project:	Equipment Locks
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Lock down high value equipment located outside of county and municipal buildings (e.g. HVAC, generators, communication equipment) to protect against earthquake or tornado damage
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, RHSOC
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Flooding of roadways and low water crossings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.15
Name of Action or Project:	Flash Flood Mitigation
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Mitigate the effects of flooding on public infrastructure by raising low water crossings and upgrading stormwater capacity.
Estimated Cost:	\$100 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Depts. of Public Works and Planning
Supporting Organization/Department:	County Commission
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	Departments of Public Works and Planning will make recommendations on this.
Progress Report	
Action Status:	In Progress
Report of Progress:	Low water crossings identified

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Earthquake, Tornado, Extreme Temperatures, Winter Weather
Problem being Mitigated:	Trapped elderly and special needs populations during a disaster event
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.16
Name of Action or Project:	Evacuation Routes
Mitigation Category:	Preparedness
Action or Project Description:	Ensure evacuation plans are adequate for nursing homes and special needs populations.
Estimated Cost:	\$0
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	Red Cross
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Tornados, Flooding, Extreme Temperatures,
Problem being Mitigated:	Keeping shelters open in all events that could displace people
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.17
Name of Action or Project:	Shelter Backup HVAC
Mitigation Category:	Preparedness
Action or Project Description:	Encourage shelters to have alternative heating sources.
Estimated Cost:	\$0
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	Red Cross
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	This is part of the overall Emergency Operations Plan which covers the entire Planning Area.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All hazards
Problem being Mitigated:	Displaced populations due to Tornados, Floods, utility outages
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.18
Name of Action or Project:	Supply Cache
Mitigation Category:	Preparedness
Action or Project Description:	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.
Estimated Cost:	\$10,000
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Columbia/Boone County Dept. of Public Health and Human Services
Supporting Organization/Department:	Office of Emergency Management; community-based organizations; faith-based organizations
Action/Project Priority:	Low
Timeline for Completion:	2020
Potential Fund Sources:	Grants; the Medical Reserve Corps (MRC) Capacity Building Grant is one potential funding source
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Mental health during hazardous events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.19
Name of Action or Project:	Mental First Aid
Mitigation Category:	Preparedness
Action or Project Description:	Host Psychological First Aid courses in order to create a local Psychological First Aid capacity.
Estimated Cost:	\$5,000
Benefits:	IC, LF, EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	All Stakeholders
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	DHSS, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Helps public know what to do to be safer during all hazards
Action or Project	
Applicable Goal Statement:	4
Action/Project Number:	1.1.20
Name of Action or Project:	Public Education
Mitigation Category:	Education
Action or Project Description:	Continue to educate the public on all hazards.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	Local Media
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Program Funds
Local Planning Mechanisms to be Used in Implementation, if any:	This is an activity of the Office of Emergency Management and is carried out through press releases and available literature.
Progress Report	
Action Status:	In progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Storms, Winter Weather, Tornados, Flooding
Problem being Mitigated:	Warns people of severe weather
Action or Project	
Applicable Goal Statement:	4
Action/Project Number:	1.1.21
Name of Action or Project:	Weather Radios
Mitigation Category:	Preparedness
Action or Project Description:	Promote the purchase and use of NOAA radios
Estimated Cost:	\$5,000
Benefits:	IC, PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	Office of Emergency Management
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Grants, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Boone County
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Promotes Readiness in the even evacuation is necessary
Action or Project	
Applicable Goal Statement:	4
Action/Project Number:	1.1.22
Name of Action or Project:	Ready-in-3
Mitigation Category:	Preparedness
Action or Project Description:	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.
Estimated Cost:	\$1,000
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Columbia/Boone County Dept. of Public Health and Human Services
Supporting Organization/Department:	OEM, community-based organizations, MO DHSS
Action/Project Priority:	Medium
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Ashland
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	All hazards are reviewed and planned for
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.6
Name of Action or Project:	Ashland COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Hall
Supporting Organization/Department:	RPC
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Grants, FEMA,
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not yet started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Ashland
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Storms, Tornados, Winter Weather
Problem being Mitigated:	Mitigates power outages during storms
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$50 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Public Works
Supporting Organization/Department:	Utility Company
Action/Project Priority:	High
Timeline for Completion:	2050 - Ongoing
Potential Fund Sources:	FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	Planning and zoning ordinance
Progress Report	
Action Status:	In Progress
Report of Progress:	Ongoing

Action Worksheet	
Name of Jurisdiction:	Ashland
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Mitigates flood damage to existing and future development
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Zoning
Supporting Organization/Department:	Boone County
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Zoning ordinances
Progress Report	
Action Status:	In progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Ashland
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	FEMA Safe Rooms
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	School District, community groups
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	Engineering in place

Action Worksheet	
Name of Jurisdiction:	Ashland
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Flash flooding in streets and parking areas
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.5
Name of Action or Project:	Stormwater Upgrade
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.
Estimated Cost:	\$1 million
Benefits:	PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	.City Public Works
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Centralia
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Storms, Tornados
Problem being Mitigated:	Public notification of severe weather
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	3.1.1
Name of Action or Project:	Siren Testing
Mitigation Category:	Preparedness
Action or Project Description:	Continue monthly testing of outdoor warning sirens in compliance with procedures set by the Office of Emergency Management.
Estimated Cost:	\$0
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	Boone County
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Centralia
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Analyze preparedness for all hazards
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.6
Name of Action or Project:	Centralia COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP)
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Administrator
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	Portions Written

Action Worksheet	
Name of Jurisdiction:	Centralia
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Severe Storms, Tornados
Problem being Mitigated:	Utility outages during major storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$ 50 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2050
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Building ordinance
Progress Report	
Action Status:	In Progress
Report of Progress:	New utilities are underground

Action Worksheet	
Name of Jurisdiction:	Centralia
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Flooding of homes and businesses
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Administrator
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	This is an ongoing process when issuing building permits and reviewing subdivision plans.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Centralia
Risk / Vulnerability	
Hazard(s) Addressed:	Wildfire
Problem being Mitigated:	Wildfires caused by burning trash or yard waste
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	3.1.5
Name of Action or Project:	Burn Ban
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Develop policy and enforcement regulations concerning burning permits.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Administrator
Supporting Organization/Department:	Volunteer Fire Department
Action/Project Priority:	Low
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Regulations are in place concerning when and how burning can take place.
Progress Report	
Action Status:	In Progress
Report of Progress:	Burning regulations in place

Action Worksheet	
Name of Jurisdiction:	Centralia
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Flash flooding of city streets and properties
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.5
Name of Action or Project:	Stormwater Upgrade
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.
Estimated Cost:	\$1 million
Benefits:	PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	Public Works
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, CDBG, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Recognition of issues in comprehensive plan and capital improvement plans, as well as subdivision regulations
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Information gaps in population location for disaster planning
Action or Project	
Applicable Goal Statement:	5
Action/Project Number:	1.1.1
Name of Action or Project:	GIS Data Sharing
Mitigation Category:	Preparedness
Action or Project Description:	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Columbia Public Works Department
Supporting Organization/Department:	GIS/Boone County
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Public Works staff will provide flood plain modeling info and Letter of Map Review (LOMR) applications to SEMA as they come available.
Progress Report	
Action Status:	In Progress
Report of Progress:	GIS data is supplied

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Flooding
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.2
Name of Action or Project:	RISK Map
Mitigation Category:	Preparedness
Action or Project Description:	Continue to participate as a partner in FEMA's RISKMap process.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	FEMA/Boone County
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal funding
Local Planning Mechanisms to be Used in Implementation, if any:	Attend meetings and contribute as possible.
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Columbia COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$50,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Committee; City Manager's Office; Enterprise Departments
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In progress
Report of Progress:	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.

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Extreme Temperatures
Problem being Mitigated:	Makes sure that people have access to shelter during extreme temperatures
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.9
Name of Action or Project:	Cooling/Warming Center Agreements
Mitigation Category:	Preparedness
Action or Project Description:	Review and formalize relationships with cooling and warming centers in each community.
Estimated Cost:	\$0
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Columbia/Boone County Department of Health & Human Services
Supporting Organization/Department:	Local non-profits and service organizations
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Review listing of current warming/cooling centers and identify gaps within community. Work with stakeholders to fill gaps.
Progress Report	
Action Status:	In progress
Report of Progress:	Identifying gaps

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Public Works staff reviews all development plans to ensure ordinances are followed.
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Sinkholes/Land Subsidence
Problem being Mitigated:	Regulates for possible disruption to steams/stormwater due to sinkholes
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	4.1.1
Name of Action or Project:	Sinkhole Regulation
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Add sinkhole regulations to stream buffer/storm water ordinance.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2020
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Staff will draft sinkhole regulations for City Council consideration.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Provide guidance for construction against hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.13
Name of Action or Project:	Building Code Update
Mitigation Category:	Preparedness
Action or Project Description:	Review building codes every two years for possible update.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Staff will review codes along with Building Code Commission and adopt current regulations as directed.
Progress Report	
Action Status:	In Progress
Report of Progress:	The City is currently in the process of reviewing the most recent code.

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Dam Failure
Problem being Mitigated:	The loss of infrastructure due to dam failure
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	4.1.2
Name of Action or Project:	Dam Road Regulation
Mitigation Category:	Preparedness
Action or Project Description:	Develop regulations for roads on dams.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	TBD
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Staff will develop ordinance for City Council consideration that addresses the placement of public roadways on non-regulated dams.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Earthquake, Tornado
Problem being Mitigated:	Ensures essential equipment isn't harmed during earthquakes or tornados
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	1.1.14
Name of Action or Project:	Equipment Locks
Mitigation Category:	Hazard Mitigate
Action or Project Description:	Lock down high value equipment located outside of county and municipal buildings (e.g. HVAC, generators, communication equipment) to protect against earthquake or tornado damage
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025-ongoing
Potential Fund Sources:	Internal, RHSOC, grants, bonds
Local Planning Mechanisms to be Used in Implementation, if any:	Facilities Planning as new facilities are built
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Damage to public infrastructure from hazardous events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	4.1.3
Name of Action or Project:	Weather Asset Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Mitigate the effects of flooding, extreme heat, utility service outage and severe storms on public infrastructure by undergrounding lines, elevating roads and low-water crossings, and clearing trees back from infrastructure.
Estimated Cost:	\$50 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Depts. of Public Works and Planning
Supporting Organization/Department:	City Council
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	Departments of Public Works and Planning will make recommendations on this.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	All hazards
Problem being Mitigated:	Displaced population supplies during major disasters
Action or Project	
Applicable Goal Statement:	1
Action/Project Number:	1.1.18
Name of Action or Project:	Supply Cache
Mitigation Category:	Preparedness
Action or Project Description:	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable populations; include strategies for food, water, hygiene, and medical supplies.
Estimated Cost:	\$10,000
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Columbia/Boone County Dept. of Public Health and Human Services
Supporting Organization/Department:	Office of Emergency Management; community-based organizations; faith-based organizations
Action/Project Priority:	Low
Timeline for Completion:	2020
Potential Fund Sources:	Grants; the Medical Reserve Corps (MRC) Capacity Building Grant is one potential funding source
Local Planning Mechanisms to be Used in Implementation, if any:	Survey for preparedness levels and obstacles to preparedness; analyze obstacles and develop strategy to overcome.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Transportation Incident
Problem being Mitigated:	Crashes at the Airport
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	4.1.4
Name of Action or Project:	Airport Compliance
Mitigation Category:	Preparedness
Action or Project Description:	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Columbia Regional Airport
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Promotes Readiness in the even evacuation is necessary
Action or Project	
Applicable Goal Statement:	4
Action/Project Number:	1.1.22
Name of Action or Project:	Ready-in-3
Mitigation Category:	Preparedness
Action or Project Description:	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.
Estimated Cost:	\$1,000
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Columbia/Boone County Dept. of Public Health and Human Services
Supporting Organization/Department:	OEM, community-based organizations, MO DHSS
Action/Project Priority:	Medium
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Property damage where flooding/flash flooding occurs
Action or Project	
Applicable Goal Statement:	5
Action/Project Number:	4.1.5
Name of Action or Project:	Flood Buyout
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Target Repetitive Loss Properties for flood buyout.
Estimated Cost:	\$0-\$20,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Public Works Department
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal, Program
Local Planning Mechanisms to be Used in Implementation, if any:	Columbia Storm Water Utility will evaluate properties that are repeatedly flooded and make decision whether to buy out or improve drainage systems.
Progress Report	
Action Status:	
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Stormwater backups
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	4.1.6
Name of Action or Project:	Overland Flow
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Identify and address areas where overland overflow for flood water is limited and implement projects to provide overflow.
Estimated Cost:	\$100,000-\$5 million
Benefits:	IC, PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	Stormwater Utility
Supporting Organization/Department:	Community Development, Office of Sustainability
Action/Project Priority:	Medium
Timeline for Completion:	2025-Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Columbia Storm Water Utility will search for areas where lack of overland flow paths for floods which exceed storm system design standards exacerbates flood risks.
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hallsville
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Hallsville COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Board of Aldermen
Supporting Organization/Department:	Mid-MO RPC
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	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.

Action Worksheet	
Name of Jurisdiction:	Hallsville
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Flash flooding of city streets and properties
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	Stormwater Upgrade
Name of Action or Project:	2.1.5
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.
Estimated Cost:	\$1 million
Benefits:	PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	Public Works
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, CDBG, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hallsville
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	City Administrator
Supporting Organization/Department:	School District, community groups
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hallsville
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Clerk
Supporting Organization/Department:	SEMA
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Public Works staff reviews all development plans to ensure ordinances are followed.
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Harrisburg
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Harrisburg COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Clerk and Board of Trustees
Supporting Organization/Department:	Boone County Emergency Management, Mid-MO RPC
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	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.

Action Worksheet	
Name of Jurisdiction:	Harrisburg
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Severe Storms, Tornados
Problem being Mitigated:	Utility outages during major storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$ 10 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Board of Trustees/City Clerk
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2050
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Building ordinance
Progress Report	
Action Status:	In Progress
Report of Progress:	New utilities are underground

Action Worksheet	
Name of Jurisdiction:	Harrisburg
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Clerk
Supporting Organization/Department:	SEMA
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Public Works staff reviews all development plans to ensure ordinances are followed.
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Harrisburg
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	City Administrator
Supporting Organization/Department:	School District, community groups
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Discuss at Strategic Planning Meeting
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Harrisburg
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Flash flooding of city streets and properties
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	Stormwater Upgrade
Name of Action or Project:	2.1.5
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.
Estimated Cost:	\$1 million
Benefits:	PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, CDBG, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hartsburg
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Clerk
Supporting Organization/Department:	SEMA
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Public Works staff reviews all development plans to ensure ordinances are followed.
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hartsburg
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Sewer station being flooded during historic floods
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	7.1.1
Name of Action or Project:	Sewer Inundation Mitigation
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Raise sewer pump station to mitigate possible future flooding.
Estimated Cost:	\$100,000
Benefits:	
Plan for Implementation	
Responsible Organization/Department:	City administration
Supporting Organization/Department:	Boone County Sewer district
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, County, FEMA, CDBG
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hartsburg
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Severe Storms, Tornados
Problem being Mitigated:	Utility outages during major storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$ 10 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2050
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Building ordinance
Progress Report	
Action Status:	In Progress
Report of Progress:	New utilities are underground

Action Worksheet	
Name of Jurisdiction:	Huntsdale
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Severe Storms, Tornados
Problem being Mitigated:	Utility outages during major storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$ 5 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Board of Aldermen
Supporting Organization/Department:	Boone Electric Co-op
Action/Project Priority:	High
Timeline for Completion:	2050
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Building ordinance. Partnership with Electric Co-Op
Progress Report	
Action Status:	In Progress
Report of Progress:	New utilities are underground

Action Worksheet	
Name of Jurisdiction:	Huntsdale
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents loss of development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Floodplain Manager
Supporting Organization/Department:	SEMA
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Floodplain ordinance
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Huntsdale
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Flash flooding of city streets and properties
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	Stormwater Upgrade
Name of Action or Project:	2.1.5
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.
Estimated Cost:	\$1 million
Benefits:	PD, LF, EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	
Action/Project Priority:	Low
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, CDBG, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Rocheport
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Severe Storms, Tornados
Problem being Mitigated:	Utility outages during major storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$ 5 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Board of Aldermen
Supporting Organization/Department:	Boone Electric Co-op
Action/Project Priority:	High
Timeline for Completion:	2050
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Building ordinance. Partnership with Electric Co-Op
Progress Report	
Action Status:	In Progress
Report of Progress:	New utilities are underground

Action Worksheet	
Name of Jurisdiction:	Rocheport
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents loss of development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Mayor and City Aldermen
Supporting Organization/Department:	Planning and Zoning
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Floodplain ordinance
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Rocheport
Risk / Vulnerability	
Hazard(s) Addressed:	Flood
Problem being Mitigated:	Flood damage to existing and future construction
Action or Project	
Applicable Goal Statement:	5
Action/Project Number:	9.1.1
Name of Action or Project:	Flood Buyout
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Acquire properties susceptible to flood damage as funds are available.
Estimated Cost:	\$0-\$100,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	City Aldermen
Supporting Organization/Department:	Planning and Zoning Commission
Action/Project Priority:	Low
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Rocheport
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Sewer station being flooded during historic floods
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	7.1.1
Name of Action or Project:	Sewer Inundation Mitigation
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Raise sewer pump station to mitigate possible future flooding.
Estimated Cost:	\$100,000
Benefits:	
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	Boone County Sewer district
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, County, FEMA, CDBG
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Sturgeon COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Mayor
Supporting Organization/Department:	City Staff, Mid-MO RPC
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most city documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	Winter Weather, Severe Storms, Tornados
Problem being Mitigated:	Utility outages during major storm events
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.2
Name of Action or Project:	Undergrounding Utilities
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Require underground utilities where feasible. Relocate current above ground utilities underground as funding is available.
Estimated Cost:	\$ 5 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Mayor/Board of Aldermen
Supporting Organization/Department:	AmerenUE
Action/Project Priority:	High
Timeline for Completion:	2050
Potential Fund Sources:	FEMA, Grants
Local Planning Mechanisms to be Used in Implementation, if any:	Building ordinance. Partnership with Electric Co-Op
Progress Report	
Action Status:	In Progress
Report of Progress:	New utilities are underground

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding
Problem being Mitigated:	Prevents loss of development in floodplain
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.12
Name of Action or Project:	Floodplain Management
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.
Estimated Cost:	\$0
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Mayor and Board of Aldermen
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	Ongoing
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	Floodplain ordinance
Progress Report	
Action Status:	Ongoing
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	Wildfire
Problem being Mitigated:	Ensuring proper water pressure for fighting structure or wild fires.
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	10.1.1
Name of Action or Project:	Waterline Replacement
Mitigation Category:	Preparedness
Action or Project Description:	Replace 2, 3, and 4 inch water lines with 6 inch lines to ensure adequate supply for fire flow.
Estimated Cost:	\$2.5 million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Mayor/Board of Aldermen
Supporting Organization/Department:	WD #10, Mid-MO RPC
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	Bonds
Local Planning Mechanisms to be Used in Implementation, if any:	talk with the water district to ensure that fire flow is considered in decisions re: location of line upgrades
Progress Report	
Action Status:	In Progress
Report of Progress:	Water District #10 has passed a \$2.5 Million bond issue and will be putting in bigger lines

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	City Administration
Supporting Organization/Department:	School District, community groups
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Flooded Sewer system
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	10.1.2
Name of Action or Project:	Sewer Inundation Mitigation
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Flood Mitigation for Sewer system/lift station. Raise sewer components.
Estimated Cost:	\$500,000-\$1.2 million
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Maintenance Department
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	CDBG, FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	Scoping for solution

Action Worksheet	
Name of Jurisdiction:	Sturgeon
Risk / Vulnerability	
Hazard(s) Addressed:	Flooding/Flash Flooding
Problem being Mitigated:	Flooded roadways and erosion of current stormwater facilities
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	10.1.3
Name of Action or Project:	Stormwater Upgrade
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Added Storm water capacity for Flash flood mitigation for flooding of roadways and erosion of current stormwater carrying facilities.
Estimated Cost:	\$500,000-\$1.2 million
Benefits:	IC, EM
Plan for Implementation	
Responsible Organization/Department:	Maintenance Department
Supporting Organization/Department:	
Action/Project Priority:	High
Timeline for Completion:	2022
Potential Fund Sources:	CDBG, FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In progress
Report of Progress:	PER and Scope of Work being developed.

Action Worksheet	
Name of Jurisdiction:	Centralia R-VI
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Safety Committee
Supporting Organization/Department:	Centralia Police Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Centralia R-VI
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Centralia School District COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Safety Committee
Supporting Organization/Department:	Administration, School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Centralia R-VI
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Safety Committee
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Columbia Public Schools
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Columbia Public Schools Administration
Supporting Organization/Department:	Columba Police and Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Columbia Public Schools
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Columbia Public Schools COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Columbia Public Schools Administration
Supporting Organization/Department:	School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Columbia Public Schools
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Columbia Public Schools Administration
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Hallsville R-IV
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Hallsville Administration
Supporting Organization/Department:	Hallsville Police and Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Hallsville R-IV
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Hallsville School District COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Hallsville Administration
Supporting Organization/Department:	School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Hallsville R-IV
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Hallsville Administration
Supporting Organization/Department:	City of Hallsville
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Harrisburg R-VIII
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Harrisburg Administration
Supporting Organization/Department:	Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Harrisburg R-VIII
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Harrisburg School District COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Harrisburg Administration
Supporting Organization/Department:	School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Harrisburg R-VIII
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Harrisburg Administration
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Southern Boone
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Southern Boone Administration
Supporting Organization/Department:	Ashland Police and Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Southern Boone
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Southern Boone School District COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Southern Boone Administration
Supporting Organization/Department:	School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Southern Boone
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Southern Boone Administration
Supporting Organization/Department:	City of Ashland, Private Organizations
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Sturgeon R-V
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$10,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Sturgeon Administration
Supporting Organization/Department:	Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Sturgeon R-V
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Sturgeon School District COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Sturgeon Administration
Supporting Organization/Department:	School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	This is in progress; most documents are now backed up on the Cloud;

Action Worksheet	
Name of Jurisdiction:	Sturgeon R-V
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Sturgeon Administration
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	Stephen's College
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$20,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Campus Security and the Emergency Management Team
Supporting Organization/Department:	Columba Police and Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	Stephen's College
Risk / Vulnerability	
Hazard(s) Addressed:	All Hazards
Problem being Mitigated:	Potential weaknesses in response to all hazards
Action or Project	
Applicable Goal Statement:	2
Action/Project Number:	1.1.6
Name of Action or Project:	Stephen's College COOP
Mitigation Category:	Preparedness
Action or Project Description:	Develop a Continuity of Operations Plan (COOP).
Estimated Cost:	\$5,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Campus Security and the Emergency Management Team
Supporting Organization/Department:	School Board
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, FEMA, grants
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	Several portions of the plan are in place waiting to be combined into one reviewable document.

Action Worksheet	
Name of Jurisdiction:	Stephen's College
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	Campus Security and the Emergency Management Team
Supporting Organization/Department:	
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	University of Missouri
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Storms, Tornados
Problem being Mitigated:	Environmental damage in the event of impact from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	18.1.1
Name of Action or Project:	Salt Dome Relocation
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.
Estimated Cost:	\$ 0.5 Million
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	Campus Facilities
Supporting Organization/Department:	MU Division of Design & Construction, City of Columbia
Action/Project Priority:	High
Timeline for Completion:	2021
Potential Fund Sources:	Insurance funds (University is self-insured)
Local Planning Mechanisms to be Used in Implementation, if any:	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.
Progress Report	
Action Status:	In Progress
Report of Progress:	Research in progress

Action Worksheet	
Name of Jurisdiction:	University of Missouri
Risk / Vulnerability	
Hazard(s) Addressed:	Severe Thunderstorms, Tornados
Problem being Mitigated:	Loss of life from storms
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	2.1.4
Name of Action or Project:	Safe Room
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.
Estimated Cost:	\$2 million
Benefits:	IC,EM
Plan for Implementation	
Responsible Organization/Department:	MU Emergency Management
Supporting Organization/Department:	MU Division of Finance
Action/Project Priority:	Medium
Timeline for Completion:	2025
Potential Fund Sources:	FEMA, Internal, grrants
Local Planning Mechanisms to be Used in Implementation, if any:	Research and apply for grants for hardening select parts of existing buildings or constructing new buildings to FEMA 361 standards.
Progress Report	
Action Status:	Not Started
Report of Progress:	

Action Worksheet	
Name of Jurisdiction:	University of Missouri
Risk / Vulnerability	
Hazard(s) Addressed:	Unwanted Intruder
Problem being Mitigated:	Unwanted Intruder in school buildings
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	11.1.1
Name of Action or Project:	Active Shooter Mitigation
Mitigation Category:	Preparedness
Action or Project Description:	Increase capacity to prevent and respond to unwanted intruder/active shooter events.
Estimated Cost:	\$20,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	MU Police Dept.
Supporting Organization/Department:	Columba Police and Boone County Sheriff's Department
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal
Local Planning Mechanisms to be Used in Implementation, if any:	School Policy
Progress Report	
Action Status:	In Progress
Report of Progress:	Lockdown procedures. Limited entry points.

Action Worksheet	
Name of Jurisdiction:	University of Missouri
Risk / Vulnerability	
Hazard(s) Addressed:	All hazards
Problem being Mitigated:	Advanced warning protects life from all hazards
Action or Project	
Applicable Goal Statement:	3
Action/Project Number:	18.1.2
Name of Action or Project:	Warning System Upgrade
Mitigation Category:	Hazard Mitigation
Action or Project Description:	Enhance alert and warning capabilities. Improve the software and hardware associated with the current system. Expand the system across campus to buildings currently not served.
Estimated Cost:	\$100,000
Benefits:	IC,PD,LF,EM
Plan for Implementation	
Responsible Organization/Department:	MU Emergency Management
Supporting Organization/Department:	MU Division of Information Technology
Action/Project Priority:	High
Timeline for Completion:	2025
Potential Fund Sources:	Internal, Grants, FEMA
Local Planning Mechanisms to be Used in Implementation, if any:	
Progress Report	
Action Status:	In Progress
Report of Progress:	Software updates

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Prevention Public Education								
1.1.3	Continue monthly testing of outdoor warning sirens in compliance with procedures set by OEM.	Boone County	H	4	All	X	X	
1.1.6	Develop COOP plan	Boone County	H	2	All	X	X	
1.1.7	Establish local sources(s) of sustainable mitigation funding to be used by participating jurisdictions in the Boone County HMP as direct project funding and/or as local match for outside grants.	Boone County	H	3	All	X		
1.1.11	Develop EAPs for dams that are not regulated by the State.	Boone County	L	1	Dam Failure	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Boone County	H	2	Flooding	X	X	X
1.1.13	Review Building codes every three years for possible update.	Boone County	H	2	Earthquake, Winter weather, Tornado		X	
1.1.13	Review Building codes every two years for possible update.	Columbia	H	2	Earthquake, Winter weather, Tornado		X	
1.1.16	Ensure evacuation plans are adequate for nursing homes and special needs populations	Boone County	H	1	Earthquake, Tornado, Winter Weather, Extreme Temperatures	X		
1.1.18	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable population; include strategies for food, water, hygiene, and medical supplies	Boone County	L	1	All	X		

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
1.1.21	Promote the purchase and use of NOAA radios	Boone County	H	4	All	X		
1.1.6	Develop COOP plan	Ashland	H	2	All	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Ashland	H	2	Flooding	X	X	X
3.1.1	Continue monthly testing of outdoor warning sirens in compliance with procedures set by OEM.	Centralia	H	3	All	X	X	
1.1.6	Develop COOP plan	Centralia	H	2	All	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Centralia	H	2	Flooding	X	X	X
1.1.6	Develop COOP plan	Columbia	H	2	All	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Columbia	H	2	Flooding	X	X	X
4.1.2	Develop regulations for roads on dams.	Columbia	H		Dam Failure		X	
1.1.18	Develop strategy for preparedness planning and 72-hour provisions for most vulnerable population; include strategies for food, water, hygiene, and medical supplies	Columbia	L	1	All	X		
1.1.6	Develop COOP plan	Hallsville	H	2	All	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Hallsville	H	2	Flooding	X	X	X

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
1.1.6	Develop COOP plan	Harrisburg	H	2	All	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Harrisburg	H	2	Flooding	X	X	X
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Hartsburg	H	2	Flooding	X	X	X
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Huntsdale	H	2	Flooding	X	X	X
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Rocheport	H	2	Flooding	X	X	X
1.1.6	Develop COOP plan	Sturgeon	H	2	All	X	X	
1.1.12	Enforce flood damage prevention/floodplain management ordinances in compliance with NFIP requirements.	Sturgeon	H	2	Flooding	X	X	X
1.1.6	Develop COOP plan	Centralia R-VI	H	2	All	X	X	
1.1.6	Develop COOP plan	Columbia Public Schools	H	2	All	X	X	
1.1.6	Develop COOP plan	Hallsville R-IV	H	2	All	X	X	
1.1.6	Develop COOP plan	Harrisburg R-VIII	H	2	All	X	X	
1.1.6	Develop COOP plan	Southern Boone	H	2	All	X	X	

Table 4.4: Hazard Mitigation Action Matrix								
#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
1.1.6	Develop COOP plan	Sturgeon R-V	H	2	All	X	X	
1.1.6	Develop COOP plan	Stephen's College	H	2	All	X	X	
18.1.2	Enhance alert and warning capabilities. Improve the software and hardware associated with the current system. Expand the system across campus to buildings currently not served.	University of Missouri	H	3	All	X	X	
	Structure and Infrastructure Projects							
1.1.4	Develop and adhere to a routine maintenance schedule for brush cutting and tree trimming to keep branches from overhanging roads.	Boone County	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Boone County	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	
1.1.14	Lock down high value equipment located outside of county and municipal buildings (e.g. HVAC, generators, communication equipment) to protect against earthquake or tornado damage	Boone County	H	3	Earthquake, Tornado	X	X	
1.1.14	Lock down high value equipment located outside of county and municipal buildings (e.g. HVAC, generators, communication equipment) to protect against earthquake or tornado damage	Columbia	H	3	Earthquake, Tornado	X	X	
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Boone County	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	

Table 4.4: Hazard Mitigation Action Matrix								
#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
1.1.15	Mitigate the effects of flooding on public infrastructure by raising low water crossings and upgrading stormwater capacity.	Boone County	H	3	Flooding	X		X
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Ashland	H	3	Winter weather, Thunderstorms, Tornados	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Ashland	H	3	Thunderstorms, Tornados	X	X	
2.1.5	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.	Ashland	H	3	Flooding	X		X
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Centralia	H	3	Winter weather, Thunderstorms, Tornados	X	X	
2.1.5	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.	Centralia	H	3	Flooding	X		X
4.1.3	Mitigate the effect of flooding, extreme heat, utility service outage and severe storms on public infrastructure.	Columbia	H	3	All	X	X	X
4.1.6	Identify and address areas where overland overflow for flood water is limited and implement projects to provide overflow.	Columbia	M	3	Flooding	X	X	X
2.1.5	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.	Hallsville	H	3	Flooding	X		X

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
2.1.4	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.	Hallsville	H	3	Severe Storms, Tornadoes	X		X
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Harrisburg	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Harrisburg	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.	Harrisburg	H	3	Flooding	X		X
7.1.1	Raise sewer pump station to mitigate possible future flooding.	Hartsburg	H	3	Flooding	X		X
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Hartsburg	M	3	Winter weather, Thunderstorms, Tornadoes	X	X	
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Huntsdale	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	
2.1.4	Expand stormwater capacity to mitigate water backups into streets and erosion of existing drainage ditches.	Huntsdale	H	3	Flooding	X		X
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Rocheport	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	
7.1.1	Raise sewer pump station to mitigate possible future flooding.	Rocheport	H	3	Flooding	X		X

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
1.1.8	Require underground utilities where feasible. Move current aboveground utilities underground.	Sturgeon	H	3	Winter weather, Thunderstorms, Tornadoes	X	X	
10.1.1	Replace 2, 3, and 4-inch water lines with 6 inch lines to ensure adequate supply for fire flow.	Sturgeon	M		Wildfires	X		
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Sturgeon	H	3	Severe Storms, Tornadoes	X	X	
10.1.2	Flood Mitigation for sewer system/lift station. Raise sewer components.	Sturgeon	H	3	Flooding	X		X
10.1.3	Added storm water capacity for flash flood mitigation for flooding of roadways and erosion of current stormwater carrying facilities.	Sturgeon	H	3	Flooding	X		X
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Centralia R-VI	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Columbia Public Schools	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Hallsville R-IV	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Harrisburg R-VIII	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Southern Boone	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Sturgeon R-V	H	3	Severe Storms, Tornadoes	X	X	

Table 4.4: Hazard Mitigation Action Matrix								
#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	Stephen's College	H	3	Severe Storms, Tornadoes	X	X	
2.1.4	Build tornado safe room(s) or harden part(s) of existing structure(s) to FEMA 361 standards.	University of Missouri	H	3	Severe Storms, Tornadoes	X	X	
	Natural Systems Protection							
3.1.5	Develop policy and enforcement regulations concerning burning permits.	Centralia	L	2	Wildfires	X	X	
4.1.1	Add sinkhole regulations to stream buffer/storm water ordinance	Columbia	M	2	Land Subsidence			
4.1.5	Target Repetitive Loss properties for buyout	Columbia	H	5	Flooding	X	X	X
9.1.1	Acquire properties susceptible to flood damage as funds are available.	Rocheport	L	5	Flooding	X	X	X
18.1.1	Move the salt dome at the University of Missouri to protect Hinkson Creek in case of damage from high winds or tornadoes.	University of Missouri	H	3	Severe Storms, Tornadoes	X		X
	Emergency Services							
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	H	5	All	X		X
1.1.1	Continue to supply updated GIS base map information to support changing/updating the D-FIRM maps using local, accurate data	Columbia	H	5	All	X		X
1.1.2	Continue to participate as a partner in FEMA's RISKMap process.	Boone County	H	1	Flooding	X	X	X
1.1.2	Continue to participate as a partner in FEMA's RISKMap process.	Columbia	H	1	Flooding	X	X	X

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
1.1.15	Conduct detailed risk assessments and cost/benefit analysis of telecommunications and networking vulnerabilities in individual municipalities.	Boone County	M	1	All	X	X	
1.1.9	Review and formalize relationships with cooling and warming centers in each community.	Boone County	H	3	Extreme Temperatures	X		
1.1.10	Establish agreements with cellular providers for “Cell on wheels” units to be made available in case of telecommunications disruptions.	Boone County	H	3	All	X		
1.1.17	Encourage shelters to have alternative heating sources	Boone County	H	3	Extreme Temperatures	X	X	
1.1.9	Review and formalize relationships with cooling and warming centers in each community.	Columbia	H	3	Extreme Temperatures	X		
4.1.4	Continue to comply with requirements of FAA 139 and TSA 1542 at Columbia Regional Airport.	Columbia	H		Transportation Incident	X		
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Centralia R-VI	H		Active Shooter	X	X	
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Columbia Public Schools	H		Active Shooter	X	X	
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Hallsville R-IV	H		Active Shooter	X	X	
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Harrisburg R-VIII	H		Active Shooter	X	X	
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Southern Boone	H		Active Shooter	X	X	

Table 4.4: Hazard Mitigation Action Matrix

#	Action	Jurisdiction	Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Sturgeon R-V	H		Active Shooter	X	X	
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	Stephen's College	H		Active Shooter	X	X	
11.1.1	Increase capacity to prevent and respond to unwanted intruder/active shooter	University of Missouri	H		Active Shooter	X	X	
	Education and Outreach							
1.1.19	Host psychological first aid courses in order to create a local psychological first aid capacity.	Boone County	H	3	All	X		
1.1.20	Continue to educate public about hazards	Boone County	H	4	All	X	X	
1.1.22	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.	Boone County	M	4	All	X		
1.1.22	Promote Ready-in-3 materials in-house at the Columbia/Boone County Dept. of Public Health and Human Services and at public events.	Columbia	M	4	All	X		

Chapter 5: PLAN MAINTENANCE PROCESS

- 5.1 Monitoring, Evaluating, and Updating the Plan.....422
 - 5.1.1 Responsibility for Plan Maintenance
 - 5.1.2 Plan Maintenance Schedule
 - 5.1.3 Plan Maintenance Process
- 5.2 Incorporation into Existing Planning Mechanisms.....424
- 5.3 Continued Public Involvement.....427

Chapter 5: Plan Maintenance Process

This chapter provides an overview of the overall strategy for plan maintenance and outlines the method and schedule for monitoring, updating and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

5.1 Monitoring, Evaluating, and Updating the Plan

44 CFR Requirement 201.6(c)(4): The plan maintenance process shall include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

5.1.1 Responsibility for Plan Maintenance

The MPC has served as an advisory committee for the duration of the update and is not a standing committee. Oversight responsibility could fall to such entities as the Boone County emergency management agency, The Regional Planning Commission, or local jurisdiction representatives. Responsibility for maintenance falls to the local emergency management officials.

Maintenance should involve agreement of the participating jurisdictions, including school and special districts, to:

- Meet annually, and after a disaster event, to monitor and evaluate the implementation of the plan;
- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high priority, low- or no-cost recommended actions;
- Maintain vigilant monitoring of multi-objective, cost-share, and other funding opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Report on plan progress and recommended changes to the County Board of Supervisors and governing bodies of participating jurisdictions; and
- Inform and solicit input from the public.

The (MPC or other designated responsible entity) is an advisory body and can only make recommendations to county, city, town, or district elected officials. Its primary duty is to see the plan successfully carried out and to report to the community governing boards and the public on the status of plan implementation and mitigation opportunities^{10(a)}. Other duties include reviewing and promoting mitigation proposals, hearing stakeholder concerns about hazard

mitigation, passing concerns on to appropriate entities, and posting relevant information in areas accessible to the public.

5.1.2 Plan Maintenance Schedule

The MPC agrees to meet annually or after a state or federally declared hazard event as appropriate to monitor progress and update the mitigation strategy. The Boone County Emergency Management Director will be responsible for initiating the plan reviews and will invite members of the MPC to the meeting.

In coordination with all participating jurisdictions, the Emergency Management Director will be responsible for initiating a five-year written update of the plan to be submitted to the Missouri State Emergency Management Agency (SEMA) and FEMA Region VII per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule.

5.1.3 Plan Maintenance Process

Progress on the proposed actions can be monitored by evaluating changes in vulnerabilities identified in the plan. The MPC during the annual meeting should review changes in vulnerability identified as follows:

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions,
- Increased vulnerability due to hazard events, and/or
- Increased vulnerability as a result of new development (and/or annexation).

Future 5-year updates to this plan will include the following activities:

- Consideration of changes in vulnerability due to action implementation,
- Documentation of success stories where mitigation efforts have proven effective,
- Documentation of unsuccessful mitigation actions and why the actions were not effective,
- Documentation of previously overlooked hazard events that may have occurred since the previous plan approval,
- Incorporation of new data or studies with information on hazard risks,
- Incorporation of new capabilities or changes in capabilities,
- Incorporation of growth data and changes to inventories, and
- Incorporation of ideas for new actions and changes in action prioritization.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the participating jurisdictions will adopt the following process:

- Each proposed action in the plan identified an individual, office, or agency responsible for action implementation. This entity will track and report on an annual basis to the jurisdictional MPC member on action status. The entity will provide input on whether the

action as implemented meets the defined objectives and is likely to be successful in reducing risk.

- If the action does not meet identified objectives, the jurisdictional MPC member will determine necessary remedial action, making any required modifications to the plan.

Changes will be made to the plan to remedy actions that have failed or are not considered feasible. Feasibility will be determined after a review of action consistency with established criteria, time frame, community priorities, and/or funding resources. Actions that were not ranked high but were identified as potential mitigation activities will be reviewed as well during the monitoring of this plan. Updating of the plan will be accomplished by written changes and submissions, as the MPC deems appropriate and necessary. Changes will be approved by the Boone County Commission and the governing boards of the other participating jurisdictions.

5.2 Incorporation into Existing Planning Mechanisms

44 CFR Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

Where possible, plan participants, including school and special districts, will use existing plans and/or programs to implement hazard mitigation actions. Those existing plans and programs were described in Section 2 of this plan. Based on the capability assessments of the participating jurisdictions, communities in Boone County will continue to plan and implement programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through the following plans:

- General or master plans of participating jurisdictions;
- Ordinances of participating jurisdictions;
- County Emergency Operations Plan;
- Capital improvement plans and budgets;
- Other community plans within the County, such as water conservation plans, storm water management plans, and parks and recreation plans;
- School and Special District Plans and budgets; and
- Other plans and policies outlined in the capability assessment sections for each jurisdiction in Chapter 2 of this plan.

The MPC members involved in updating these existing planning mechanisms will be responsible for integrating the findings and actions of the mitigation plan, as appropriate. The MPC is also responsible for monitoring this integration and incorporation of the appropriate information into the five-year update of the multi-jurisdictional hazard mitigation plan.

Additionally, after the annual review of the Hazard Mitigation Plan, the Boone County Emergency Management Director will provide the updated Mitigation Strategy with current status of each mitigation action to the County Commission as well as all Mayors, City Clerks, and School District Superintendents. The Emergency Manager Director will request that the mitigation strategy be incorporated, where appropriate, in other planning mechanisms.

Table 5.1 below lists the planning mechanisms by jurisdiction into which the Hazard Mitigation Plan will be integrated.

Jurisdiction	Planning Mechanisms	Integration Process for Previous Plan	Integration Process for Current Plan
Unincorporated Boone	Annual Budget Process, EOP	Annual Budget Process, Floodplain Ordinances, Generator acquired through RHSOC	Actions identified Over 4 meetings and added to Emergency Operations Plan then addressed in Annual Budget Process
Ashland	Annual Budget Process	Annual Budget Process, Floodplain ordinances, Building codes, saferoom planning	Email/phone meeting. Reviewed by BOA during annual budget. Added to Capital Improvement Program and Comprehensive Plan
Centralia	Annual Budget Process, Ordinances	Annual Budget Process, building codes	Attended 1 meeting. Annual Budget Process. Review for Comprehensive Plan and Subdivision regulations.
Columbia	Annual Budget Process, Ordinances	Annual Budget Process, building codes, floodplain ordinances, sustainability regulations	Attended 2 meetings. Capital Improvement Project Annual Budget Process
Hallsville	Annual Budget Process	Annual Budget Process, building codes,	Attended 1 meeting. City work plan and Annual Budget Process. Comprehensive plan.
Harrisburg	Annual Budget Process	Annual Budget Process, floodplain ordinances	Email/phone meeting. Annual Budget Process and Strategic Plan
Hartsburg	Annual Budget Process	Annual Budget Process, floodplain ordinances	Attended 1 meeting. Annual Budget Process and city ordinances
Huntsdale	Annual Budget Process	Annual Budget Process, floodplain ordinances	Phone/Email meeting. Annual Budget Process and city ordinances
Rocheport	Annual Budget Process	Annual Budget Process, floodplain ordinances	Attended 1 meeting. Capital Improvement Project Annual Budget Process
Sturgeon	Annual Budget	Annual Budget Process,	Attended 2 meetings.

	Process, Ordinances	city ordinances, public works maintenance program	Capital Improvement Project, Annual Budget Process, CDBG stormwater project
Centralia R-IV	Centralia R-IV District Planning Committee & Board of Education	Annual Budget process, updated policy, system testing	Attended 1 meeting. Safety committee annual budget meeting, building policy updates, staff training
Columbia Public Schools	Columbia Public Schools District Planning Committee & Board of Education	Annual budget process, policy updates, updated emergency alert system	Attended 1 meeting. Added to Emergency response plans. Reviewed by Board of Education
Hallsville R-IV	Hallsville R-IV Planning Committee & Board of Education	Updated policy	Attended 1 meeting. Added to School Improvement Plan, staff training, policy update
Southern Boone School District	Southern Boone School Planning Committee & Board of Education	Policy update, staff training	Attended 2 meetings. Update Facilities Plan,
Sturgeon R-V	Sturgeon R-V Planning Committee & Board of Education	Policy updated, staff training, notification system upgrade	Attended 1 meeting. Sturgeon R-V Long-Range Plan update
Stephens College	Stephens College Planning Committee & Board of Education	Updated policy, notification system upgrade	Phone/Email meeting. Stephens College Planning Committee & Planning/Facilities Documents
University of Missouri	MU Planning Committee & Board of Education	Updated policy, notification system upgrade	Attended 1 meeting. Emergency management department policies. Budget process.

5.3 Continued Public Involvement

44 CFR Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

The hazard mitigation plan update process provides an opportunity to publicize success stories resulting from the plan's implementation and seek additional public comment. Information about the annual reviews will be posted on the Boone county website following each annual review of the mitigation plan and will solicit comments from the public based on the annual review. When the MPC reconvenes for the five-year update, it will coordinate with all stakeholders participating in the planning process. Included in this group will be those who joined the MPC after the initial effort, to update and revise the plan. Public notice will be posted and public participation will be actively solicited, at a minimum, through available website postings and press releases to local media outlets, primarily newspapers.

Appendix A: Adoption Resolutions

A RESOLUTION OF THE City of Ashland Board of Aldermen, ADOPTING THE Boone Hazard Mitigation Plan 2020.

WHEREAS the City of Ashland Board of Aldermen recognizes the threat that natural hazards pose to people and property within the City of Ashland, Mo; and

WHEREAS the City of Ashland Board of Aldermen has participated in the preparation of a multi-jurisdictional local hazard mitigation plan, hereby known as the Boone Hazard Mitigation Plan 2020, hereafter referred to as the *Plan*, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the City of Ashland, Mo. from the impacts of future hazards and disasters; and

WHEREAS the City of Ashland Board of Aldermen recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the City of Ashland, Mo. will endeavor to integrate the *Plan* into the comprehensive planning process; and

WHEREAS adoption by the City of Ashland Board of Aldermen demonstrates their commitment to hazard mitigation and achieving the goals outlined in the *Plan*.

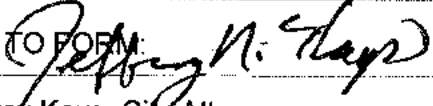
NOW THEREFORE, BE IT RESOLVED BY THE City of Ashland Board of Aldermen in the State of Missouri, THAT:

In accordance with the adoption of Resolutions of the City of Ashland Board of Aldermen adopts the final *FEMA-approved Plan*.

ADOPTED by a vote of 6 in favor and 0 against, and 0 abstaining, this 15th day of September, 2020.

By (Sig): 
Print name: Richard Sullivan, Mayor

ATTEST:
By (Sig.): 
Print name: Darla Sapp, City Clerk

APPROVED AS TO FORM:
By (Sig.): 
Print name: Jeffrey Kays, City Attorney

CERTIFIED COPY OF ORDER

STATE OF MISSOURI

} ca.

September Session of the July Adjourned

Term. 2020

County of Boone

In the County Commission of said county, on the

1st

day of

September


2020

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 after adoption on the Boone County Office of Emergency Management webpage.

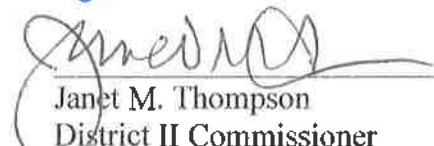
Done this 1st day of September 2020.

ATTEST:


Brianna L. Lennon
Clerk of the County Commission


Daniel K. Atwill
Presiding Commissioner


Fred J. Parry
District I Commissioner


Janet M. Thompson
District II Commissioner

The following resolution was adopted by Boone County, Missouri on

September 1, 2020.

RESOLUTION NO. 384-2020

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

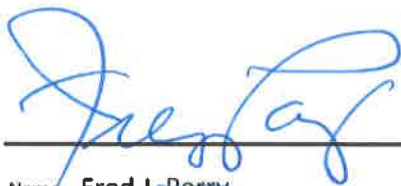
WHEREAS, Boone County has reviewed the Plan and affirms that the Plan will be updated no less than every five years

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.

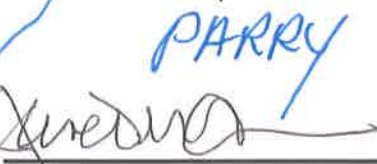
ADOPTED this 1st day of September, 2020 at the meeting of the County Commission.



Name Daniel K. Atwill Position Presiding Commissioner Date 9-1-20



Name Fred J. Perry Position District 1 Commissioner Date 9-1-20



Name Janet M. Thompson Position District 2 Commissioner Date 9/1/2020

BILL TO CREATE A RESOLUTION ENTITLED:

A RESOLUTION OF THE CITY OF CENTRALIA, MISSOURI TO ADOPT THE BOONE COUNTY HAZARD MITIGATION PLAN 2020.

WHEREAS, the Centralia Board of Aldermen recognizes the threat that natural hazards pose to people and property within the City of Centralia, Missouri; and

WHEREAS, the Centralia Board of Aldermen has participated in the preparation of a multi-jurisdictional local hazard mitigation plan, hereby known as the Boone County Hazard Mitigation Plan 2020, hereafter referred to as the *Plan*, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS, the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the City of Centralia, Missouri, from impacts of future hazards and disasters; and

WHEREAS, the Centralia Board of Aldermen recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the Centralia Board of Aldermen will endeavor to integrate the *Plan* into the comprehensive planning process; and

WHEREAS, adoption by the Centralia Board of Aldermen demonstrates their commitment to hazard mitigation and achieving the goals outlines in the *Plan*.

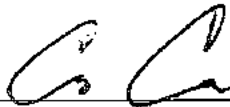
NOW, THEREFORE, BE IT RESOLVED BY the Board of Aldermen of the City of Centralia, in the State of Missouri, THAT:

In accordance with Section 7-6 of the Centralia City Code, the Centralia Board of Aldermen adopts the final *FEMA-approved Plan*.

RESOLVED this 17th day of August, 2020 by the Board of Alderman of the City of Centralia, Missouri.


Alderman Wilkins: Absent
Alderman Hudson: Yes
Alderman Motley: Absent

Alderman Stevens: Yes
Alderman Rodgers: Yes
Alderman Magley: Yes



Mayor, Chris Cox

ATTEST:



City Clerk, Tara Strain

RESOLUTION

A RESOLUTION OF THE COLUMBIA PUBLIC SCHOOL DISTRICT ADOPTING THE BOONE HAZARD MITIGATION PLAN 2020.

WHEREAS the Columbia Public School District recognizes the threat that natural hazards pose to people and property within the Columbia Public School District; and

WHEREAS the Columbia Public School District has participated in the preparation of a multi-jurisdictional local hazard mitigation plan, hereby known as the Boone Hazard Mitigation Plan 2020, hereafter referred to as the *Plan*, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the Columbia Public School District from the impacts of future hazards and disasters; and

WHEREAS the Columbia Public School District recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the Columbia Public School District will endeavor to integrate the *Plan* into the comprehensive planning process; and

WHEREAS adoption by the Columbia Public School District demonstrates their commitment to hazard mitigation and achieving the goals outlined in the *Plan*.

NOW THEREFORE, BE IT RESOLVED BY THE COLUMBIA PUBLIC SCHOOL DISTRICT, in the State of Missouri, THAT:

The Columbia Public School District adopts the final *FEMA-approved Plan*.

ADOPTED by a vote of 7 in favor and 0 against, and 0 abstaining, this 14th day of September, 2020.

By: 
Helen Wade, President, Board of Education

ATTEST:
By: 
Tracy Davenport, Secretary, Board of Education

RESOLUTION NO. 2020-2

A RESOLUTION OF THE CITY OF HALLSVILLE ADOPTING THE Boone Hazard Mitigation Plan 2020.

WHEREAS, the Board of Aldermen recognizes the threat that natural hazards pose to people and property within the City of Hallsville; and

WHEREAS, the City of Hallsville has participated in the preparation of a multi-jurisdictional local hazard mitigation plan, hereby known as the Boone County Hazard Mitigation Plan, hereafter referred to as the *Plan*, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS, the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the City of Hallsville from the impacts of future hazards and disasters; and

WHEREAS, the Board of Alderman recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the Board of Aldermen will endeavor to integrate the *Plan* into the comprehensive planning process; and

WHEREAS, adoption by the Board of Aldermen demonstrates their commitment to hazard mitigation and achieving the goals outlined in the *Plan*.

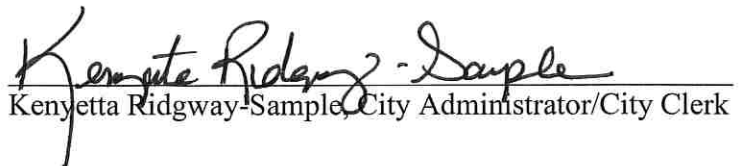
NOW THEREFORE, BE IT RESOLVED by the Board of Aldermen that the City of Hallsville, in the State of Missouri, adopts the *FEMA-approved Plan* as this jurisdiction's Hazard Mitigation Plan, and resolves to execute the actions in the Plan.

ADOPTED by a vote of 3 in favor and 0 against, and 1 abstaining, this 20 day of August, 2020.



Logan Carter, Mayor

SEAL



Kenyetta Ridgway-Sample, City Administrator/City Clerk

A RESOLUTION OF THE VILLAGE OF HARRISBURG ADOPTING THE Boone Hazard Mitigation Plan 2020.

WHEREAS the *Village of Harrisburg* recognizes the threat that natural hazards pose to people and property within the Village of Harrisburg; and

WHEREAS the Village of Harrisburg has participated in the preparation of a multi-jurisdictional local hazard mitigation plan, hereby known as the Harrisburg Mitigation Plan 2020 hereafter referred to as the *Plan*, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the *Plan* identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the Village of Harrisburg from the impacts of future hazards and disasters; and

WHEREAS the Village of Harrisburg recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the Village of Harrisburg will endeavor to integrate the *Plan* into the comprehensive planning process; and

WHEREAS adoption by the Village of Harrisburg demonstrates their commitment to hazard mitigation and achieving the goals outlined in the *Plan*.

NOW THEREFORE, BE IT RESOLVED BY THE VILLAGE OF HARRISBURG, in the State of Missouri, THAT:

In accordance with, the Village of Harrisburg adopts the final *FEMA-approved Plan*.

ADOPTED by a vote of 3 in favor and 0 against, and 0 abstaining, this 1ST day of October, 2020

By (Sig): Regenia Wilhite

Print name: Regenia Wilhite

ATTEST:
By (Sig.): Kathy Wilhite
Print name: Kathy Wilhite

APPROVED AS TO FORM:
By (Sig.): Regenia Wilhite
Print name: Regenia Wilhite

A RESOLUTION OF THE Village of Huntsdale, Missouri ADOPTING THE Boone County Hazard Mitigation Plan 2020.

WHEREAS the Village of Huntsdale recognizes the threat that natural hazards pose to people and property within the Village of Huntsdale; and

WHEREAS the Village of Huntsdale has participated in the preparation of a multi-jurisdictional local hazard mitigation plan, hereby known as the Boone County Hazard Mitigation Plan 2020. Hereafter referred to as the Boone County Hazard Mitigation Plan 2020, in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the Boone County Hazard Mitigation Plan 2020 identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the *Village of Huntsdale* from the impacts of future hazards and disasters; and

WHEREAS the Village of Huntsdale recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the Village of Huntsdale will endeavor to integrate the Boone County Hazard Mitigation Plan 2020 into the comprehensive planning process; and

WHEREAS adoption by the Village of Huntsdale demonstrates their commitment to hazard mitigation and achieving the goals outlined in the Boone County Hazard Mitigation Plan 2020.

NOW THEREFORE, BE IT RESOLVED BY THE VILLAGE OF HUNTSDALE, in the State of Missouri, THAT:

the Village of Huntsdale adopts the final *FEMA-approved Plan*.

ADOPTED by a vote of 5 in favor and 0 against, 0 abstaining,

This 30 day of September, 2020

By (Sig): Debby Lancaster
Print name: Debby Lancaster

ATTEST:
By (Sig.): [Signature]
Print name: Ann Lopez

APPROVED AS TO FORM: [Signature]
By (Sig.): [Signature]
Print name: Dorothy J. Eberhart



RESOLUTION NO. 08242020

“A RESOLUTION ADOPTING THE BOONE COUNTY, MISSOURI HAZARD MITIGATION PLAN OF 2020 AS THE HAZARD MITIGATION PLAN FOR THE CITY OF STURGEON, MISSOURI.”

WHEREAS, the Boone County, Missouri Hazard Mitigation Plan of 2020 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 2000; 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 recognizes that land use policies have a major impact on whether people and property are exposed to natural hazards, the City of Sturgeon will endeavor to integrate the Plan into the comprehensive planning process; and

WHEREAS, adoption by the City of Sturgeon demonstrates their commitment to hazard mitigation and achieving the goals outlined in the Plan.

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

In accordance with the City of Sturgeon adopts the final FEMA-approved Plan.

ADOPTED: by a roll call vote:

Alderman Janice Butler yes Alderman Kyle Schultz yes

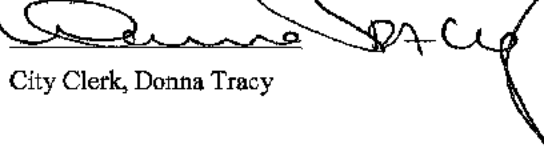
Alderman Ashley Long yes Alderman Stan Robinson yes

PASSED by the City of Sturgeon, Missouri Board of Aldermen and APPROVED by the City of Sturgeon, Missouri Mayor this 24th day of August



Mayor Steve Crosswhite

ATTEST:

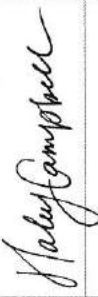











City Clerk, Donna Tracy

Appendix B: Sign-In Sheets/Meeting Minutes

BOONE COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN UPDATE KICKOFF MEETING—SIGN-IN SHEET

Project:	Boone County, Missouri Multi-jurisdictional Hazard Mitigation Plan Update	Meeting Date/Time:	06/25/2019 10:00
Facilitator:	Sierra Thomas, Fiscal Officer Mid-Missouri Regional Planning Commission	Place/Room:	Boone County Emergency Management Agency 2145 County Drive Columbia, MO 65202

Name	Title	Department/Agency	Email / Don't Forget!	Phone #	Signature
Hailey Campbell	Mitigation & Recovery Specialist	BCOEM	ncampbell@boonecountymissouri.org	573.682.7912	
Jennifer Bowden	Mid Mo Planner	Mid Mo RPL			
Tom Hurley	Director	BCOEM	Thurley@BooneCountyMo.org	554-7908	
Mike Paris	Area Manager	City of Columbia	michael.paris@com.org	817-5064	
Heather Russell	City Administrator	City of Centralia	heather@centraliamissouri.org	573-682-239	
Steve Walsh	Press Secretary	Rep. Vickie Martler	stevewalsh@mail.house.mo.gov	573-645-9626	
ERIC HEMPEL	ENERGY EDUCATOR	CITY OF COLUMBIA	eric.hempel@com.org	573.441.5573	
Barbara Buffaloe	sustainability manager	city of columbian	Barbara.Buffaloe@com.org	573 817 5025	
Rebecca Estes	Senior Planner	Columbia/Boone Public Health & Human Services	Rebecca.Estes@com.org	573 817 6401	
Ann Tratermann	G. M.	Boone County Regional Sealer of District	tratermann@bcrsd.com	573-443-2774	

Boone County Hazard Mitigation Meeting #2 Minutes

July 30, 2019

Call to order: 10am

Few were in attendance. Those with Boone EOC, Tom Ratterman of Boone Sewer, Jennifer Bowden and Sierra Thomas of Mid-MO RPC showed up. Questionnaires were gathered at the start of the meeting and staff was available to answer questions.

Discussed potential sewer project for flood mitigation based on risk assessment. There is need to raise and harden pump stations in a few towns and this could be a good candidate for HM funding. A trip is planned for next week to view the stations at risk.

Adjourned: 10:45am

Next meeting scheduled for October 1, 2019

Appendix C: Additional Climate Change Resources

Columbia 5-Year IMP Action Plan ¹			
Program or Project ²	Goal	Anticipated Actions	Targeted Community Benefits ³
Wastewater Treatment			
Wet Weather Improvements*	Implement early measures to enhance peak flow capacity at CRWWTP.	<ul style="list-style-type: none"> Modify existing CRWWTP structures to provide additional wet weather flow storage. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality. Regulatory compliance.
Digester Rehabilitation*	Rehabilitate aging biosolids digestion facilities.	<ul style="list-style-type: none"> Target design completion by 2019. Target construction completion by 2021. 	<ul style="list-style-type: none"> Provide sustainable services for the future.
Constructed Wetlands Maintenance	Initiate constructed wetlands maintenance efforts to improve treatment efficiency.	<ul style="list-style-type: none"> Develop plan and detailed cost estimates for implementing improvement actions. 	<ul style="list-style-type: none"> Provide sustainable services for the future.
Wastewater Collection			
System Renewal*	Continue system renewal at current rates with appropriation of dedicated funding to provide effective wastewater collection.	<ul style="list-style-type: none"> Rehabilitate up to 1% of collection system structures per year, depending upon contractor availability and pricing. Secure dedicated annual funding for continued renewal. Current bond funding runs out in 2019. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality.
Private Common Collector Elimination (PCCE)*	Implement identified PCCE projects in the CIP with appropriation of dedicated funding to reduce illicit sewage discharges.	<ul style="list-style-type: none"> Continue Private Common Collector elimination, depending on ability to gain easements, as well as contractor availability and pricing. Secure dedicated funding. Current bond funding runs out in 2019. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality.
Reduce Building Backups*	Implement backflow prevention program to reduce building backups.	<ul style="list-style-type: none"> Obtain Council approval for backflow prevention program with allocation of \$100,000 per year for 5 years. Implement community outreach to build awareness of backflow prevention program. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality.
System Capacity Enhancements and Private I/I Reduction*	Reevaluate private I/I program to reduce peak wet weather flows.	<ul style="list-style-type: none"> Assess benefits and cost-effectiveness of previous and modified private I/I program. Implement community outreach to build awareness of modified program. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality. Regulatory compliance.
System Expansion	Provide adequate and cost-effective wastewater services to developing areas for watershed protection.	<ul style="list-style-type: none"> Fund expansion projects currently identified in the CIP, as needed. Develop systematic approach for evaluating sewer extensions to better identify sewer mains that should be upsized to convey future capacity. 	<ul style="list-style-type: none"> Protect quality of life. Provide sustainable services for the future. Improve water quality.
Wet Weather Planning*	Develop collection system model and evaluate future system capacity enhancement strategies.	<ul style="list-style-type: none"> Conduct comprehensive flow monitoring through 2020 to calibrate collection system model. Develop model by 2021. Evaluate system capacity enhancement strategies through 2022. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality. Regulatory compliance.

Columbia 5-Year IMP Action Plan ¹			
Program or Project ²	Goal	Anticipated Actions	Targeted Community Benefits ³
System Cleaning	Enhance sewer cleaning program to practicably mitigate overflows and backups due to blockages.	<ul style="list-style-type: none"> Develop prioritized cleaning program. Purchase new jet truck. Plan for new building for field operations and collections personnel. 	<ul style="list-style-type: none"> Protect public health and safety Improve quality of life Provide sustainable services for the future Improve water quality
Stormwater Management			
MS4 Program Enhancements*	Enhance Public Education and Outreach, Illicit Discharge Detection and Elimination, and Construction Site Stormwater Runoff Control to reduce bacteria, sediment, and trash discharges.	<ul style="list-style-type: none"> Continue to develop and distribute public education messages as outlined in the Stormwater Management Plan. Hire technician to support MS4 program with focus on IDDE. Conduct streamwalks and outfall inspections in all City streams within 5-year action plan period. Develop map of stormwater outfalls. Update Erosion and Sediment Control Manual and policies and procedures. Continue to work with MS4 partners to effectively implement stormwater management program, particularly Minimum Control Measure #4. Continue to work with MS4 partners to implement CAM program to improve Hinkson Creek water quality. 	<ul style="list-style-type: none"> Protect public health and safety Improve quality of life Provide sustainable services for the future Improve water quality Regulatory compliance
System Renewal	Implement renewal program to address failing corrugated metal pipe (CMP) and structures beyond physical effective life.	<ul style="list-style-type: none"> Initiate renewal activities as resources and funding allow. Secure additional funding to implement these actions. 	<ul style="list-style-type: none"> Protect public health and safety Improve quality of life Provide sustainable services for the future Improve water quality
Condition Assessment	Establish and begin implementing a condition assessment program.	<ul style="list-style-type: none"> Begin assessing CMP throughout the City. Secure additional funding to implement these actions. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality
Flood Reduction	Address known areas of flooding to reduce public health and safety concerns.	<ul style="list-style-type: none"> Implement opportunistic flood reduction projects, depending on available funding after emergency and critical system repairs. Develop stormwater project ranking system. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality
Runoff Treatment	Reduce pollutant runoff in Hinkson Creek tributary watersheds to improve water quality.	<ul style="list-style-type: none"> Implement opportunistic runoff treatment projects, depending on available funding. Develop stormwater project ranking system. Continue to implement CAM process. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality

Columbia 5-Year IMP Action Plan ¹			
Program or Project ²	Goal	Anticipated Actions	Targeted Community Benefits ³
Stream Erosion Control	Stabilize stream channels with excessive channel erosion to reduce sediment discharges.	<ul style="list-style-type: none"> Identify and implement opportunistic stream erosion control projects, depending on available funding after emergency and critical system repairs. Develop stormwater project ranking system. Continue to implement CAM process. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality
Planning and Program Support	Develop stormwater master plan and enhance data management processes.	<ul style="list-style-type: none"> Initiate master planning and data management efforts. Secure additional funding to implement these actions. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality
Activities to Measure Water Quality Improvements ⁴			
Water Quality Monitoring	Implement water quality monitoring program to help define baseline conditions and track future improvements.	<ul style="list-style-type: none"> Develop water quality monitoring plan within first 5 years and implement when additional funding is secured. 	<ul style="list-style-type: none"> Evaluate IMP effectiveness Provide technical basis for future IMP modifications
Hinkson Creek Flow Gage	Collect continuous Hinkson Creek stream flow data.	<ul style="list-style-type: none"> Continue annual funding for USGS flow gage operation. 	<ul style="list-style-type: none"> Evaluate IMP effectiveness Provide technical basis for future IMP modifications
<p>Note 1 - Goals and actions identified in this 5-Year IMP Action Plan reflect the City's understanding of infrastructure and regulatory needs and priorities with respect to the information currently available. The City will implement these actions to the extent possible but acknowledge that weather, staff availability, Council approval and other resource constraints or unanticipated needs may impede complete implementation of the Action Plan or require that it be modified. Further, the City notes that many of the activities outlined in this Action Plan assume that sufficient additional funding will be made available through sewer rate increases, bond financing that must be approved through a local election, and stormwater rate increases that must be approved by a majority vote. If sufficient additional funding does not become available, the 5-Year IMP Action Plan will be modified to reflect available funding and resources.</p> <p>Note 2 - High priority program and project needs were identified by City staff and are denoted with an asterisk (*). These represent projects that are intended to directly and expeditiously reduce significant public health risks, improve water quality, or enhance customer service.</p> <p>Note 3 - Targeted community benefits are presented in Section 4.3 and explained in greater detail in Attachments J and N.</p> <p>Note 4 - Element 5 of EPA's Framework requires that municipalities outline activities that will be used to measure IMP effectiveness. Activities listed here will be used to measure water quality improvements that occur over time. Additional program management and Utility service performance measures are discussed in Section 6.</p>			

Climate Trends Summary

Introduction

This brief summarizes observed and projected changes in climate for the City of Columbia and the surrounding region. It particularly focuses on temperature, heat waves, precipitation, flooding, drought, air quality, and severe storms.

This summary draws from existing datasets and literature, and therefore is subject to the scope and limitations of those sources of information.¹ In addition, since various sources are referenced, the time periods and spatial scales of the information varies. Where possible, information specific to Columbia was sought out and utilized, but other spatial scales frequently used in this summary are the state of Missouri and the Midwest. Most projections are for mid-century (generally the 2050s) and end of century (2100) and use high and low emissions scenarios, described in more detail in the section on projected changes in climate.

Historical Climate and Observed Trends

Columbia's climate is generally characterized as temperate. The average high temperature during the year is 87.9°F (in July), and the average low is 20.9°F (in January) [1]. There is natural variability that creates temperature and precipitation extremes; the record minimum temperature is -26°F, and the record maximum is 113°F [1]. Rainfall is typically heaviest in May, which sees 5 inches of rainfall on average, while January is typically the driest month of the year, with 1.9 inches on average [1]. During the winter months, precipitation often comes in the form of snow. On average, Columbia gets 18.4 inches of snowfall in the year [1].

The following sections describe the changes that have been observed in Columbia and/or the surrounding region to date.

¹ Much of the information included in this summary was based on the Climate in the Heartland report analysis, which used historical climate data from the Columbia Regional Airport weather station, 28 National Weather Service cooperative stations across Missouri, and climate change projections completed by Iowa State University scientists based on downscaled data from the international Coupled Model Intercomparison Project 3 (CMIP3) and nine different global climate models [1].

TEMPERATURE



OBSERVED CHANGES

Annual temperatures in the Midwest are now 1.3°F warmer on average, and the coldest day of the year is now 2.9°F warmer, compared to the 1900-1950 average. In Columbia, winters and springs have had the most warming, with fewer cold waves since the mid-1980s. Meanwhile, summer nights in Columbia have been getting warmer and more humid.

Across the Midwest, the annual average temperature has increased by 1.3°F since the first half of the 20th century [3]. The greatest change has been in the annual lows, which have increased by 1.8°F on average, with the temperature on the very coldest day of the year in the Midwest now 2.9°F warmer [3]. In Missouri, average temperatures are about 0.5°F warmer now than they were in the early 20th century [4]. So far, the 21st century has had warmer temperatures than any other period in the historical record, except for the 1930s Dust Bowl [4].

Like the rest of the region, Columbia has experienced increasing annual temperatures in the last century (see Figure 1) [5].² About 12 of the past 20 years have been warmer than the historical average between 1895 and 1998. The year 2012 was the warmest year on record since 1895 [1].

Winter and spring are the seasons that have shown the most warming in Missouri. Three out of the five warmest winters on record have occurred since 1991 [5]. During the past 25 years, the number of extremely cold days (with a minimum temperature below 0°F) has been below the historic average [4]. This trend is observed in Columbia as well. Since 1970, the most notable increases in temperature compared to historical averages have been during the winter and spring [1]. There have been fewer cold waves since the mid-1980s and fewer heating degree days since 1970 when Columbia residents need to turn their heaters on at home [1].³ In the last 30 years, the last spring frost has been occurring three to four days earlier in the year than it did historically, which farmers in the greater Columbia area have had to take into account in their planting decisions [1].

² Trends in the temperature record for Columbia are most reliable between 1970 to present. Prior to this period, the weather instrumentation was relocated several times before arriving at its current location at the Columbia Regional Airport. It is also worth noting that the airport is in a rural area 11 miles southeast of Columbia, and the recorded temperatures have been notably lower than records taken at the University of Missouri-Columbia campus in the urban core. This suggests that an urban heat island (UHI) effect—which describes the way that developed urban areas tend to be hotter than nearby rural areas because roads, buildings, and other dry impermeable surfaces have replaced open land and vegetation—may be leading to warmer temperatures in Columbia than the surrounding area. More impervious surface area, as a measurement of urbanization, has been correlated with higher land surface temperatures in urban areas [25]. Across the U.S., the UHI effect has led to an average increase in urban temperatures of 5.2°F [24].

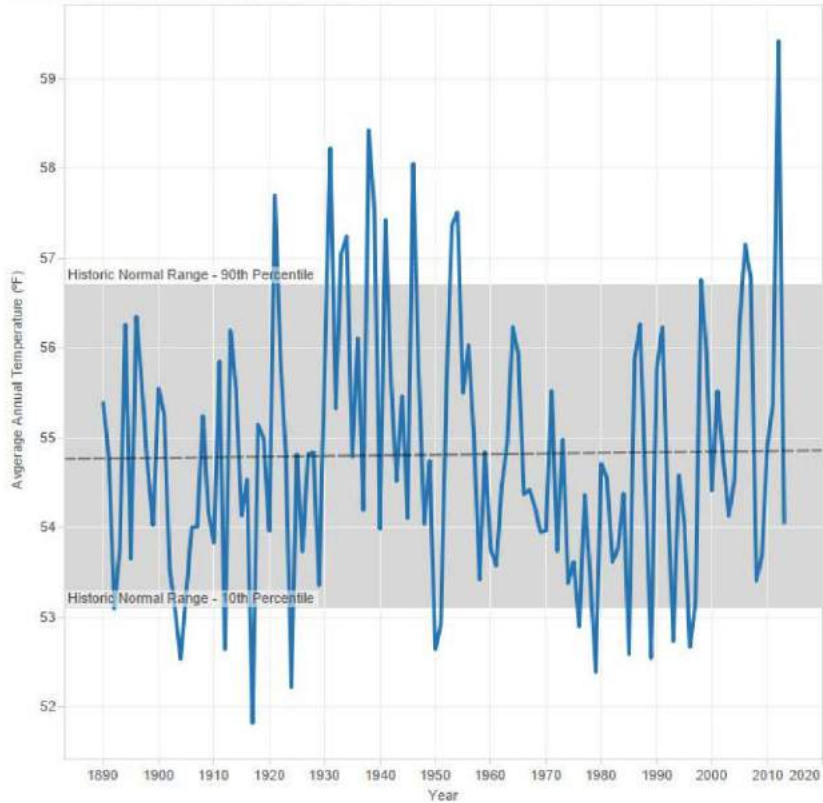
³ Although the projected decrease in heating degree days is not available for Columbia, Kansas City is projected to see a 14 percent decrease by 2060 compared to the 1976-2015 historical average under a high emissions scenario [26].

Summers have also become warmer across the state over the past 120 years, and have been unusually hot since 2010 compared to other hot summers Missouri experienced before [1]. Specifically, the minimum daily temperatures during the summer have been increasing across the state as well as in the Columbia area, meaning summer nights are warmer [1, 4]. This change has driven a trend in more cooling degree days in Columbia since 1970, meaning more days when residents need to use air conditioning [1].⁴

Dew point temperatures—the point when water condenses—are also rising [6]. When the dew point is higher, the air usually feels more humid and it is harder for sweat to evaporate so people's bodies stay cool. Across the state, dew points have been above average for the past several decades [5]. Columbia has experienced above-normal summer dew point temperatures in more than three-quarters of the years since 1981 [1]. Warmer summer nights combined with higher dew points can lead to longer and more frequent periods of high heat indices, which in turn contribute to heat-related illnesses.

⁴ The specific projected change in cooling degree days is not available for Columbia. For reference, Kansas City is projected to have over 45 percent more cooling degree days by 2060 compared to the 1976-2015 historical average under a high emissions scenario [26].

Figure 1. Recorded annual average temperature in Columbia, MO with trendline [1]. The average annual temperature in Columbia has been gradually increasing since 1895, as the trendline (gray dashed line) shows. Although there have been periods in the past, such as 1920-1955, when there were several years outside the normal historical range (gray bar), the recent warming trend since 1970 has been notable, with over half of the past 20 years being warmer than the 1895-2010 average.



HEAT WAVES



OBSERVED CHANGES

Available science is not conclusive about whether Columbia has seen more or fewer heat waves over time.

Heat waves are prolonged periods of extreme heat. In Columbia, the available data makes it difficult to identify a long-term trend in the frequency of heat waves [1]. Across the Midwest, there have generally been fewer heat waves since the 1960s, but this trend may be related to more intensive agricultural production, which can have a localized cooling effect by adding more vegetation [3, 7].

The impacts of heat waves can be exacerbated by high humidity. However, low humidity and drought conditions have also been known to support extreme, prolonged, and high-impact heat waves [6].

PRECIPITATION

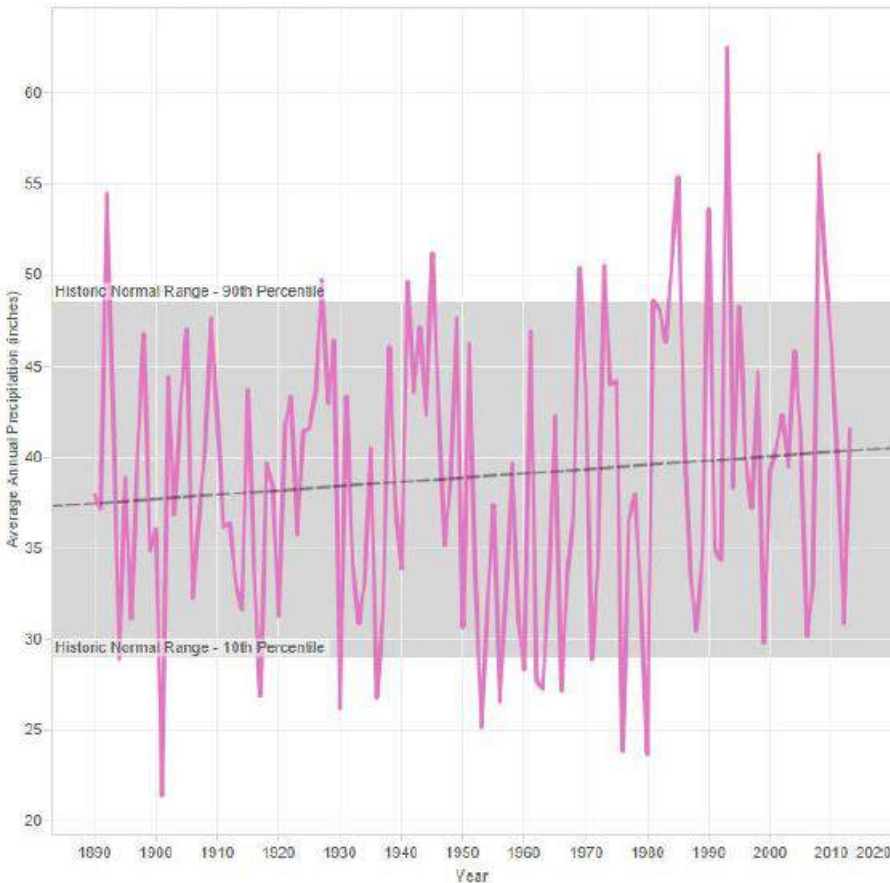


OBSERVED CHANGES

Columbia is getting about 10 percent more precipitation, with more of that increase coming in the winter and spring. The biggest storms are bringing more rain than they used to. Heavy rain events are also happening more often—twice as often now as compared to 1890-1984. Increased rainfall has meant more frequent flooding.

Figure 2 shows recorded rainfall in Columbia since 1890. In the past 30 years, annual rainfall was nearly 10 percent more than the past century’s average [1]. There has been more rainfall in all four seasons, but the most notable increase has been during winter and spring [1]. Heavy rain events have also become more frequent. During the past three decades, extreme rainfall events, with 3 or more inches of rain, are happening more than twice as often compared to the 1890-1984 average [1]. The Columbia area more often sees unusually heavy rainfall during spring and fall, rather than winter or summer.

Figure 2. Recorded annual average precipitation in Columbia, MO with trendline [1]. As the trendline (dashed gray line) indicates, average annual precipitation in Columbia has increased since 1895. Since 1980, there have been more extremely wet years that peak well above the historical normal range (gray bar). However, even with this change, there has still been seasonal variability in precipitation that is not shown in this figure.



Increases in heavy and extreme daily events and multi-day rainfall events compared to the long-term average have also been seen statewide [8]. Extreme rainfall has become more frequent in Missouri over the past 60 years. The biggest storms have become even larger during that time, such that they now hold 20 percent more rainfall [9]. Since the early 1970s, daily precipitation records have been broken at many weather stations across the state, which have been recording precipitation for 120 years [9].

One impact of these precipitation trends is more frequent flooding, which has been seen in rivers across the Midwest [8]. In Missouri, flooding has become more frequent for most flood-prone areas over the course of the last century [5]. During December 2015, for example, record rainfall in some parts of the state led to significant flooding—an unusual occurrence during the winter, as most rainfall usually occurs during the spring [10]. Flooding that can come from extreme rainfall events can damage or destroy buildings, bridges, and roads, such as what occurred during the spring of 2017 when a 1-in-1,000-year rainfall event caused historic flooding in some parts of Missouri [11].

DROUGHT

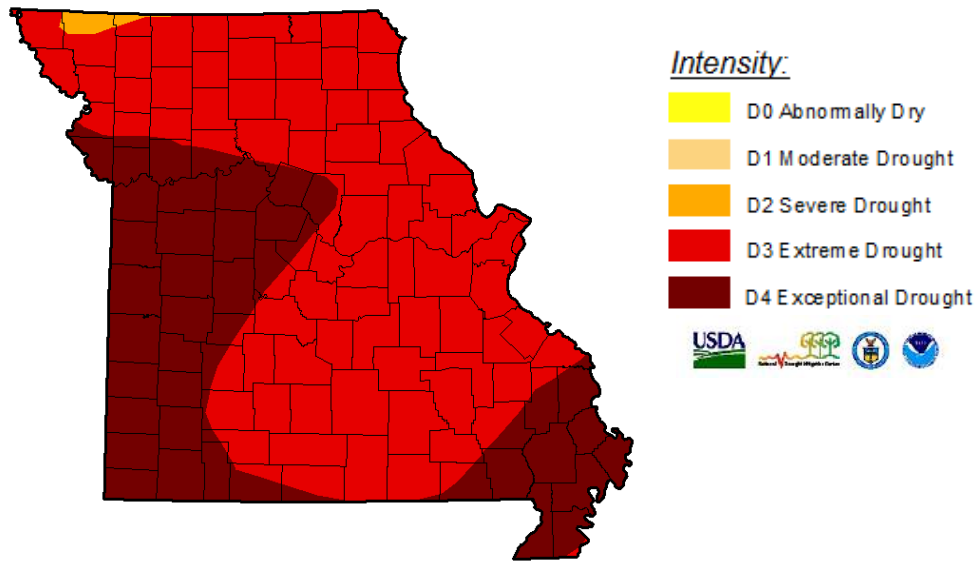


OBSERVED CHANGES

Since there is limited historical data, it is not clear whether drought has become more or less frequent in Columbia.

There is limited historical data on local drought occurrence, which makes it difficult to determine a long-term trend and relate it to climate change. It is worth noting that in 2012, the Midwest/Great Plains region experienced the most severe summer drought ever recorded there [8]. Figure 3 shows the areas of drought by intensity across Missouri in August 2012. In Boone County, there were 35 consecutive weeks of severe or worse drought conditions between July 2012 and February 2013—far longer than any stretch since 2000, as shown in Table 1. Scientists have found that the 2012 drought was partly caused by an unusual series of weather patterns that limited thunderstorm activity during the summer, and some studies show that human-caused global warming may have also contributed [8].

Figure 3. Drought intensity in Missouri on August 21, 2012 [12]. The 2012 drought was the most severe drought on record in the Midwest region.



Author: Michael Brewer, NCDC /NOAA

Table 1. Consecutive weeks of severe drought or worse in Boone County between 2000 and 2017 [12]. Based on the drought intensity classification, under severe drought conditions, crop or pasture losses are likely to occur, water shortages are common, and water restrictions are often imposed.⁵

Start Date	End Date	Number of Consecutive Weeks
7/3/2012	2/26/2013	35
4/18/2000	5/23/2000	6
7/26/2005	8/23/2005	5
8/12/2003	8/26/2003	3
8/8/2006	8/22/2006	3
3/7/2017	3/21/2017	3

AIR QUALITY

OBSERVED CHANGES



Air quality in Boone County reached unhealthy levels on 13 days between 2012 and 2014. Long-term trends are unknown, but warmer air temperatures are known to increase ozone smog.

Warmer air temperatures can increase ozone smog, which can negatively affect lung and heart health. Between 2012 and 2014, Boone County had 13 days when the air quality was deemed unhealthy for people sensitive to poor air quality, such as older adults, children, and people with respiratory disease [13]. Ozone can also slow plant growth and reduce yields of soybean and winter

⁵ The data presented here on drought occurrence is from the U.S. Drought Monitor and is best understood at the regional scale rather than inferring about specific local conditions [12]. Nevertheless, it can be a useful tool to contextualize what was experienced in a given year relative to historical conditions in the region.

wheat if ozone levels are high enough. In some areas of Missouri, ozone levels have been high enough to potentially reduce crop yields. [5].

SEVERE STORMS AND TORNADOS



OBSERVED CHANGES

The U.S. has seen fewer days with tornados since the 1970s, but more tornados have been forming on those days. In Columbia, limited data makes it difficult to determine if there is any local trend in tornado activity.

Historical data on tornado occurrence is limited since it relies on visual observations by eyewitnesses, and people are not always around to see every tornado. Reports are inconsistent and do not indicate a clear long-term trend in tornado frequency for Columbia [1]. National data indicates some trends: across the U.S. since the 1970s, there have been fewer days each year when tornadoes occur, but more tornadoes have been forming on those days [14]. In addition, the season of high tornado activity has been occurring earlier in the year [14]. These trends have not been attributed to climate change.

Projected Changes in Climate

Long-term trends indicate that the climate is changing driven by global greenhouse gas emissions. The concentration of carbon dioxide in our atmosphere has surpassed the level that was last observed millions of years ago [2]. If greenhouse gas emissions continue to grow at the current rate, the concentration of carbon dioxide in our atmosphere could reach a level well beyond anything that has been observed in tens of millions of years. Scientists broadly agree that as emissions warm the Earth at a faster rate, the risk of highly damaging and potentially irreversible impacts increases. Although short-term emission trends show variability, such as a slowing down in 2014 and 2015 when economic growth was not as carbon-intensive, this variability is not significant enough to alter the trajectory of warming [2].

The following sections describe the future changes in climate that have been projected for Columbia or the surrounding region and some of the potential impacts on our city and our resources. While Columbia will still experience variability in its climate, climate change will shift the range of that variability.

Scientists use emissions scenarios to model how the climate might change in the future. Scenarios make assumptions about future changes in population, technology, policy, and other factors that would influence human-caused greenhouse gas emissions. This climate trends summary relies on the scenarios used in the literature. Studies commonly use low and high emissions scenarios called Representative Concentration Pathway (RCP) scenarios 4.5 and 8.5, respectively. RCP 4.5 represents

an increase in emissions from present day until 2100, after which emissions are stabilized. Under RCP 8.5, emissions increase at a greater pace through 2100 and continue to rise after that point.⁶

TEMPERATURE



PROJECTED FUTURE CHANGE

By the late century, temperatures in Columbia will regularly be outside what has been considered normal since 1970. Columbia could have over 50 days each year when the temperature is above 95°F, compared to fewer than 5 days that we currently experience on average.

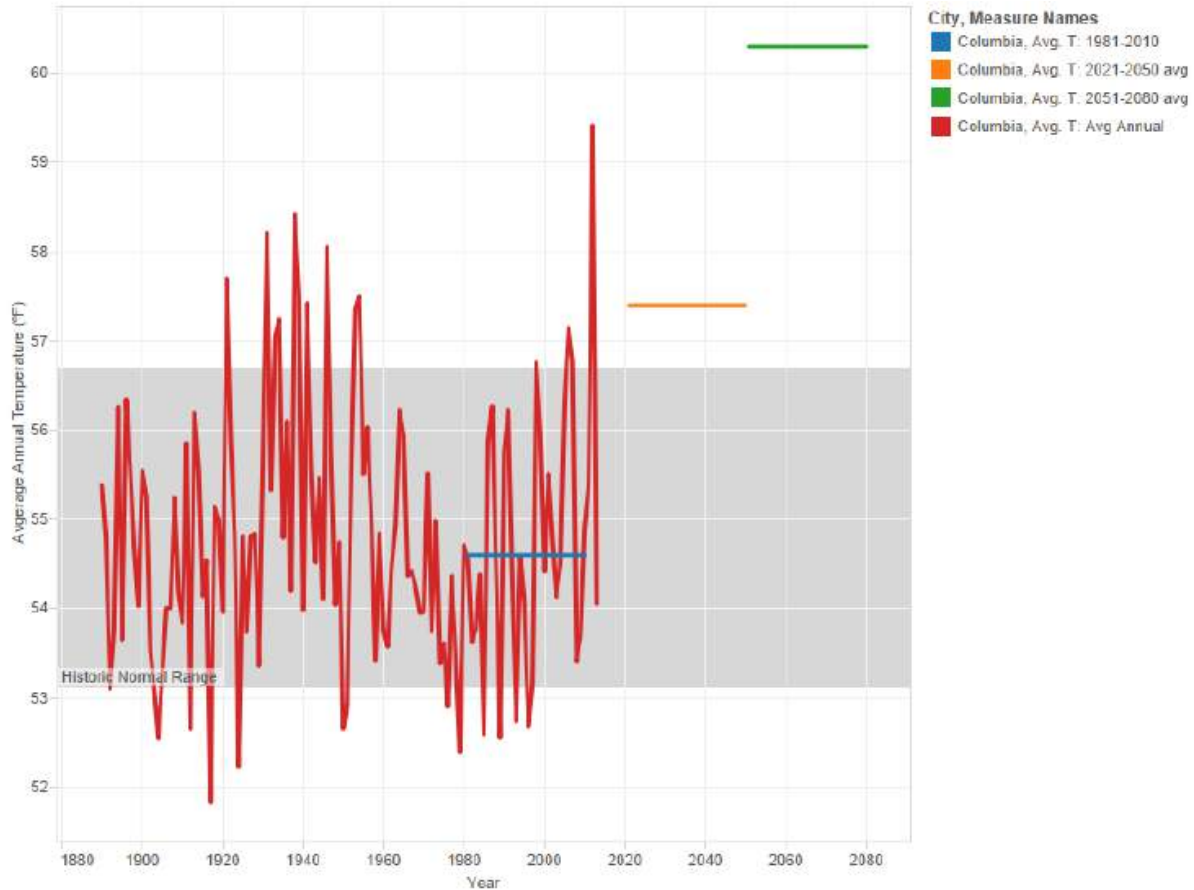
Across the Midwest, the annual average temperature is projected to increase 4.2-5.3°F by mid-century and 5.6-9.5°F by the end of the century under a low and high emissions scenario, respectively [3]. These projections hold for Columbia as well, with the greatest increases during spring, summer, and winter [1]. By the 2050s, average temperatures are expected to regularly exceed the normal temperature range Columbia has experienced since 1970, as shown by the green line in Figure 4 [1].

These changes will bring a continued shift in seasonal frosts. By mid-century, Columbia's last frost in spring is projected to occur more than one week earlier than it does today. Meanwhile, the first fall frost will happen slightly later [1].

Extreme temperatures are also projected to change in the Midwest. The coldest day of the year could be 9.5°F warmer and the hottest day of the year could be 6.7°F warmer by mid-century [3]. By the late century, Missouri is expected to have over 25 days per year when the temperature exceeds 95°F, compared to between 5-15 seen across the state in 2016 [5]. Under a high emissions scenario, Columbia is projected to see this change even sooner—reaching over 20 days per year above 95°F by 2050 and over 50 days by 2100, compared to less than 5 on average between 1997-2016 [15]. By 2080, maximum daily highs in the summertime could reach nearly 104°F and not dip below 80°F in Columbia, meaning warmer nights [1].

⁶ A primary report included in our review (Climate in the Heartland Report) projects future climate conditions using scenarios from SRES (Special Report on Emissions and Scenarios) rather than the RCPs, which were developed later. Overall, the low (A1B) and high (A1F1) emissions SRES scenarios used are very similar to RCPs 4.5 and 8.5, respectively. The high emissions scenario most closely resembles the observed trend in global emissions through 2015. This future is consistent with no implementation of climate policies, a continued reliance on fossil fuels, and three times as many CO₂ emissions in 2100 as we emit today [27]. RCP 4.5 is consistent with more stringent climate policies and a lower energy intensity in the future. The lowest-emission RCP scenario is 2.6, which includes achieving net negative carbon dioxide emissions before 2100 [28]. Many studies do not include this scenario.

Figure 4. Annual temperatures from the historic record (1895-2010) and projected future temperatures for Columbia, MO. By mid-century, the average annual temperature for the next 30 years (orange line) is expected to be approximately 3°F above the 1981-2010 average (blue line), and outside the historic normal range (grey area). By the second half of the century, the 30-year average (green line) is expected to increase again by about 3°F, far above today's typical range. Meanwhile, the most extreme temperatures will be much higher than the projected averages.



HEAT WAVES



PROJECTED FUTURE CHANGES

Heat waves in the Midwest are expected to become even hotter by 2050, with temperatures increasing by about 13°F. With that change, extreme heat in Columbia could more regularly reach temperatures well over 100°F, with the hottest periods exceeding 103°F by 2080.

During a period of extreme heat in June 2012, the temperature in Columbia reached 107°F [16]. These extremes will become more common in the next few decades as summer temperatures and humidity increase under climate change, and communities will likely feel even more heat stress. In the Midwest, temperatures during heat waves are projected to increase by about 13°F by mid-century [3]. In Columbia, the maximum temperature during the hottest 3-day period is expected to increase to 100°F by 2050 and further increase to over 103°F by 2080, compared to an average of 97°F between 1981-2010 [1]. Children, the elderly, those who are sick, and low-income households

are especially vulnerable to heat stress [5]. Those living in Columbia's urban areas may be more vulnerable as well, as cities are denser and have more heat-trapping concrete than rural areas.

PRECIPITATION



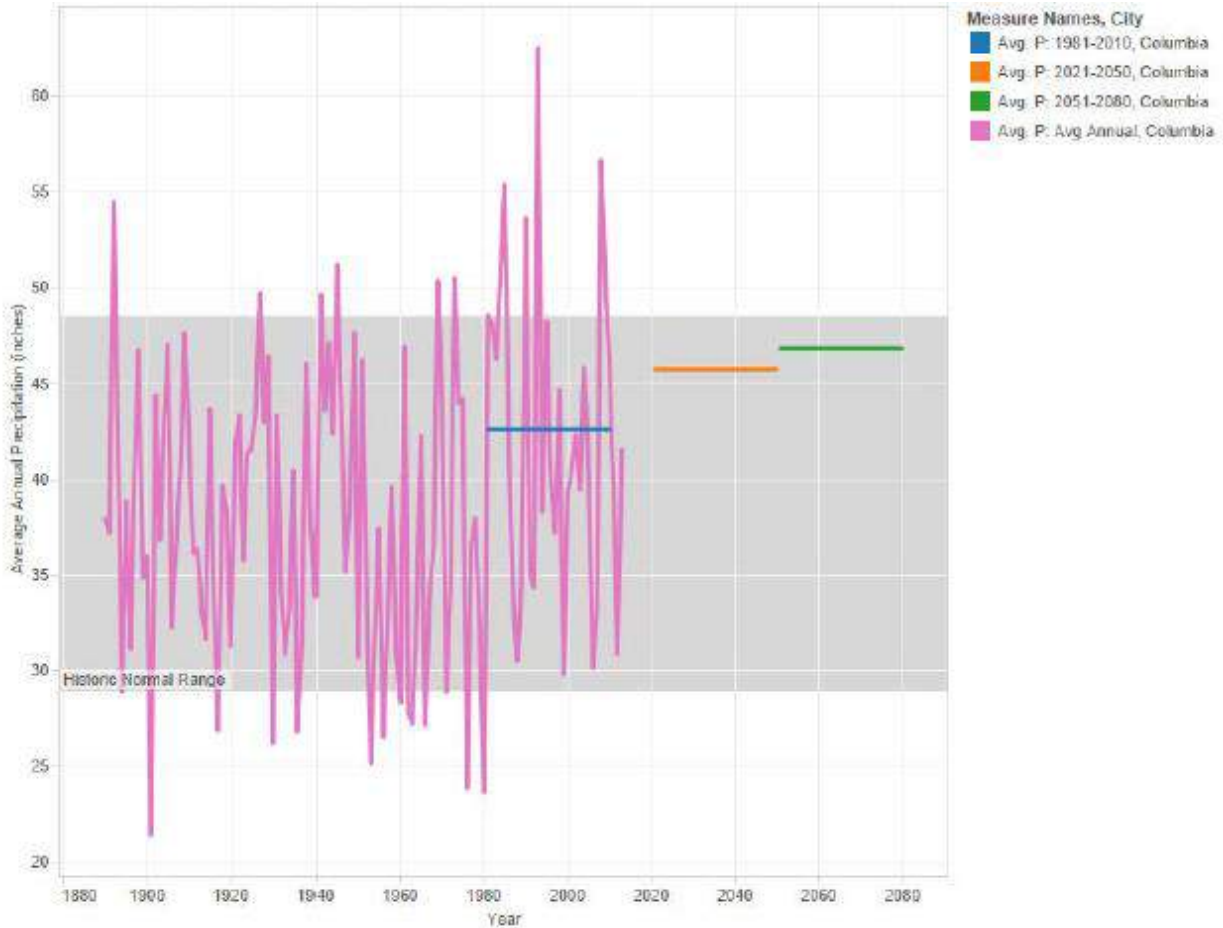
PROJECTED FUTURE CHANGES

Across the Midwest, annual precipitation is expected to increase. By mid-century, Columbia's annual average rainfall could be 7 percent more than the average in the last century. Heavier rain events are expected as well.

In the greater Midwest, average annual precipitation is expected to increase between now and 2100, in large part due to increases in spring rainfall [5]. Similarly, average annual precipitation in Columbia is projected to increase 7 percent by 2021-2050 compared to 1895-2010 and will continue to increase substantially beyond this period, as Figure 5 shows [1]. Between 2050 and 2081, annual precipitation is projected to be on par with the wettest years Columbia faces today in its current climate [1]. On a seasonal basis, spring and fall will experience the greatest increases in precipitation, while summertime precipitation is expected to decrease [1].

Heavy rain events are also projected to become more frequent in Columbia [1]. This is similar to what is expected for the Midwest at large, with severe rainstorms likely intensifying during this century [5]. More precipitation and especially heavy rainfall events will increase the risk of local flooding, which will require additional protection measures [5, 8]. Given the changes in rainfall expected in Missouri in the next 25 years, protection efforts will have to address flood events that usually occur at 500-year intervals, compared to what are now 100-year events, in order to maintain the current level of protection against high-risk flooding [17]. Flooding could be more of a problem if heavier rains occur in winter when soils are already saturated and there is little vegetation to help absorb the additional water [10]. Developed areas with more concrete that prevents rain from soaking into the ground will be more likely to experience flooding during heavy rain events [10].

Figure 5. Annual precipitation from the historic record (1895-2010) and projected temperatures into the future for Columbia, MO. Annual precipitation by mid-century (orange line) is expected to be in the higher range of what Columbia has seen since 1895. In the next 30 years (orange line), Columbia can expect to have about 3 more inches of precipitation annually than the 1981-2010 average (blue line). By 2051-2080 (green line), annual precipitation will increase by another inch. With this change, Columbia will still have extremely wet and dry years, but they will overall be slightly wetter than before. Seasonal precipitation will still vary, meaning that even in the wetter years, summers can be dry.



DROUGHT



PROJECTED FUTURE CHANGES

Summer drought will likely be more common in Missouri in the future.

While Missouri springs are expected to be wetter in the future, summers are expected to be drier, bringing more severe summer droughts [5]. During drought, rivers are more likely to have lower streamflow, which causes river navigation challenges and increases the risk of economic impacts on the shipping industry [5]. Drought can also reduce municipal water supply, decrease energy production that relies on water from rivers, and warm lakes and ponds that are used for recreation or cooling [10].

Agricultural production may be negatively affected by drought, especially on farms without irrigation. In particular, surface soil is projected to be drier across the U.S., even in regions where precipitation is projected to increase, which will pose a challenge to crop production [8].

Drought may also reduce forest productivity by causing stress on trees and increasing their susceptibility to insects and disease. However, these losses may be offset by longer growing seasons and more carbon in the atmosphere, which can help plants use water more efficiently and protect them against drought [5].

AIR QUALITY



PROJECTED FUTURE CHANGES

Warmer temperatures may worsen air quality in parts of Missouri in the future. Days of poor air quality may become more common in Columbia, and the air quality may be worse on those days.

Rising temperatures and climate change will increase the risk of ozone smog pollution, especially for areas in Missouri that are currently experiencing higher ozone levels [9]. In Columbia, these impacts could mean more days each year with poor air quality and possibly worse air quality on high-ozone-risk days. In addition, warming temperatures may lengthen the pollen season statewide and make it more severe, given that pollen-producing plants grow better with more carbon dioxide in the atmosphere [9]. These changes could worsen allergy symptoms and possibly contribute to asthma attacks.

Warmer temperatures and lower humidity levels could also increase fire risk [18]. Smoke from natural cover fires could cause periods of lower air quality. Climate change is increasing wildfire risk in forests in other parts of the country, and this could have consequences for Missouri as well: in 2017, smoke from fires in the Western U.S. and Canada reached as far as Missouri [19].

SEVERE STORMS AND TORNADOS



PROJECTED FUTURE CHANGES

The Midwest could see more favorable conditions for storms by 2100. The science on tornados makes it hard to say what the future could hold for Columbia and Missouri specifically.

Severe thunderstorm conditions could become more frequent across the Midwest by the end of the century [14].⁷ Under future climate conditions, there may be more lightning strikes—potentially increasing 12 percent or more for every 1°C of warming [20]. Lightening poses a fire risk as well as

⁷ Projections of storm frequency use temperature, humidity, and wind conditions as a proxy for thunderstorms, rather than eyewitness reports.

a potential human safety hazard. Severe storms could also cause flash flooding, potentially damaging infrastructure, homes, and croplands [10].

When it comes to tornados, it is challenging to project future changes in frequency and severity as there are various factors at play. Tornadoes are more likely to occur when there is unstable air in the atmosphere, and when wind closer to the ground is moving at a different speed and direction than the wind above it, a situation known as wind shear. While rising humidity is likely to make air less stable in the future, wind shear is generally expected to decrease [5]. However, it is difficult to project changes in severe storms and tornados specifically for Columbia since the weather patterns and conditions that support these events occur at a much broader regional scale.

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Our Columbia Waters
Integrated Management Plan
Wastewater & Stormwater



Columbia Wastewater and Stormwater Integrated Management Plan

Final Report

Draft for Public Comment

City of Columbia, MO

June 1, 2018

<https://www.como.gov/utilities/sewer/imp/>

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- Attachment B.** Memorandum of Understanding between the Missouri Department of Natural Resources and the City of Columbia, Missouri regarding the Integrated Management Plan for Wastewater and Stormwater.
- Attachment C.** Project Framework and Approach.
- Attachment D.** Visioning Workshop Summary.
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- Attachment M.** Technical Memorandum 7 – Stormwater System Alternatives.
- Attachment N.** Technical Memorandum 9 – Alternatives Decision Analysis Process.
- Attachment O.** Technical Memorandum 10 – Residential Affordability and Socioeconomic Evaluation.

Section 1. Introduction and Objectives

Over the past decade, population growth, aging infrastructure, increasingly complex water quality issues, and challenging economic conditions have strained municipal utility management across the country. This situation has been further complicated by federal and state regulatory structures that historically focused on enforcing individual Clean Water Act (CWA) requirements on fixed schedules, without full consideration of all obligations that a utility may be facing or whether compliance efforts will result in meaningful improvements in environmental and public health. These narrow regulatory processes limit a community's ability to efficiently manage their utilities because they must address new regulatory requirements on a "first come, first served" basis, rather than prioritizing affordable and protective solutions to resolve the most critical environmental and public health issues.

"The integrated planning approach does not remove obligations to comply with the CWA [Clean Water Act], nor does it lower existing regulatory or permitting standards, but rather recognizes the flexibilities in the CWA for the appropriate sequencing and scheduling of work."

From EPA's 2012 Integrated Municipal Stormwater and Wastewater Planning Approach Framework

In 2011, the US Environmental Protection Agency (EPA) recognized that when afforded the flexibility to balance wastewater and stormwater improvements, municipalities can make important cost effective environmental improvements that align with community priorities¹. To support communities in these efforts, EPA

released the *Integrated Municipal Stormwater and Wastewater Planning Approach Framework*² (Framework). The Missouri Department of Natural Resources (MDNR) also supports municipal integrated planning and has developed a similar framework³. EPA's framework outlines a process that allows municipalities to meet human health and water quality objectives by using existing CWA flexibilities to appropriately prioritize and schedule wastewater and stormwater improvements according to a community's needs and financial capability.

The City of Columbia, Missouri (City) initiated this Integrated Planning effort after multiple and significant regulatory challenges, and aging infrastructure demands highlighted the importance of balancing and prioritizing investments. In January 2011, the Missouri Department of Natural Resources (MDNR) initiated enforcement negotiations with the Sewer Utility Division for wet weather sanitary sewer overflows (SSOs). During this timeframe, MDNR and the US Environmental Protection Agency (USEPA) developed the Hinkson Creek Total Maximum Daily Load (TMDL) to address a biological impairment. The Hinkson Creek TMDL did not include specific pollutant wasteload allocations but rather established stream flow targets to restore the beneficial use. Urban stormwater discharged from the City's municipal separate storm sewer system (MS4), as well as the Boone County's and University of Missouri's MS4s, were considered significant pollution sources in the TMDL. The TMDL resulted in the creation of the

¹ Stoner, N. and C. Giles. 2011. Achieving Water Quality through Integrated Municipal Stormwater and Wastewater Plans. October 27, 2011. Washington DC.

² Stoner, N. and C. Giles. 2012. Integrated Municipal Stormwater and Wastewater Planning Approach Framework. June 5, 2012. Washington DC.

³ Hirschvogel, Lacey. 2016. Missouri Integrated Planning Framework. Water Protection Program. Jefferson City, MO.

Collaborative Adaptive Management (CAM) process that the City is currently implementing in coordination with EPA, MDNR, Boone County, and the University of Missouri. With these two impactful regulatory drivers alone, the City realized that the community may ultimately face unaffordable program costs with typical regulatory implementation requirements, which would be exacerbated by additional regulatory obligations and the City's other infrastructure challenges.

In addition to these two significant regulatory issues, the City also faces a number of future issues (**Attachment A**) and service demands that will continue to impact wastewater and stormwater infrastructure decisions and investments for the next several decades. When EPA's Framework was issued, the Columbia City Council, Mayor, and Utility managers recognized that it provided a means to address existing and future regulatory requirements while continuing to meet the needs of the systems operations and chose to use it to develop this Integrated Management Plan (IMP). In 2017, the City and MDNR executed a Memorandum of Understanding (MOU) which acknowledged that the City would prepare the IMP to prioritize



future wastewater and stormwater improvements (**Attachment B**) and MDNR would use the IMP recommendations in future regulatory and permitting decisions.

The City retained HDR Engineering, Inc., and their team, which includes Geosyntec Consultants, Inc., Shockey Consulting Services, LLC, Black and Veatch, Inc., and TREKK Design Group, LLC (collectively, the Project Team), to assist in developing the IMP. This planning effort is focused on developing a prioritized and balanced infrastructure investment

Integrated planning allows the City to proactively and affordably balance and prioritize regulatory issues and infrastructure needs

strategy to address wastewater and stormwater management needs, including programmatic and capital funding for the wastewater collection, wastewater treatment, and stormwater management programs.

In their Framework, EPA recognizes that integrated plans should be appropriately tailored to the size of the municipality and scope of the issues, but they anticipate that all integrated plans will address the following six planning elements:

- **Element 1** – A description of the water quality, human health and regulatory issues (**Attachment A**) to be addressed.
- **Element 2** – A description of existing wastewater and stormwater systems under consideration and summary information describing the systems’ current performance.
- **Element 3** – A process which opens and maintains channels of communication with relevant community stakeholders in order to give full consideration of the views of others in the planning process and during implementation of the plan.
- **Element 4** – A process for identifying, evaluating, and selecting alternatives and proposing implementation schedules.
- **Element 5** – A process for evaluating the performance of projects identified in a plan.
- **Element 6** – An adaptive management process for making improvements to the plan.



Columbia's IMP project approach

To develop this IMP, the City and the Project Team tailored an approach that aligns with EPA’s six elements and allows the City to affordably meet CWA requirements (**Attachment A**) while planning for infrastructure investments over the next 20 years (**Attachment C**).

The City envisions implementing the IMP in a phased manner to address the most critical existing infrastructure and regulatory drivers first, while allowing adequate time to gather the information needed for thoughtful infrastructure planning. As discussed in **Section 4.2** below, critical needs were identified and prioritized based on their anticipated environmental, social, and economic benefits. Using this approach, the City will have an adaptable plan that addresses current regulatory drivers, provides investment certainty over the next 5 to 10 years, accounts for necessary non-regulatory investments prior to taking on investments to deal with future regulations, and defines affordability for the City’s ratepayers.

This IMP also builds on previous sewer and stormwater planning efforts undertaken by the City. In 2004, the City completed wastewater master planning efforts⁴ to identify capital improvement projects and funding needed to address anticipated collection and treatment needs through

⁴ <https://www.como.gov/utilities/wp-content/uploads/sites/20/2016/09/ColumbiaSewerMasterPlan-Nov2004.pdf>

2030. The City completed a similar stormwater assessment⁵ in 2008 and finalized a rate study⁶ in 2014 to identify revenue needs to satisfy forecasted annual operating, debt service, and capital requirements for the Storm Water Utility. The City recognizes that although these wastewater and stormwater plans continue to be useful planning documents, the recommendations must be reviewed periodically to account for changes in customer growth and economic projections, facility and program needs, and regulatory requirements.

In August 2015, the City formed the Mayor's Task Force on Infrastructure (MTFI) to broadly review and identify the City's overall infrastructure needs. The MTFI evaluated the overall operation, maintenance, and funding of the stormwater system, sewer system, downtown electric system, and major street plan and transportation infrastructure. The MTFI also reviewed past planning efforts, as well as current and future project priorities for these programs. The MTFI also provided both functional recommendations and financial/policy recommendations for the City Council and staff to consider. The functional recommendations were considered during the development of this IMP and incorporated where reasonable and appropriate. The majority of the MTFI financial and policy recommendations were beyond the scope of the IMP and were not evaluated. A summary of the functional recommendations and how they were addressed by the IMP is included in Section 7.

Details regarding the overall planning approach, as well as supporting data, information, and analyses used to inform the final IMP recommendations and actions are documented throughout the remainder of this report.

⁵ <https://www.como.gov/utilities/stormwater-engineering/2008-stormwater-utility-assessment/>

⁶ Burton and Associates, Inc., 2014. City of Columbia Stormwater Utility Rate Study. September 30, 2014.

Section 2. Build the Vision

Element 1 of EPA's framework involves identifying the important regulatory, environmental, human health, and infrastructure issues that will be addressed in the planning process. To build a cohesive vision for the IMP, the City hosted a two-day visioning workshop in May 2016 to discuss existing and future challenges facing the City, goals and objectives of the IMP, and potential IMP strategies to meet those goals (**Attachment D**). Workshop participants included representatives from a number of City Departments, including: City Management, Utilities Department, Columbia/Boone County Public Health and Human Services, Finance Department, Sustainability Office, Legal Department, and Community Relations. Representatives from the University of Missouri, Boone County, and the Boone County Regional Sewer District also participated. The City Council and Mayor were also individually interviewed to capture the critical issues and desired outcomes for the IMP process.

Over the course of the two-day workshop, the group discussed issues that would impact IMP development such as anticipated state and federal regulatory drivers, affordability concerns and strategies for characterizing ratepayer impacts, current conditions and future expectations for the City's wastewater and stormwater systems, and key stakeholder groups that should be included in the process. Through these discussions, the group broadly characterized goals, priorities, and challenges to inform the IMP. These ideas were captured in a vision statement intended to clearly and effectively communicate the intent and desired outcomes of the IMP to community stakeholders.

Columbia IMP Vision Statement

The stormwater and wastewater Integrated Management Plan is a community-driven, affordable infrastructure plan that enhances human health and safety, water quality, economic vitality, and environmental resources by leveraging existing assets and implementing innovative solutions.

To achieve this vision and guide the successful development of the IMP, workshop participants identified several key considerations that should be addressed during the planning process.

- Regulatory uncertainty is one of the largest challenges facing the City. The plan should provide at least five years of regulatory certainty so that the City can conduct important system condition assessments, develop asset management tools, and undertake other improvements that are necessary to develop an effective, long-term asset management and capital improvement program.
- Financial impacts on all City ratepayers, and specifically disadvantaged communities, must be carefully considered as IMP alternatives are developed or implemented.
- Integrated planning is a community-driven process. Therefore, stakeholder and community involvement is critical to developing an effective IMP. As part of the community engagement effort, the City should obtain input from a wide variety of stakeholders. Project information should also be developed so that the community can

easily understand the known problems and how the proposed projects will address these problems and provide additional benefits.

- The IMP recommendations should focus on identifying projects that have multiple benefits and are technically-feasible, prioritized, funded, and supported by the community. Specifically, the IMP will be successful if it provides a means to implement currently planned, critical infrastructure projects over the next five years and positions the City to successfully plan for and meet long-term environmental and infrastructure goals. In the near term, the IMP should focus on the most critical wastewater and stormwater priorities, which include:
 - Developing and implementing an asset management system to support system renewal efforts, identify performance baselines, measure progress, and assist in communicating infrastructure needs to ratepayers;
 - Addressing wet-weather issues, particularly basement backups, SSOs, and areas with persistent inflow and infiltration (I/I) challenges;
 - Reducing capacity-related issues in the existing wastewater treatment and collection systems; and
 - Improving stormwater planning, education, outreach, and inter-departmental coordination in an effort to formalize projects needed to address known drivers and accurately characterize future funding needs.

The visioning workshop was an important first step in the IMP development process because the vision, goals, and considerations identified helped to focus planning activities and shape the overall direction and objectives of the plan.



Feedback received during the two-day IMP visioning workshop shaped the overall direction and objectives of the plan

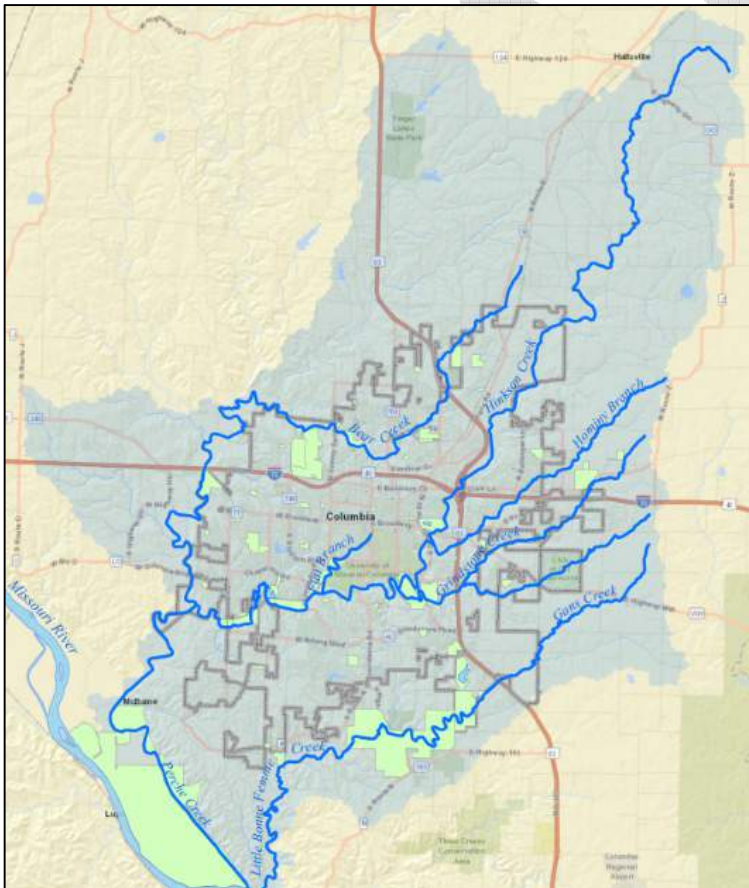
Section 3. Existing System Evaluation

The next step of the planning process includes evaluating the City's environmental resources and infrastructure assets to better define the existing condition, performance, and needs of its systems. This step directly addresses Element 2 of EPA's framework and forms the basis for developing alternatives (Element 4) and performance tracking systems to measure progress (Element 5) during future IMP phases.

To develop a comprehensive understanding of existing conditions, the City and their Project Team compiled and evaluated existing surface water quality and biological condition (**Attachment E**), wastewater collection (**Attachment F**), wastewater treatment (**Attachment G**), and stormwater management (**Attachment H**) data. For a detailed description of the data, performance assessments, and identified data gaps, refer to the corresponding technical memoranda attached to this report. Summaries of these evaluations are included below.

3.1 Surface Water Quality Conditions in Columbia

Columbia is widely known for its urban area streams, lakes, and wetlands and natural areas. There are approximately 300 miles of streams and more than 100 public and private lakes



Quality of life in the Columbia area is improved by the numerous water and natural resources

within the 200 square miles of watersheds that adjoin or intersect the City. The Missouri Department of Conservation's (MDC) Eagle Bluffs Conservation Area (Eagle Bluffs) is a regional natural resource asset and is supported by treated effluent from the Columbia Regional Wastewater Treatment Plant (CRWWTP). The City's water resources are prominent natural features that support wildlife habitat and recreational opportunities. Therefore, understanding current water quality conditions in Columbia area streams is critical for establishing priorities through the IMP process.

The State of Missouri has established water quality standards for streams, lakes, and wetlands across the state. These standards are implemented by MDNR and specify water quality conditions that are protective of both aquatic life and public health. If water quality

standards are not met, the City may be required to take corrective action if the impairment is attributed to activities within the City’s jurisdictional area.

There are a number of streams and lakes in Columbia that MDNR has identified as impaired because conditions do not meet water quality thresholds intended to protect designated beneficial uses. Designated beneficial uses associated with waters in the Columbia area include: whole body contact recreation or swimming, secondary contact recreation such as fishing or wading, protection of warm water aquatic life, protection of human health-fish consumption, and livestock and wildlife watering. The most common impairment in the Columbia area is for whole body contact recreation, or swimming. These recreational impairments are related to high bacteria levels that may pose health risks to users.

Beneficial uses of several regional streams and lakes are considered impaired due to unsatisfactory water quality conditions

Waterbody	Impaired Designated Beneficial Use	Impairment Source	Pollutant	Impairment Status
Hinkson Creek	Swimming and Wading	Nonpoint and Urban Runoff	Bacteria	Awaiting TMDL
Hinkson Creek	Aquatic Life Support	Nonpoint and Urban Runoff	Unknown	Approved TMDL & CAM Process Initiated
Hominy Branch	Swimming and Wading	Nonpoint and Urban Runoff	Bacteria	Awaiting TMDL
Grindstone Creek	Swimming and Wading	Nonpoint and Urban Runoff	Bacteria	Awaiting TMDL
Little Bonne Femme Creek	Swimming and Wading	Unknown	Bacteria	Awaiting TMDL
Perry Phillips Lake	Human Health Protection	Atmospheric Deposition	Mercury	Awaiting TMDL
Lake of the Woods	Human Health Protection	Atmospheric Deposition	Mercury	Awaiting TMDL

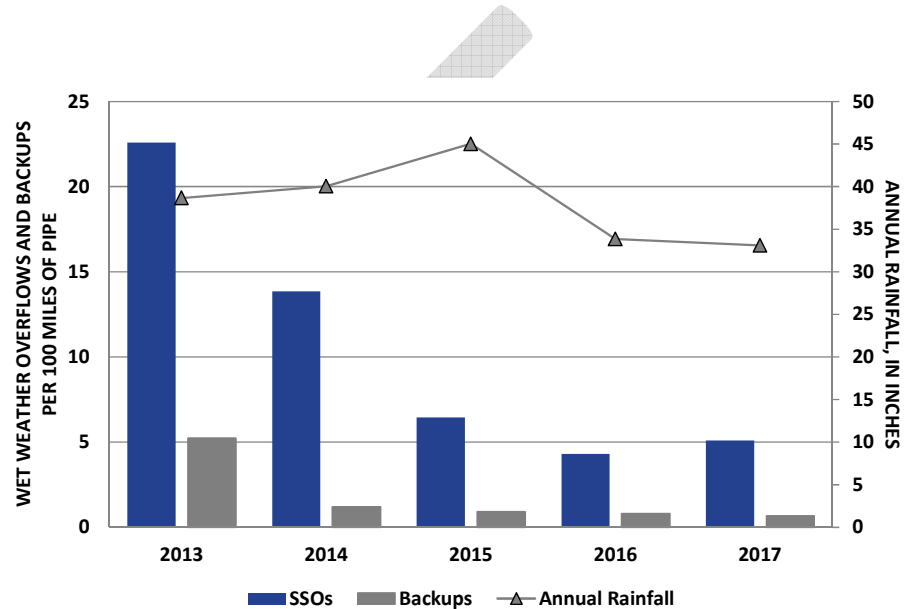
In addition to reviewing existing impairments, the Project Team compiled data from accessible, publicly-available sources to facilitate characterization of water quality conditions in and around Columbia. The water quality database included more than 17,000 data records from over 100 monitoring locations in Columbia watersheds. Most of the historical data were collected from the main stem of Hinkson Creek but are not robust or consistent throughout the remaining watersheds. Although these data were sufficient for evaluating large scale patterns and trends, the limited data available from most sites generally prevented detailed analysis needed to identify potential pollution sources or areas of concern.

Results of the data analysis indicated that the current list of impaired waters adequately characterizes the existing water quality concerns in Columbia. In general, elevated bacteria levels are the most pervasive issue throughout Columbia area waters. These high levels are exacerbated following rainfall events that contribute runoff to the streams. Significant or widespread impacts caused by other parameters such as low dissolved oxygen, chloride, and nutrients were not apparent from the data.

3.2 Wastewater Collection System Review

The wastewater collection system is an important component of the infrastructure owned and operated by the City’s Sewer Utility. Effective management of the collection system is vital for meeting important goals like reducing SSOs, achieving regulatory compliance, efficiently managing wastewater, and improving customer satisfaction. The Project Team worked with City staff to review the existing program and characterize the City’s current collection system management strategies and practices in the context of good engineering practices and core attributes that are fundamental to effectively managing and operating sanitary collection systems.

The collection system performance review indicated that City’s program has consistently improved over time and is meeting or exceeding expectations associated with an effectively managed Utility. For example, the City has made significant progress addressing overflows and building backups that occur during major wet weather



The Sewer Utility has implemented effective measures to reduce overflows and backups from Columbia’s sanitary sewer system

events through a combination of operational improvements at the CRWWTP influent pump station, I/I reduction efforts, and capacity improvement projects. Although the influent pump station continues to be a significant hydraulic restriction during wet-weather events, these improvements dramatically reduced surcharging and SSOs in the collection system upstream of the CRWWTP in 2015.

While the City has made significant improvements in the collection system, a number of capital and programmatic needs and data gaps were identified during the wastewater collection system assessment. According to the assessment, the City should:

- Develop and implement strategies to support system renewal and maintenance efforts using an asset management approach, including a mechanism to establish sufficient dedicated funding for these efforts.
- Develop a hydraulic model to identify improvements that will address remaining system capacity limitations and reduce I/I, building backups, and SSOs caused by wet weather flows.

- Maintain collection system maintenance performance to limit dry weather backups and SSOs due to blockages despite the challenges presented by aging infrastructure and community growth. Ensure adequate funding is available to achieve this performance.
- Update collection system goals to ensure they reflect the City's short and long-term priorities. Progress towards achieving these goals could be measured through actionable Key Performance Indicators (KPIs) that support the City in making business decisions, allocating resources, and identifying challenges that could negatively impact performance and service levels.

Planning level alternatives to address these needs are included in **Section 5** of this report.

3.3 Wastewater Treatment System Review

Wastewater treatment is an essential service provided by the City and is critical for protection of human health and regional water quality. The CRWWTP treats residential, commercial, and industrial wastewater generated within the Columbia metropolitan area and is one of the City's most significant infrastructure assets. The CRWWTP's ability to comply with current and future regulations, while managing wastewater from a growing population, was a vital consideration for the City during the IMP development process.

The CRWWTP consists of a mechanical treatment plant followed by a series of four treatment wetlands units that provide additional wastewater treatment. The constructed treatment wetlands are a unique feature of the CRWWTP. Constructed treatment wetlands use natural



The Columbia Regional Wastewater Treatment Plant is a critical asset to effectively manage and treat wastewater from the City and surrounding area

physical, biological, and chemical processes to remove a wide array of wastewater pollutants, including organics, nutrients, ammonia, metals, and bacteria. Treated effluent from the CRWWTP is discharged into Eagle Bluffs to provide a valuable water source for wildlife habitat.

Since the CRWWTP was initially constructed in 1983, more than 100 small WWTPs have been eliminated in Columbia. The CRWWTP continues to be an important regional asset that is effectively used to manage and treat wastewater generated from this growing community.

Currently, there are 38 domestic and 8 industrial wastewater treatment plants in or near Columbia. Of the 38 domestic National Pollutant Discharge Elimination System (NPDES) permits, 11 are decommissioning and joining either the CRWWTP or Boone County Regional Sewer District (BCRSD) systems.

In 2013, the City completed a \$64 million upgrade and expansion of the CRWWTP. The upgrade was necessary to meet more stringent ammonia limits established by MDNR in the City's discharge permit. The upgrade also increased the capacity of the CRWWTP from a design average flow (DAF) of 20.6 million gallons per day (MGD) to 25.2 MGD. The project included the addition of two new mechanical plant treatment trains and improvements to the headworks, wet wells, grit removal system, solids handling, and various upgrades intended to improve treatment efficiency, effectiveness, and health and safety protections.

With the CRWWTP upgrade, effluent quality has dramatically improved. Specifically, discharged ammonia, biochemical oxygen demand, and bacteria concentrations have decreased and are maintained at levels necessary to support aquatic life and secondary contact recreational uses in Eagle Bluffs. The CRWWTP has also consistently complied with discharge permit limits implemented by MDNR.

The CRWWTP is currently producing a high quality effluent, but the City understands that it is appropriate to plan for future treatment system needs that will improve existing operations; address anticipated regulatory drivers related to the wet-weather program, disinfection, nutrient removal, and more stringent ammonia limits; and continue to provide for efficient and effective regional treatment services. Planning level alternatives to address these needs are included in **Section 5** of this report.

3.4 Stormwater System Review

Effective management and efficient implementation of the stormwater program is necessary for meeting important environmental and public safety goals such as improving water quality, minimizing flooding impacts, and reducing property damage. To develop a better understanding of the City's existing stormwater assets, the Project Team compiled relevant data and worked with the City to inventory the existing system, review its performance, and evaluate system capacity. More specifically, the Project Team characterized the number, size, and probable condition of existing stormwater conduits and structures; evaluated historical drainage and flooding issues; and reviewed conveyance system capacity design standards. From a water quality and regulatory perspective, the Project Team assessed the City's ability to maintain compliance with the requirements of their municipal separate storm sewer system (MS4) permit. This MDNR-issued permit outlines provisions for how the City must develop, implement, and enforce their stormwater management program and plan to reduce pollutant discharges to the maximum extent practicable.



Stormwater system failures contribute to public health, safety, and water quality concerns across Columbia

Most critically, the evaluation highlighted the fact that the current level of asset management investment is not sufficient to address existing and future needs. Currently, approximately 15% of pipes in the system are likely beyond their physical effective life. This number is expected to grow to nearly 60% over the next 20 years at the current renewal rate. The assessment findings also indicated that only 1% of the pipes and 7% of the structures have been inspected and assigned a condition rating. The City currently spends a portion of the annual storm water budget addressing failing pipes and inlets. Continued underfunding and deferment of system replacement, renewal, and assessment activities will further reduce system function and reliability.

These asset renewal issues contribute to public health, safety, and water quality concerns. Yard, street, and house flooding is an important health and safety concern for the City because these issues can affect the integrity of other infrastructure such as roads and sewer lines. Collapsing storm pipes and roadway failures can also impact water quality in area streams and lakes, which is a significant concern for the Storm Water Utility because there are seven water quality impairments in the City that are identified as being caused by urban and other nonpoint source runoff.

To address water quality issues, the City has developed a joint stormwater management plan (SWMP) under their MS4 permit in coordination with Boone County and the University of Missouri. The SWMP reflects federal (40 CFR 122.34) and state (10 CSR 20-6.200(5)(A)1-6)) regulations which requires the City to implement six minimum control measures (MCMs) to protect water quality and effectively reduce stormwater runoff to the maximum extent practicable. The six minimum controls are: public outreach and education, public involvement and participation, illicit discharge detection and elimination, construction stormwater runoff control, post-construction stormwater management in new development and redevelopment, and pollution prevention and good housekeeping for municipal operations.

The City and their co-permittees are currently fulfilling the requirements of the MS4 permit. However, the evaluation highlighted several opportunities for improvement in the current program. Most notably, developing a more strategic and proactive illicit discharge detection and elimination inspection program and refining erosion and sediment control inspection operations would allow the City to more effectively resolve issues that cause immediate water quality concerns.

The stormwater system review also identified a number of gaps and limitations related to management of the existing system data and database. The City is aware of these issues and has been working to advance their data collection, tracking, and maintenance procedures but continued and better-funded efforts will help improve future stormwater system planning, maintenance, and performance.

Planning level alternatives to address identified stormwater needs are included in **Section 5** of this report.

Section 4. Community Outreach

Effective outreach is a vital component of the planning process since the community's input directly informs development of the IMP. During the outreach process, the Project Team educated participants by highlighting important infrastructure, environmental, and public health needs; consulted participants to gain an understanding of community needs; and involved



The Columbia IMP was developed with robust community input using multiple methods of engagement

participants by working with them directly throughout the process to identify criteria by which to measure the benefit of potential solutions. Through early and continuous outreach, the City brought diverse perspectives and values into the decision-making process and strived to ensure that concerns and needs were thoroughly considered. This outreach process will result in an IMP that incorporates community goals and values.

Element 3 of EPA's Framework suggests that municipalities pursue the following principles when conducting integrated planning outreach activities:

- Provide appropriate opportunities that allow for meaningful input during the identification, evaluation, and alternative selection phases of the planning effort,
- Make new information available and provide opportunities for input into the development of proposed modifications of the plan, and
- Allow public involvement to assist in evaluating the opportunities and effectiveness of potential green infrastructure alternatives, if they are relevant to the plan.

The Project Team worked with City staff to implement an engagement strategy (**Attachment I, Attachment J**) that described the planning process, provided for continuing input by stakeholders, and ensured that stakeholder concerns received fair consideration. The approach was intended to bring a diverse group of stakeholders together, educate them regarding various options, and gather input in a structured, inclusive, and transparent process. In the context of EPA's Framework, community outreach should be an ongoing process that is used to inform and refine IMP goals and outcomes over time. Therefore, the City expects that IMP implementation will be reviewed through outreach activities such as an open comment period and public hearings and Columbia City Council meetings.

4.1 Stakeholder Involvement

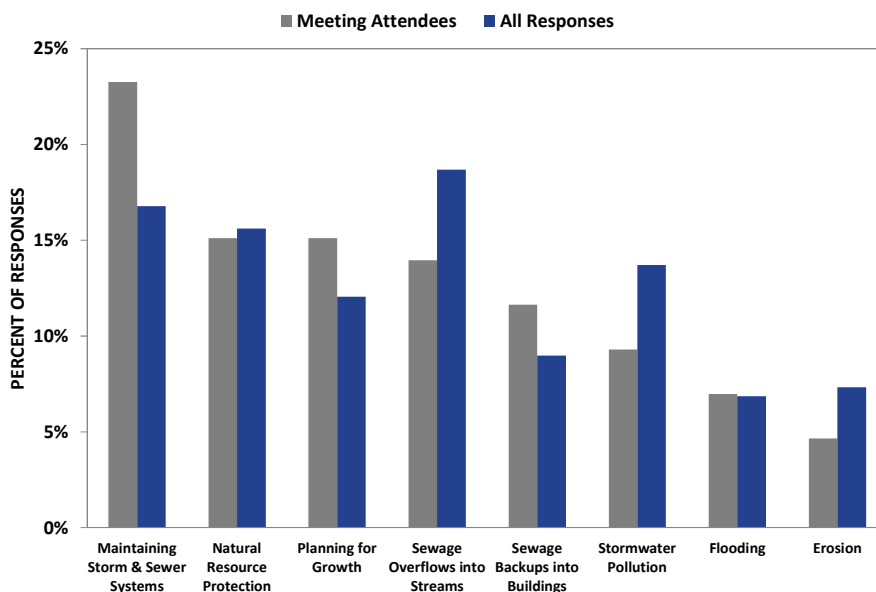
In addition to the general public, the Project Team identified key stakeholders from a balance of interests across the community. These stakeholders included representatives from the Columbia City Council, government agencies, representatives of economically and socially disadvantaged populations, environmental and conservation groups, the business and development community, nonprofit and civic organizations, large impervious surface property owners, and residents who have experienced chronic building backups. The team reached out to specific organizations within these groups in an attempt to get a wide variety of participation in the planning process. Overall, more than 160 members of the community participated or provided input into the planning process.



IMP Workshops provided an opportunity to inform the public about wastewater and stormwater infrastructure issues and capture community priorities

4.2 IMP Outreach Activities

Outreach efforts with the general public focused on preparing and providing relevant information to educate the community at large and getting high-level, value-based input from interested stakeholders. The activities included distributing project fact sheets to introduce the IMP, share the desired outcomes, and provide opportunities for the public to get involved; maintaining a project website; and issuing press releases and social media posts to notify the public of opportunities to provide input. The project website has since been incorporated into the City’s website: <https://www.como.gov/utilities/sewer/imp/>.



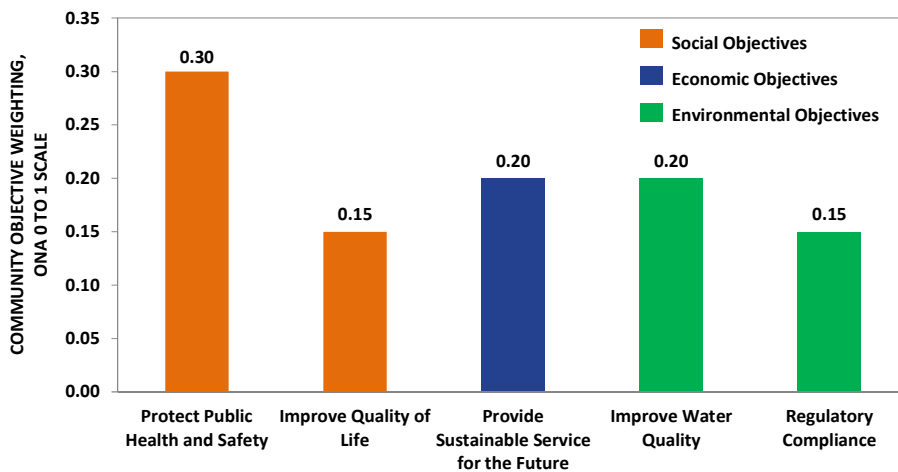
Workshop and survey participants provided important input on infrastructure, public health, and water quality priorities that should be addressed in the IMP

In addition to these broad outreach efforts, the Project Team developed an online survey and conducted a series of four workshops; 162 people participated in the survey and 77 individuals attended at least one community workshop. The goal of these efforts was to obtain specific input on the infrastructure, water quality, and public health needs that should be addressed by the IMP (Workshops #1 and #2); review potential solutions (Workshop #2); discuss the resources needed to implement the solutions affordably (Workshop #3); and outline the process and decision criteria used to evaluate project costs and benefits (Workshop #4).

The City and Project Team also met with Council members throughout development of the IMP so that they were informed about the planning process. Each Council member was invited to meet, both individually and in pairs, and discuss the planning process; these meetings were held early during the Visioning phase of the project to ensure that each person’s priorities were captured in the plan and then later to discuss the engineering alternatives, costs, and potential ratepayer impacts associated with addressing those priorities. A preliminary draft of this IMP was presented to the Council during a work session on August 7, 2017. Prior to finalizing the IMP, the City also offered a 30-day public comment period to solicit additional input and allow the public to review recommendations included in the plan.

4.3 Applying Outreach Results to the IMP

Feedback received over the course of the IMP outreach indicated that maintaining storm and sewer systems was the highest programmatic and infrastructure-related priority for Columbia stakeholders. However, other issues such as natural resource protection, planning for growth, reducing building backups and sewage overflows into streams, and flooding were also important issues to participants. Although all waterbodies in and around Columbia are important to



Columbia residents, Hinkson Creek and its tributaries, Eagle Bluffs, and regional high quality streams such as Bonne Femme and Little Bonne Femme Creeks are generally valued highest.

IMP community outreach provided social, environmental, and economic – the triple bottom line – priorities and weightings for informed decision making

Based on this information and other feedback received from the survey, workshops, and City

Council coordination described above, the Project Team used a triple bottom line approach to develop a series of weighted objectives that captured the community’s social, economic, and environmental goals for the IMP. These five objectives were used as the primary decision criteria for evaluating potential IMP wastewater and stormwater alternatives to ensure that all potential community needs and priorities were considered in the planning process.

Section 5. Alternatives Analysis

Element 4 of EPA’s Framework includes identification, evaluation, and selection of alternatives and implementation schedules for system and water quality improvements. For Columbia, these solutions were developed based on the outcomes of the Visioning Workshop, existing system performance assessment, and community outreach program. This element is by far the most complex step in the planning process, as the goal is to identify alternatives that could meet all of those needs effectively and affordably. The Project Team’s approach for identifying and optimizing alternatives, as well as the proposed implementation schedule for those alternatives, is summarized below.

5.1 Identifying Alternatives

The goal of the alternatives identification process was to develop planning level project descriptions and cost estimates to characterize the additional level of investment required to address system needs, anticipated regulatory drivers, and City goals over the next 20 years (the IMP planning period). This step included outlining alternatives for the wastewater collection (**Attachment K**), wastewater treatment (**Attachment L**), and stormwater management programs (**Attachment M**). To facilitate this evaluation, wastewater and stormwater alternatives were grouped and analyzed by project category.

Wastewater and stormwater program alternatives were assessed by project category to characterize long-term IMP investment needs

Wastewater Treatment	Wastewater Collection	Stormwater Management
<ul style="list-style-type: none"> • Wet Weather Improvements • Expanded Nitrification • Biological Nutrient Removal • Chemical Disinfection • Constructed Wetlands Maintenance • Digester Rehabilitation • Digester Capacity Improvements 	<ul style="list-style-type: none"> • Wet Weather Program Planning • Asset Management • System Renewal • System Capacity • Reducing Building Backups • Private Common Collector Elimination • System Expansion • Cleaning Program • Pump Station Repair • Annual Sewer Improvements 	<ul style="list-style-type: none"> • Stormwater Planning • System Assessment and Cleaning • System Renewal • Flood Control • Stream Erosion • Runoff Treatment to Improve Water Quality • Stormwater Management Program

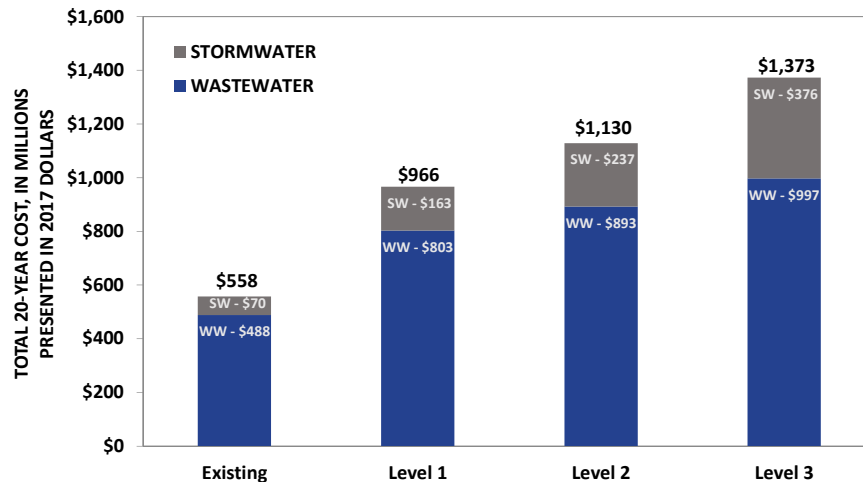
Cost estimates were developed for each project category to quantify the investments and resources needed *in addition to* those already expended by the Sewer and Storm Water Utilities. The planning level cost estimates included potential additional capital costs, operation and maintenance costs, and costs associated with necessary planning or data collection activities needed over the 20-year IMP planning period.

The three potential funding scenarios used to guide the cost analyses for each project category were broadly defined as follows:

- **Level 1 Funding (Level 1)** – Funding needed to **provide the minimum** level of service that meets both community-wide expectations and **existing** regulatory requirements over the 20-year IMP planning period.
- **Level 2 Funding (Level 2)** – Funding needed to **exceed the minimum** level of service that meets community-wide expectations and **more proactively** meets existing regulatory requirements over the 20-year IMP planning period.
- **Level 3 Funding (Level 3)** – Funding needed to **address all** forecasted infrastructure needs, and proactively meet **both** existing and forecasted regulatory requirements over the 20-year IMP planning period.

The project categories and funding assumptions were refined during a series of workshops between the Project Team and the City’s Sewer and Storm Water Utilities. Specific methodologies and assumptions used to develop funding level estimates for each of the project categories, as well as detailed cost forecasts, are described in more detail in the corresponding technical memoranda attached to this report (**Attachments K, L, and M**). Given the uncertainties and data gaps identified during the existing system evaluation described in **Section 3**, the alternatives and costs identified for the IMP were only intended to serve as planning level estimates. These alternatives and associated costs should be refined as additional information is developed during future phases of the IMP.

The alternatives analysis identified three potential funding levels to address system needs, regulatory drivers, and customer expectations

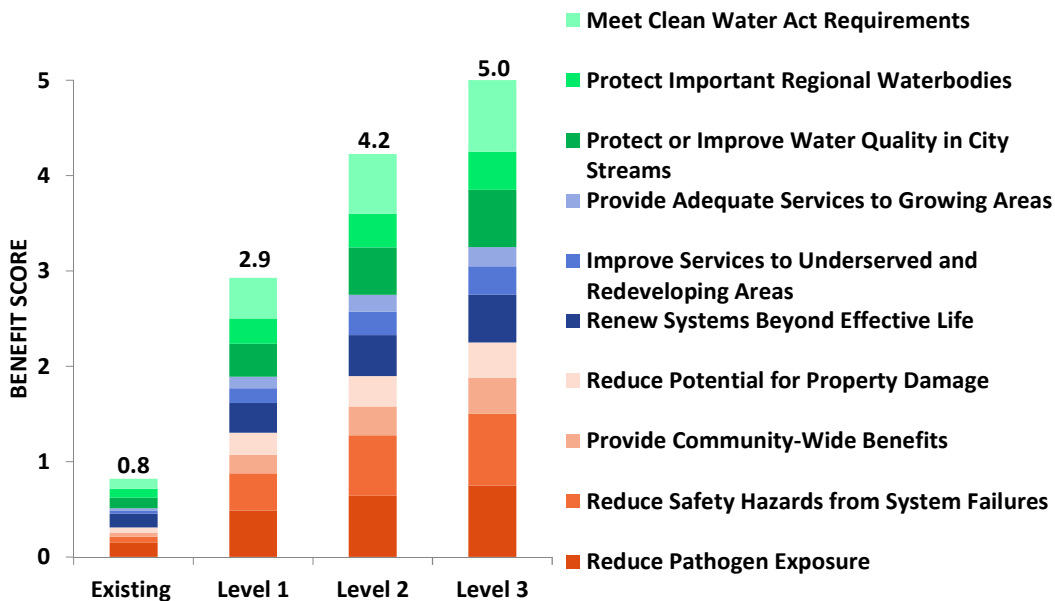


The City’s existing (as of 2017) annual Sewer and Storm Water Utility budgets were approximately \$24.4 million and \$2.4 million, respectively, with stormwater set to increase through 2020. If the City were to maintain the existing programs and associated levels of funding over the 20-year IMP planning period, the City’s total investment (in 2017 dollars) for wastewater and stormwater would be approximately \$488 million and \$70 million, respectively. The funding scenarios evaluated as part of the alternatives identification process indicate that significant additional investments would be needed to address system needs, regulatory drivers, and customer expectations over that same timeframe. According to the analysis, total costs to

meet wastewater and stormwater needs over the next 20 years are potentially between \$966 million and \$1.37 billion.

5.2 Optimizing Programs to Maximize Community Benefits

To determine which funding level alternative appropriately balanced costs with community objectives over the 20-year IMP planning period, the Project Team applied a multiple criteria decision analysis (MCDA) tool to calculate a total benefit score that represented the anticipated value that each alternative would produce for the community. Community priorities established through the outreach program were the primary decision criteria used and formed the basis for the MCDA scoring process. Using the MCDA tool (**Attachment N**), the Project Team rated each of the funding level alternatives relative to those community priorities with a standardized rating system and final scores were normalized using a 0 to 5 scale. The MCDA results indicate that each potential IMP funding level produces varying degrees of community benefits.

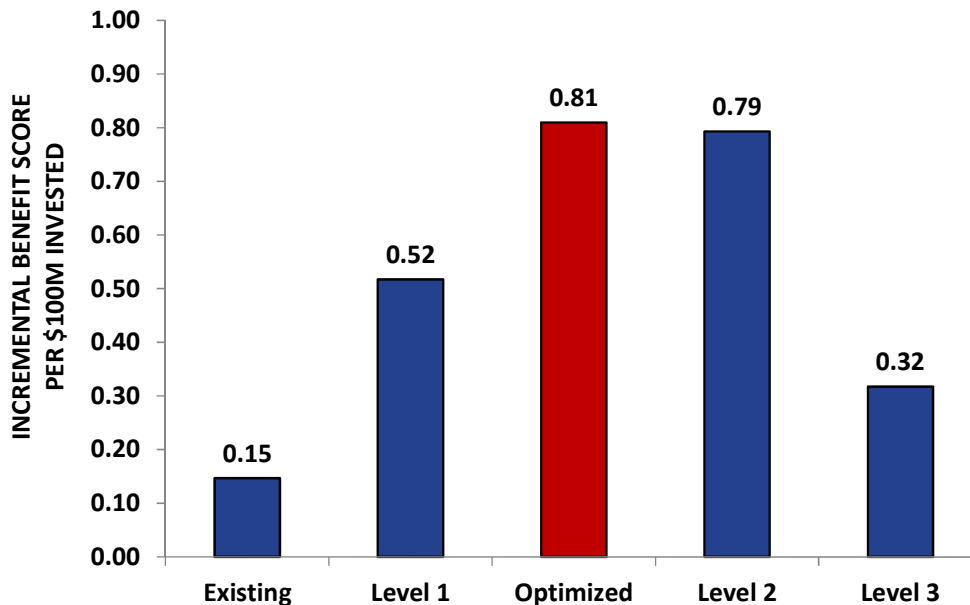


Columbia’s IMP funding level alternatives deliver varying degrees of community benefits

Cost-effectiveness is a critical consideration in selecting a balanced and prioritized suite of wastewater and stormwater management alternatives. According to the benefits analysis, the greatest increase in benefit occurs when moving from the Existing funding to Level 1 funding (2.1 point increase). However, this increase in benefit must be evaluated with respect to the increased cost to implement the alternatives. When assessed in this way, results showed that Level 2 funding is the most cost-effective alternative because it produces the greatest benefit (0.79 points) for every \$100 million dollars of total cost.

The Project Team recognized that although Level 2 funding had the highest benefit to cost ratio, an Optimized suite of alternatives could be developed by combining the project categories that

provided the best value from among the four funding levels. On a per dollar basis, this Optimized suite of alternatives produced marginally greater benefit than the Level 2 funding alternative (0.81 points vs. 0.79 points) while costing \$114 million dollars less over the 20-year planning period. Due to the reduced cost of this best value suite of alternatives, the Optimized suite of alternatives is the preferred program portfolio for the IMP.



The Optimized suite of IMP alternatives produces the greatest overall benefit to the community

5.3 Residential Affordability and Socioeconomic Evaluation

The MCDA evaluation was limited to quantifying the costs and benefits of potential alternatives and did not assess the impact of the increased cost of Utility services on the City’s customers. Before committing to the implementation of the Optimized suite of alternatives, the City evaluated its impact relative to community socioeconomic conditions and average residential monthly bills to confirm that forecasted financial impacts would be affordable to residential customers (**Attachment O**).

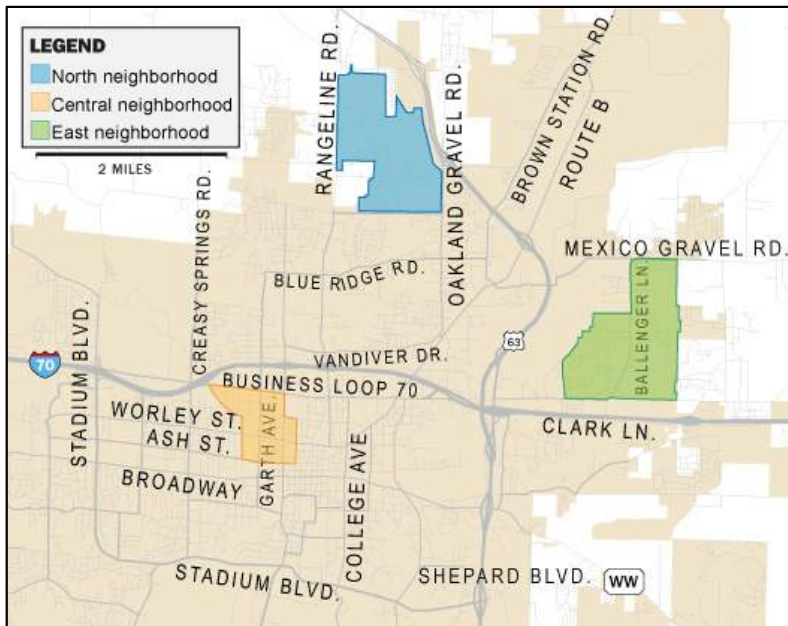
Both EPA and MDNR allow communities the flexibility to consider financial and economic impacts and affordability when developing implementation schedules for integrated planning or permitting purposes. Historically, the affordability analysis tools that regulators have relied upon are narrowly-focused and did not provide communities sufficient flexibility to fully consider local socioeconomic considerations that may impact the financial capability of the municipality and customers. Recent guidance issued by both EPA⁷ and MDNR⁸ however, has clarified expectations for municipalities conducting affordability analyses in the context of an integrated

⁷ Kopocis, K., and C. Giles. 2014. Financial Capability Assessment Framework for Municipal Clean Water Act Requirements. Office of Enforcement and Compliance Assurance. Washington, D.C.

⁸ Hirschvogel, L. 2016. Missouri Integrated Planning Framework. Water Protection Program. Jefferson City, Missouri.

plan. These guidance documents recognize that community-specific information may be necessary to develop a “more accurate and complete picture” of financial capability.

Additional flexibility is important for assessing affordability conditions in the City, as one of the City’s goals in the most recent 2016-2019 Strategic Plan⁹ is to improve social equity across the entire community. To this end, the City has identified three neighborhoods in north, central, and east Columbia on which to initially focus their resources to improve equity issues. The IMP affordability evaluation was structured to complement the City’s Strategic Plan by characterizing



Source: Ystebøe, Taylor. “City begins effort to address social, economic equity issues in three neighborhoods.” Columbia Missourian (Columbia, MO). April 13, 2016.

Evaluating impacts on Columbia’s strategic planning focus neighborhoods is important to the consideration of overall economic and social equity of IMP investments

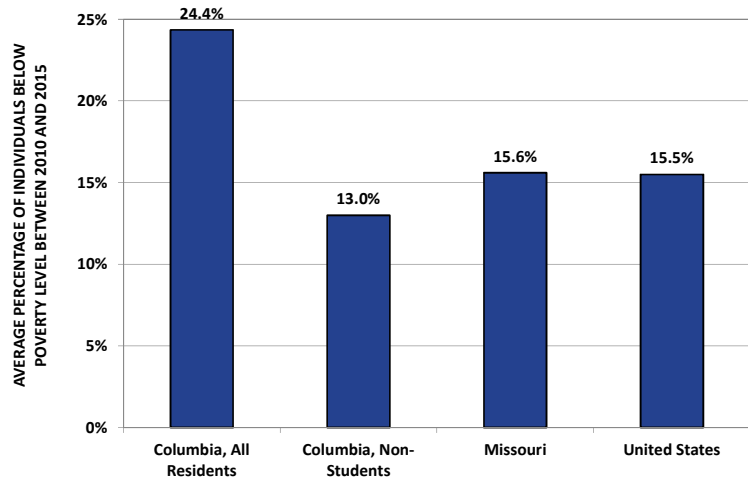
that future Sewer Utility rate increases will impact both City and BCRSD ratepayers. However, a focused analysis of potential impacts to BCRSD customers was not conducted because sufficiently detailed socioeconomic data specific to those users were not readily available.

socioeconomic conditions and potential financial impacts both broadly across the City and within sensitive neighborhoods (as measured by Census tracts).

An additional complication with assessing affordability in Columbia is that residential customers reside within both the City limits and portions of the Boone County Regional Sewer District (BCRSD) service area outside of the City boundary. The City and BCRSD operate under multiple agreements whereby the City accepts wastewater flows from some BCRSD facilities in order to provide regional treatment services. The City understands

⁹ City of Columbia, Missouri. 2015. Strategic Plan 2016-2019. <https://www.como.gov/wp-content/uploads/2016-2019-Strategic-Plan.pdf>

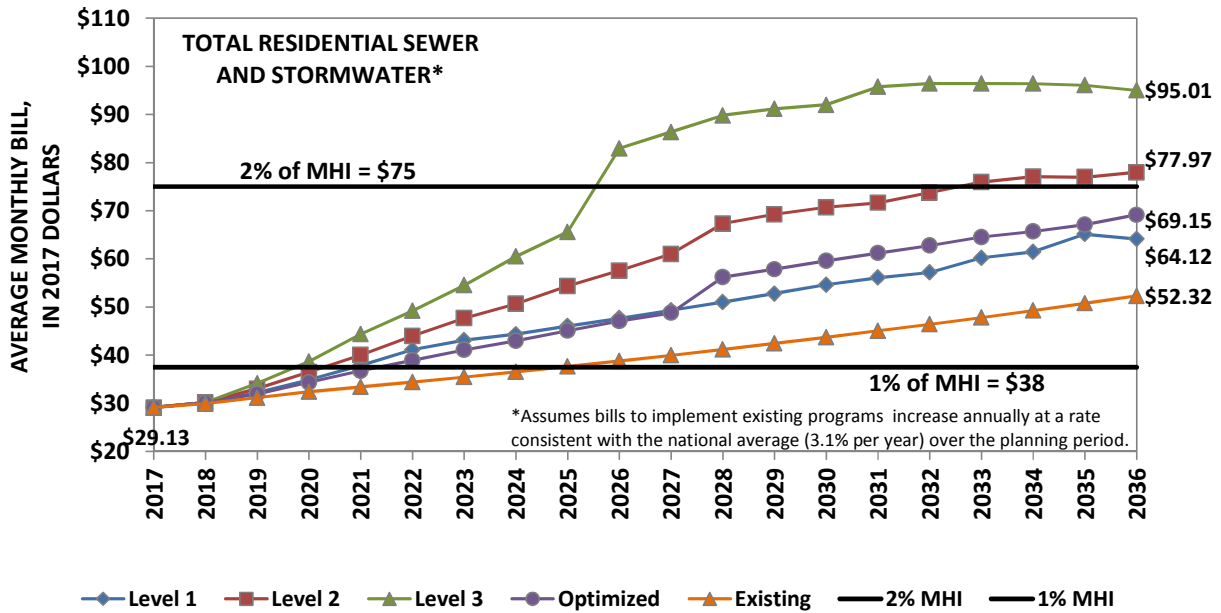
In the analysis of City-wide socioeconomic conditions, the Project Team found that resident college students influence results of important socioeconomic metrics that are traditionally used to characterize communities. For example, approximately 24% of individuals in Columbia are below the poverty level. However, that estimate is influenced by the resident college student population because traditional poverty level measures exclude individuals who live in dormitories but include students living in off-campus housing within the City limits. These students generally report low incomes and contribute to higher poverty rate estimates. After removing students from the population, the individual poverty level in Columbia falls to approximately 13%, which is comparable to levels in Missouri and the United States. In Columbia, resident students also impact estimates of population (driving it higher) and median household income (driving it lower). While the student population is an important segment of the City's customer base, evaluation of socioeconomic metrics of the City's permanent population is a key consideration for the IMP.



While Columbia's overall population indicates significant poverty, the City's permanent population is comparable to the State and National averages

When metrics are assessed for the City's permanent population, overall socioeconomic conditions in the City are generally strong. However, there are disadvantaged segments of the community which warrant additional consideration. To identify those disadvantaged areas, the Project Team evaluated economic stress indicators related to median household income (MHI), median family income (MFI), poverty rates, occupancy rates, homeowner housing costs, renter housing costs, supplemental nutrition assistance program participation rates, and health insurance coverage rates across the 25 census tracts in the City. The analysis indicated that four tracts, primarily located in central Columbia, exceeded stress thresholds for at least 80% of the metrics reviewed and exhibited a strong potential for economic stress.

The qualitative review of socioeconomic stress was coupled with a quantitative assessment of future billing impacts across census tracts to characterize potential affordability issues associated with implementing the Optimized level of funding. Future bills were calculated by the City using existing stormwater and wastewater rate models to forecast future residential user rates and bills based on projected 20-year cash flows for the IMP alternatives. Rate structures were maintained at current base and volume charge ratios for rate and bill forecasting.



The Optimized IMP funding level supports moderate bill increases and maintains community-wide affordability

Under the Optimized funding level, the average community-wide combined stormwater and sewer bill would increase from approximately \$29 dollars per month in 2017 to \$69 dollars per month in 2036 (in 2017 dollars). Although it is an imperfect indicator, EPA generally considers 1% to 2% of MHI as the limit of affordability for municipal sewer and stormwater ratepayers. Under the Optimized funding scenario, community-wide average bills remain below 2% of MHI during the 20-year planning period. Some residents in the central neighborhood of Columbia may face some affordability impacts, but average bills in that area will increase gradually and will not approach the potentially unaffordable level of 2% MHI until 2028. Therefore, the affordability and socioeconomic evaluation suggests that the Optimized funding level will be affordable over the first 10 years of IMP implementation.

The Optimized funding level is preferred because it provides the most overall value to the community, maintains community-wide monthly bills within EPA’s traditional 1-2% MHI threshold bounds for affordability, and supports moderate bill increases throughout the planning period. Because the forecasted billing impacts were based on planning level cost estimates, they will likely change as the City gathers additional information and innovates to find cost-effective solutions during IMP implementation. Additionally, changes in regulatory requirements, program needs, or socioeconomic conditions across the City may also influence future affordability projections. Therefore, the City understands that it will be important to refine projected sewer and stormwater program needs, costs, and bill impact evaluations every 5 to 10 years.

5.4 Optimized IMP Suite of Alternatives

The Optimized suite of alternatives is the preferred program portfolio for the IMP because it provides the greatest value to the community and can be implemented affordably. The Optimized portfolio includes a combination of Level 1 funding for most wastewater treatment and collection system project categories and Level 2 funding for stormwater projects. The higher level of stormwater projects is consistent with the results of the existing system performance evaluation (**Section 3**) which highlighted the significance of the City’s stormwater system needs relative to the funding currently available.

System	Wastewater Treatment						Wastewater Collection								Stormwater Management										
Project Category	Wet Weather Imp.	Expanded Nitrification	Biological Nutrient Removal	Chemical Disinfection	Constructed Wetlands Impr.	Digester Rehabilitation	Digester Capacity Imp.	Wet Weather Program	Asset Management	System Renewal	System Capacity	Building Backups	Private Common Collectors	System Expansion	Cleaning Program	Pump Station Repair	Annual Improvements	SW Planning	System Assessment	System Renewal	Flood Control	Stream Erosion	Runoff Treatment	M54 Program	
Level 1		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓					✓		✓
Level 2	✓					✓					✓								✓	✓	✓		✓		
Level 3																									

The Optimized suite of alternatives includes the combination of Level 1 and Level 2 funding projects that provide the best value for the community and ratepayers

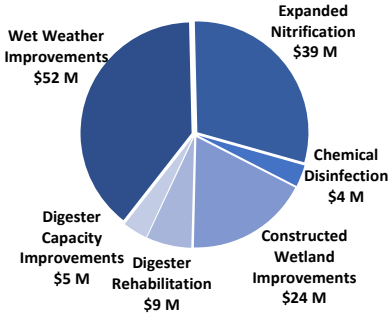
For the wastewater treatment system, the City’s largest planned capital expenditure over the 20-year IMP planning period is targeted for addressing wet weather capacity issues at the CRWWTP. Inflow and infiltration into the City’s sewer system has caused sewer backups and overflows for decades. Since 2012, significant collection system rehabilitation and I/I reduction projects have been completed and staff have implemented operational changes at the CRWWTP that have significantly reduced sewer overflows along the major trunk sewers, mostly near the treatment plant. Despite these recent improvements, the CRWWTP can further improve management of peak wet weather flows in a manner that effectively limits the number of SSOs within the collection system during very large events. Improvements identified in the Optimized suite of alternatives are intended to reduce SSOs and allow the City to effectively manage peak flows.

Although wet weather improvements are the largest wastewater treatment capital expenditure identified, these improvements will not be implemented until at least 2027 to allow the City to continue ongoing I/I reduction efforts and develop a better understanding of wet weather peak flows and volumes through flow monitoring and modeling. In the near term, necessary projects related to digester rehabilitation and constructed wetlands maintenance are anticipated.

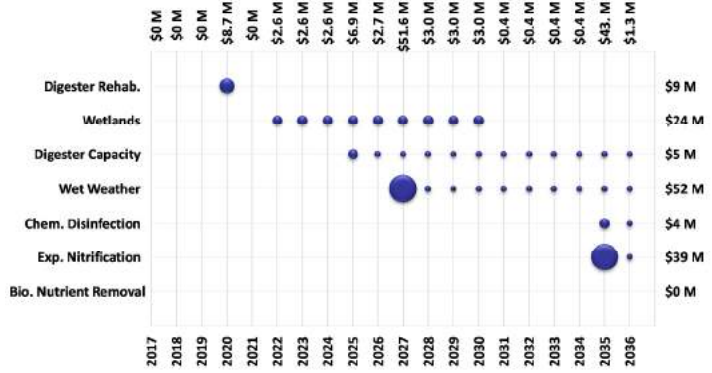
Columbia's Optimized Suite of IMP Alternatives

Refer to Attachments 5, 6, and 7 for Project Descriptions and Detailed Cost Estimates

Wastewater Treatment

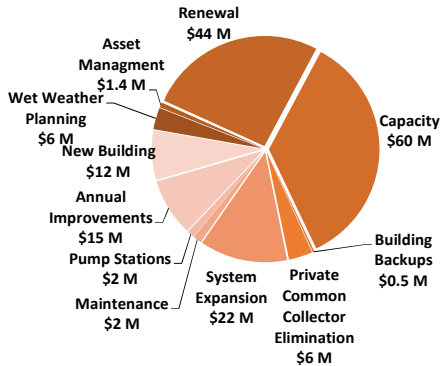


20-Year Total Cost

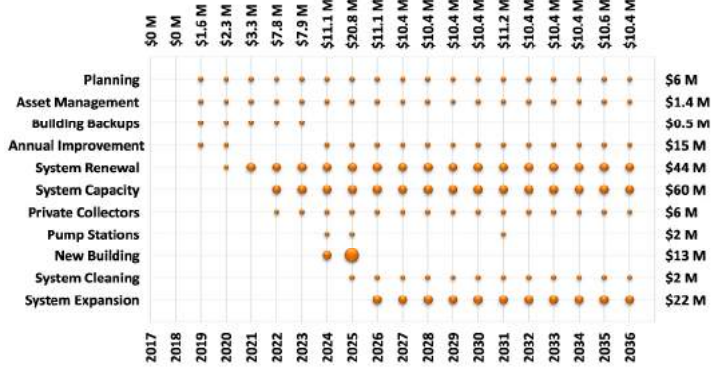


Relative Spending over Time

Wastewater Collection

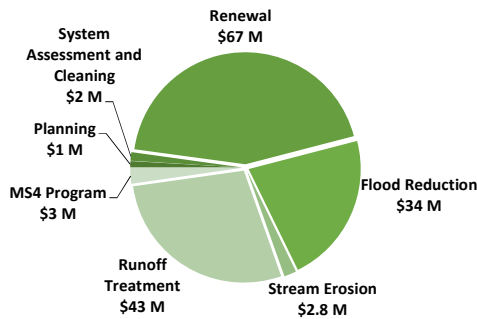


20-Year Total Cost

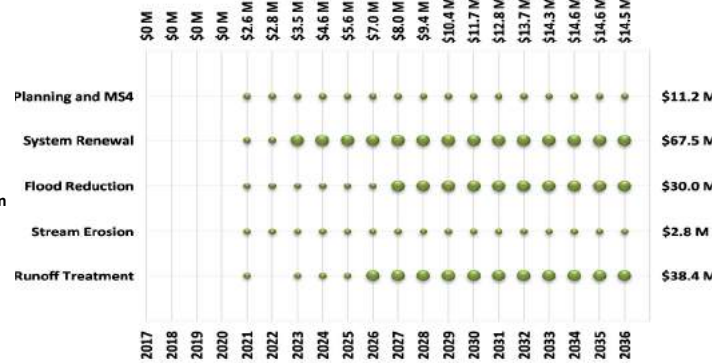


Relative Spending over Time

Stormwater Management



20-Year Total Cost

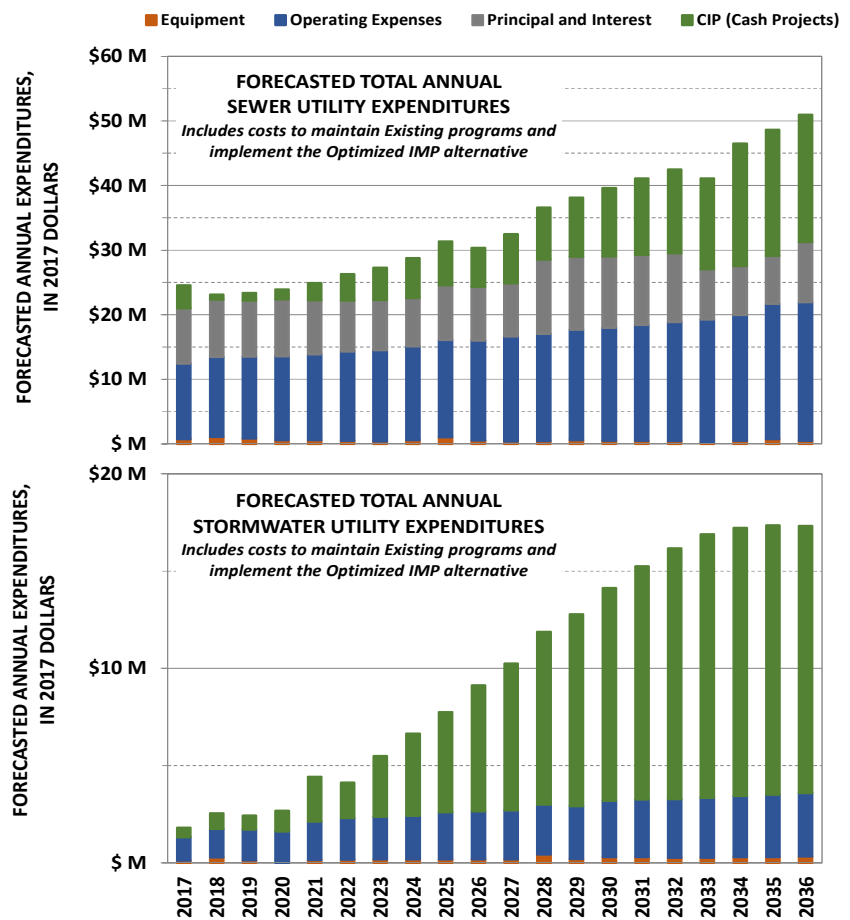


Relative Spending over Time

The optimized IMP funding level includes a suite of projects and program enhancements that balance and prioritize infrastructure needs and community expectations with Clean Water Act goals

In addition to addressing peak flow capacity issues at the CRWWTP, one of the primary goals identified during the two-day IMP visioning workshop described in **Section 2** was to reduce wet weather backups and overflows caused by capacity constraints in the collection system. During early stages of IMP implementation, the Optimized alternative includes funding to improve wet weather planning and implement a backflow prevention program to reduce building backups at individual residences and businesses. The largest anticipated collection system expenditures over the 20-year IMP implementation period are for system renewal and capacity improvements. Anticipated annual costs for these improvements are relatively consistent throughout the period and are intended to address aging infrastructure, reduce public and private I/I, and improve system capacity in critical areas. All of these planning activities, programs, and improvements will address system capacity issues and reduce building backups and SSOs over time.

For stormwater, the 2015 voter-approved rate increase is scheduled to continue through 2020. As a result, the IMP assumes that additional expenditures will not be committed until the City can address potential rate increases in 2021. After 2021, the largest planned expenditures address system renewal needs, flooding issues, and water quality improvements through runoff treatment. Raising the revenue to meet these current and future needs is contingent upon voter approval of stormwater rate increases. In the interim, the City plans to add staff that will help to enhance the stormwater management program and ultimately improve surface water quality across the City. Similar to the sewer system, additional planning resources are needed to improve the longevity and effectiveness of the stormwater system. It has been almost 20 years since comprehensive stormwater management, planning, and modeling tools have been evaluated. Over this period, Columbia has grown and the existing system has



Under the Optimized IMP alternative, forecasted annual expenditures will increase gradually over time

continued to age. Therefore, the Optimized alternative anticipates that resources will be needed during early phases of IMP implementation to conduct stormwater planning that is necessary to maintain the expected level of service.

Annual expenditures to fund the Optimized alternative depend largely on the timing of major capital projects, but must be balanced with respect to financial considerations such as maintaining sufficient debt capacity and cash reserves to ensure the City's programs are planned and administered in a financially responsible manner. Given the anticipated timing and magnitude of projects outlined in the Optimized funding level, the City determined that the annual Sewer Utility budget is projected to increase by approximately \$25 million over the 20-year IMP planning period. These projections include the costs for equipment purchases, operations, cash-funded capital projects, and principal and interest payments corresponding to existing and anticipated bond-funded capital projects. For the Storm Water Utility, the annual budget is projected to increase by approximately \$15 million over the planning period. As described previously, these Sewer and Storm Water Utility budget increases correspond to a 30% total increase in combined sewer and stormwater bills for the average user in Columbia over the 20-year period.

5.5 5-Year Action Plan to Implement the Optimized Alternative

Element 4 of EPA's Framework specifies that municipalities identify an implementation schedule for their integrated planning projects. The Optimized IMP alternative reflects the City's understanding of infrastructure and regulatory needs and priorities over the next 20-years with respect to the information currently available. As discussed in **Sections 3** and **5.1**, a number of data gaps and uncertainties exist that precluded the development or analysis of specific projects, costs, or implementation dates for many of the program elements evaluated for the IMP. In addition, judicial interpretation of the Missouri Constitution stipulates that municipal stormwater rates must be approved by a majority vote. Bond financing of wastewater capital projects must also be approved through a local election. Therefore, the forecasted timing and cost of wastewater and stormwater program improvements included in the Optimized alternative are planning level estimates that must be more accurately characterized, and in some cases affirmed, by residents before the City can commit to implementation.

To refine the estimates and implement early actions, the City will pursue a 5-Year IMP Action Plan focused on collecting critical data needed to more precisely forecast future needs while continuing to implement currently-identified Capital Improvement Program¹⁰ projects and necessary operation and maintenance activities. The City will pursue these actions to the extent possible but acknowledge that weather, funding, staff availability, and other resource constraints or unanticipated needs may impede complete implementation of the plan. After five years, the City will use the new information to revise IMP projections with respect to evolving regulatory requirements, program needs, and socioeconomic conditions across the City. This implementation approach satisfies Element 6 of EPA's Framework, which requires that municipalities include a process for reevaluating projects and schedules based on changing circumstances to improve overall effectiveness of the plan.

¹⁰ <https://www.como.gov/finance/wp-content/uploads/sites/21/2017/10/FY-2018-CIP.pdf>

The City's 5-Year IMP Action Plan addresses a range of wastewater and stormwater program needs that were identified during the IMP planning process. Several high priority, early actions will be implemented in the near term to directly and expeditiously reduce significant public health risks, improve water quality, or enhance customer service. These early actions include the following:

- **Wet Weather Improvements (Wastewater Treatment) and Planning (Wastewater Collection)** – As discussed in the previous section, wet weather capacity limitations at the CRWWTP and I/I issues within the collection system currently contribute to sewer backups and overflows in the City. In recent years, City staff have reduced sewer overflows along major trunk sewers through a combination of collection system rehabilitation and I/I reduction projects and operational changes at the CRWWTP. However, additional improvements are needed to more effectively manage peak wet weather flows and the City's existing hydraulic model is not sufficiently accurate to develop long-term capacity improvement alternatives with a high degree of confidence.

Over the next five years, the City will conduct flow monitoring and develop a comprehensive hydraulic model to yield a better understanding of the collection system. This model will allow the City to better evaluate the benefits and costs of necessary system improvements. In the interim, the City plans to repurpose an existing sludge storage lagoon to provide excess flow storage at the CRWWTP. When combined with the existing peak flow lagoon, this interim improvement will increase wet weather storage capacity to more than 13 million gallons.

- **Digester Rehabilitation (Wastewater Treatment)** – Digester rehabilitation must be completed during the first five years to address aging infrastructure and ensure sound operation of the existing CRWWTP. The City is targeting completion of the planned rehabilitation project by 2021.
- **System Renewal (Wastewater Collection)** – The City owns and operates over 715 miles of gravity sewer lines and forcemains. As this existing infrastructure ages and deteriorates, the probability for the occurrence and frequency of overflows and backups in the system increases. Proactive condition assessment and renewal efforts will allow the City to address aging infrastructure through cost-effective, trenchless rehabilitation techniques that minimize disruption to the public. These renewal activities also address a portion of the infiltration entering the system from public sources, which may reduce backups and SSOs. In addition, these improvements mitigate potential exfiltration from the sewer system through broken pipes that could adversely affect water quality. The City currently renews approximately 0.8% of the existing system annually. Current funding (\$2.7 million per year) for renewal work is provided through a 2013 bond issue that extends through 2019. A key area of focus in the City's 5-Year IMP Action Plan is to secure a dedicated, consistent long-term source of funding after 2019 so that the City can continue these renewal efforts uninterrupted.

- **Private Common Collector Elimination (PCCE) (Wastewater Collection)** – Private common collectors (PCC) are privately-owned collection systems that serve multiple homes or businesses. PCCs typically consist of small diameter pipes that have generally not been maintained by the property owners since installation. As these are privately owned collection systems, the City does not have access to maintain or repair these lines. These aging PCCs are prone to blockage or failure resulting in significant public health and water quality risk. Failing PCCs may cause building backups, exfiltrate sewage that exposes the public to pathogens, and exacerbate I/I issues that ultimately contribute to overflows to local water bodies. The City has been working to eliminate PCCs, but funding for these efforts is currently provided through a 2013 bond issue that extends through 2019. A key area of focus in the City’s 5-Year IMP Action Plan is to secure a dedicated, consistent long-term source of funding after 2019 so that the City can continue these PCC elimination efforts uninterrupted.
- **Building Backup Reduction (Wastewater Collection)** – Sewage backups into buildings pose significant public health risks. Backups may be due to poor plumbing practices and/or condition, building floor elevations that were constructed too low relative to the sanitary sewer elevation, inadequate capacity in the sewer system, and private I/I sources connected to the service lateral. Many building backups cannot be cost effectively addressed through capacity improvements to the public sewer system. To address this issue, the City recently approved a cost reimbursement program for the installation of low pressure sewers, installation of backflow prevention devices, or the removal of plumbing fixtures on private property. Over the next five years, the City will conduct community outreach to build awareness and increase participation in this new program.
- **System Capacity Enhancements and Private I/I Reduction (Wastewater Collection)** – Ultimately, the scope of the program and level of funding needed for system capacity enhancements will be determined based on the wet weather program management and planning activities discussed above. However, capital improvements needed to meet the City’s desired level of wet weather service will likely include a combination of capacity improvement projects and I/I reduction efforts. Public I/I reduction is primarily addressed through system renewal efforts. The cost-effectiveness of private I/I control is highly dependent on the source and location. Once the system hydraulic model is developed, the City will evaluate private I/I costs compared to system capacity improvements to determine the most cost-effective strategy to address wet weather challenges.

Until that time, the City will focus on conducting community outreach to build awareness and increase participation for its recently revised I/I reduction cost reimbursement program. This program reimburses property owners for activities that reduce the input of groundwater, stormwater, or other unpolluted water into the sanitary sewer system. The program was recently updated to more closely align with the building backup cost reimbursement program. The City expects that these revisions will increase I/I reduction

efforts by allowing for simpler navigation of the existing program and additional participation by property owners.

- **Municipal Separate Storm Sewer System Program Enhancements (Stormwater Management)** – The City, County, and University of Missouri are co-permittees under a Phase II municipal separate storm sewer system (MS4) permit issued by MDNR. The three entities are collectively responsible for compliance with their MS4 permit, which includes provisions for developing and implementing a stormwater management program to reduce pollutant discharges to the maximum extent practicable. The MS4 programs implement six minimum control measures (MCM): 1) Public Education and Outreach, 2) Public Involvement and Participation, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Stormwater Runoff Control, 5) Post-Construction Stormwater Management, and 6) Pollution Prevention and Good Housekeeping for Municipal Operations. The City's ability to fulfill its commitments to the other co-permittees and maintain compliance with the requirements of the MS4 permit is an important consideration for the IMP.

Over the next five years, the City plans to increase stormwater management program activities under MCMs 1, 3, and 4 to enhance water quality protections. Specifically, the City will increase education and outreach activities to build public awareness for the stormwater program and positively influence individual behaviors (MCM 1); improve illicit discharge detection and elimination activities to reduce the direct contribution of bacteria, nutrients, and other pollutants to City streams (MCM 3); and update erosion and sediment control guidelines to reduce sediment runoff from urban areas and construction sites (MCM 4).

The City will also continue participation in the Hinkson Creek CAM process. As mentioned previously, the CAM process and underlying agreement was developed in response to the USEPA TMDL developed for Hinkson Creek in 2011. Under the agreement, the MS4 partners agreed to work collaboratively to improve water quality in Hinkson Creek using a science-based approach. The CAM process is guided by three stakeholder groups that identify scientific needs, implement management actions, and measure progress towards attaining water quality goals. The City has been actively involved in these stakeholder groups since April 2012, and will continue to work with the MS4 partners to further CAM goals.

Columbia 5-Year IMP Action Plan ¹			
Program or Project ²	Goal	Anticipated Actions	Targeted Community Benefits ³
Wastewater Treatment			
Wet Weather Improvements*	Implement early measures to enhance peak flow capacity at CRWWTP.	<ul style="list-style-type: none"> Modify existing CRWWTP structures to provide additional wet weather flow storage. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality. Regulatory compliance.
Digester Rehabilitation*	Rehabilitate aging biosolids digestion facilities.	<ul style="list-style-type: none"> Target design completion by 2019. Target construction completion by 2021. 	<ul style="list-style-type: none"> Provide sustainable services for the future.
Constructed Wetlands Maintenance	Initiate constructed wetlands maintenance efforts to improve treatment efficiency.	<ul style="list-style-type: none"> Develop plan and detailed cost estimates for implementing improvement actions. 	<ul style="list-style-type: none"> Provide sustainable services for the future.
Wastewater Collection			
System Renewal*	Continue system renewal at current rates with appropriation of dedicated funding to provide effective wastewater collection.	<ul style="list-style-type: none"> Rehabilitate up to 1% of collection system structures per year, depending upon contractor availability and pricing. Secure dedicated annual funding for continued renewal. Current bond funding runs out in 2019. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality.
Private Common Collector Elimination (PCCE)*	Implement identified PCCE projects in the CIP with appropriation of dedicated funding to reduce illicit sewage discharges.	<ul style="list-style-type: none"> Continue Private Common Collector elimination, depending on ability to gain easements, as well as contractor availability and pricing. Secure dedicated funding. Current bond funding runs out in 2019. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality.
Reduce Building Backups*	Implement backflow prevention program to reduce building backups.	<ul style="list-style-type: none"> Obtain Council approval for backflow prevention program with allocation of \$100,000 per year for 5 years. Implement community outreach to build awareness of backflow prevention program. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality.
System Capacity Enhancements and Private I/I Reduction*	Reevaluate private I/I program to reduce peak wet weather flows.	<ul style="list-style-type: none"> Assess benefits and cost-effectiveness of previous and modified private I/I program. Implement community outreach to build awareness of modified program. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality. Regulatory compliance.
System Expansion	Provide adequate and cost-effective wastewater services to developing areas for watershed protection.	<ul style="list-style-type: none"> Fund expansion projects currently identified in the CIP, as needed. Develop systematic approach for evaluating sewer extensions to better identify sewer mains that should be upsized to convey future capacity. 	<ul style="list-style-type: none"> Protect quality of life. Provide sustainable services for the future. Improve water quality.
Wet Weather Planning*	Develop collection system model and evaluate future system capacity enhancement strategies.	<ul style="list-style-type: none"> Conduct comprehensive flow monitoring through 2020 to calibrate collection system model. Develop model by 2021. Evaluate system capacity enhancement strategies through 2022. 	<ul style="list-style-type: none"> Protect public health and safety. Improve quality of life. Provide sustainable services for the future. Improve water quality. Regulatory compliance.

Columbia 5-Year IMP Action Plan¹			
Program or Project²	Goal	Anticipated Actions	Targeted Community Benefits³
System Cleaning	Enhance sewer cleaning program to practicably mitigate overflows and backups due to blockages.	<ul style="list-style-type: none"> • Develop prioritized cleaning program. • Purchase new jet truck. • Plan for new building for field operations and collections personnel. 	<ul style="list-style-type: none"> • Protect public health and safety • Improve quality of life • Provide sustainable services for the future • Improve water quality
Stormwater Management			
MS4 Program Enhancements*	Enhance Public Education and Outreach, Illicit Discharge Detection and Elimination, and Construction Site Stormwater Runoff Control to reduce bacteria, sediment, and trash discharges.	<ul style="list-style-type: none"> • Continue to develop and distribute public education messages as outlined in the Stormwater Management Plan. • Hire technician to support MS4 program with focus on IDDE. • Conduct streamwalks and outfall inspections in all City streams within 5-year action plan period. • Develop map of stormwater outfalls. • Update Erosion and Sediment Control Manual and policies and procedures. • Continue to work with MS4 partners to effectively implement stormwater management program, particularly Minimum Control Measure #4. • Continue to work with MS4 partners to implement CAM program to improve Hinkson Creek water quality. 	<ul style="list-style-type: none"> • Protect public health and safety • Improve quality of life • Provide sustainable services for the future • Improve water quality • Regulatory compliance
System Renewal	Implement renewal program to address failing corrugated metal pipe (CMP) and structures beyond physical effective life.	<ul style="list-style-type: none"> • Initiate renewal activities as resources and funding allow. • Secure additional funding to implement these actions. 	<ul style="list-style-type: none"> • Protect public health and safety • Improve quality of life • Provide sustainable services for the future • Improve water quality
Condition Assessment	Establish and begin implementing a condition assessment program.	<ul style="list-style-type: none"> • Begin assessing CMP throughout the City. • Secure additional funding to implement these actions. 	<ul style="list-style-type: none"> • Protect public health and safety • Provide sustainable services for the future • Improve water quality
Flood Reduction	Address known areas of flooding to reduce public health and safety concerns.	<ul style="list-style-type: none"> • Implement opportunistic flood reduction projects, depending on available funding after emergency and critical system repairs. • Develop stormwater project ranking system. 	<ul style="list-style-type: none"> • Protect public health and safety • Provide sustainable services for the future • Improve water quality
Runoff Treatment	Reduce pollutant runoff in Hinkson Creek tributary watersheds to improve water quality.	<ul style="list-style-type: none"> • Implement opportunistic runoff treatment projects, depending on available funding. • Develop stormwater project ranking system. • Continue to implement CAM process. 	<ul style="list-style-type: none"> • Protect public health and safety • Provide sustainable services for the future • Improve water quality

Columbia 5-Year IMP Action Plan ¹			
Program or Project ²	Goal	Anticipated Actions	Targeted Community Benefits ³
Stream Erosion Control	Stabilize stream channels with excessive channel erosion to reduce sediment discharges.	<ul style="list-style-type: none"> Identify and implement opportunistic stream erosion control projects, depending on available funding after emergency and critical system repairs. Develop stormwater project ranking system. Continue to implement CAM process. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality
Planning and Program Support	Develop stormwater master plan and enhance data management processes.	<ul style="list-style-type: none"> Initiate master planning and data management efforts. Secure additional funding to implement these actions. 	<ul style="list-style-type: none"> Protect public health and safety Provide sustainable services for the future Improve water quality
Activities to Measure Water Quality Improvements ⁴			
Water Quality Monitoring	Implement water quality monitoring program to help define baseline conditions and track future improvements.	<ul style="list-style-type: none"> Develop water quality monitoring plan within first 5 years and implement when additional funding is secured. 	<ul style="list-style-type: none"> Evaluate IMP effectiveness Provide technical basis for future IMP modifications
Hinkson Creek Flow Gage	Collect continuous Hinkson Creek stream flow data.	<ul style="list-style-type: none"> Continue annual funding for USGS flow gage operation. 	<ul style="list-style-type: none"> Evaluate IMP effectiveness Provide technical basis for future IMP modifications
<p>Note 1 - Goals and actions identified in this 5-Year IMP Action Plan reflect the City's understanding of infrastructure and regulatory needs and priorities with respect to the information currently available. The City will implement these actions to the extent possible but acknowledge that weather, staff availability, Council approval and other resource constraints or unanticipated needs may impede complete implementation of the Action Plan or require that it be modified. Further, the City notes that many of the activities outlined in this Action Plan assume that sufficient additional funding will be made available through sewer rate increases, bond financing that must be approved through a local election, and stormwater rate increases that must be approved by a majority vote. If sufficient additional funding does not become available, the 5-Year IMP Action Plan will be modified to reflect available funding and resources.</p> <p>Note 2 - High priority program and project needs were identified by City staff and are denoted with an asterisk (*). These represent projects that are intended to directly and expeditiously reduce significant public health risks, improve water quality, or enhance customer service.</p> <p>Note 3 - Targeted community benefits are presented in Section 4.3 and explained in greater detail in Attachments J and N.</p> <p>Note 4 - Element 5 of EPA's Framework requires that municipalities outline activities that will be used to measure IMP effectiveness. Activities listed here will be used to measure water quality improvements that occur over time. Additional program management and Utility service performance measures are discussed in Section 6.</p>			

Section 6. Measuring IMP Success

Element 5 of EPA's Framework calls for municipalities to outline the performance measures, monitoring data, or milestones that will be used to measure progress as integrated plans are implemented. The City intends to measure both the environmental and programmatic improvements that result from implementing the IMP. These are discussed below.

Measuring Water Quality Improvements

The ultimate goal of EPA's integrated planning process is to provide municipalities with a framework that can be used to affordably meet human health and water quality protections required by the CWA. As presented in the 5-Year Action Plan, the City will measure progress towards meeting these regulatory requirements by developing a water quality monitoring program for City streams and continuing to fund the existing Hinkson Creek flow gage. These efforts will allow the City to track water quality improvements over time and adjust future IMP activities, if necessary.

Measuring Program Efficacy and Service Performance

Program efficacy is generally measured through an evaluation of level of service (LOS) goals. LOS goals are typically qualitative goals used by utilities to guide sewer and stormwater operations. Progress towards meeting LOS goals are generally tracked through a series of quantitative key performance indicators (KPI) that are used to evaluate a utility's success in meeting strategic goals, quantify the benefits of continuous improvement initiatives, and to measure performance in managing infrastructure.

Through IMP development, the City and Project Team reviewed existing LOS goals and KPIs for the Sewer (**Attachment K**) and Storm Water (**Attachment M**) Utilities to identify performance measures that could be used to measure success of the IMP over time. For the Sewer Utility, the City has focused on taking actions to address dry weather operations, wet weather operations, and system renewal. For the Storm Water Utility, the City is interested in providing public safety, improving environmental integrity, renewing and maintaining the conveyance system, and adequately funding and staffing the Utility.

Although the City has goals for each Utility, IMP planning efforts highlighted the fact that the City has numerous information gaps that must be filled in order to develop a more complete understanding of the systems, create formal goals, and reliably track KPIs. For example, the City needs to develop an accurate hydraulic model to understand the costs and benefits of establishing a specific wastewater collection system design storm prior to defining the City's LOS goal for wet weather conveyance. With respect to the Storm Water Utility, improved management of the existing data collection, tracking, and maintenance procedures will improve future stormwater system planning, maintenance, and performance.

The City will refine LOS goals and KPIs over time as the IMP is implemented. In the interim, IMP success will be measured using milestones and actions outlined in the 5-year IMP Action Plan. At the end of the first five year period, the City will evaluate progress to determine if goals were achieved and make necessary changes and adjustments during future phases to ensure continuing progress towards satisfying infrastructure demands and meeting CWA obligations.

Section 7. Alignment with Mayor's Task Force on Infrastructure

As discussed in **Section 1**, the City has proactively been working to identify and prioritize the City's infrastructure needs. In August 2015, the City formed the Mayor's Task Force on Infrastructure (MTFI) to review the City's infrastructure needs, including those in the sewer and stormwater systems. To maintain consistency between infrastructure planning activities being conducted in the City, the Project Team reviewed the functional stormwater and sewer recommendations outlined by the MTFI in their 2016 Final Report to evaluate alignment with recommendations developed independently from the IMP process. Financial and policy recommendations developed by the MTFI were not reviewed as these items are outside the scope of the IMP.

MTFI Functional Storm Water Utility Recommendations

The MTFI Final Report included the following four functional recommendations for the stormwater system:

1. The City should expand its internal and cooperative mapping capacity with MU and Boone County, cataloguing equipment information, engaging water runoff tools, and continued use of Light Detection and Ranging (LIDAR).

Currently, scheduled data exchanges occur on a regular basis with the members of the GIS consortium. This recommendation aligns with IMP recommendations to increase funding for program support, which would include enhancing data management and geographical information system (GIS) mapping processes. The Optimized alternative assumes approximately \$1 million in funding for this program element over the 20-year planning period. Additional discussion of this recommendation is included in **Section 3.1** of **Attachment M**.

2. The City should coordinate with MU and Boone County to install an automated rain gauge system to better track precipitation within the MS4 permit area.

An automated rain gauge system would be useful for characterizing rainfall patterns and runoff in the service area. However, it would take many years of data for any improvements in design criteria to be realized and would provide limited immediate operational improvements. Given the magnitude of funding allocated to the address immediate stormwater system needs in the Optimized alternative (\$224 million), installing and maintaining a rain gauge system is considered a low priority due to fiscal constraints. Therefore, this system is not included within the IMP recommendations. As the City implements the IMP over time, the addition of a rain gauge system should be reevaluated. The City should also investigate the utility of alternative methods, such as gauge adjusted radar, which may provide a more efficient tool for characterizing rainfall across the City.

The IMP does recommend that the City reevaluate key stormwater design standards, such as the assumed temporal storm distributions (See **Section 3.2 of Attachment H**), to help address runoff control and stream channel stability.

3. The City should model the public stormwater system hydraulics to identify system deficiencies to assess future impacts of development and troubleshoot existing capacity.

This MTFI recommendation aligns with IMP recommendations to increase funding for master planning and conveyance system modeling support. The Optimized alternative assumes approximately \$1 million in funding for this program element over the 20-year planning period. Additional discussion of this recommendation is included in **Section 3.1 of Attachment M**.

4. The City should adopt an objective grading system to prioritize stormwater capital improvement projects ensure a consistent and objective evaluation process for selecting projects.

This MTFI recommendation aligns with IMP recommendations to increase funding for master planning, modeling, and program support. These efforts will enhance project planning, prioritization, and identification of improvement locations to more fully meet conveyance system assessment goals. They will also help to refine future funding needs and identify a long term improvement plan to address the conveyance issues present within the system. The City has already started developing a weighted scoring system to prioritize potential projects. The Optimized alternative assumes approximately \$1 million in funding for continued development of a stormwater master plan. Additional discussion of this recommendation is included in **Section 3.1 of Attachment M**.

MTFI Functional Sewer Utility Recommendations

The MTFI final report included seven functional recommendations for the sewer system:

1. The City should create a comprehensive wastewater collection system model, including physical and hydraulic attributes to better analyze changes to the system.

This MTFI recommendation aligns with IMP recommendations to increase funding for wet weather program planning and asset management support. This will be one of the first objectives to be implemented. The Optimized alternative assumes \$6 million in funding for this program element, which is included within the 5-Year IMP Action Plan. Additional discussion of this recommendation is included in **Section 3.1 and 3.2 of Attachment K**.

2. The City should define a residential sewer user as “the owner or occupant of a dwelling unit that is connected directly or indirectly to the city’s sanitary sewer system”.

This MTFI recommendation is a policy decision that falls outside the scope of the IMP.

3. The City should rehabilitate or replace a minimum of one percent of the sewer collection system annually.

This MTFI recommendation generally aligns with IMP recommendations for system renewal. The Optimized alternative assumes \$44 million in funding for this program element. Additional discussion of this recommendation is included in **Section 3.3 of Attachment K**. Note that the exact percentage of the system renewed each year is anticipated to vary based on the size of the infrastructure being addressed and the corresponding types of renewal work required. On average, between 0.8% and 1% of the system will likely be renewed on an annual basis.

4. The City should pursue programs that place greater responsibility on property owners to identify and eliminate private sources of inflow and infiltration.

The IMP Project Team agrees with this MTFI recommendation. However, the recommendation contradicts the MTFI recommendation that the City should assume greater responsibility for the condition of private service lateral infrastructure (addressed in item 5, below). The IMP project team recommends that the City further evaluate cost-effective means of reducing private I/I during wet weather program development. The City recently revised Section 22-217.3 of the City code to update I/I reduction program requirements to more closely align with the cost reimbursement program for the installation of low pressure sewers, backflow prevention devices, or removal of plumbing fixtures. The City expects that these revisions will increase I/I reduction efforts by allowing for simpler navigation of the existing program and additional participation by property owners. The City will implement outreach to build awareness of the programs.

5. The City should assume responsibility for all connection points within the public sewer as well as responsibility for any portion of a private sewer service lateral located within a public right-of-way or within a dedicated sewer easement.

The IMP does not include this recommendation. There are approximately 50,000 private service lateral connections to the City's collection system. Assuming responsibility for all service lateral connection points and the portion of all private service laterals located within a public right-of-way or sewer easement would substantially increase the amount of sewer infrastructure managed by the City. A preliminary analysis based on typical right-of-way and easement widths estimated that this would add over 200 miles of sanitary sewer that would be managed by the City (note that mapping of the locations of these private service laterals is not available and this mileage could be greater than estimated).

Unlike the City's public sewers, most private service laterals have not been regularly cleaned, inspected, or repaired. If the City were to assume responsibility for this privately owned infrastructure, the City would need to regularly maintain, inspect, and rehabilitate these service laterals. Service laterals are typically small diameter pipes that often include many horizontal and vertical bends; this necessitates the use of special equipment to maintain and inspect these pipes. Additionally, many laterals have limited

accessibility and in their existing state would not be accessible except through interior building plumbing (as opposed to public sewers which are accessed through manholes for typical maintenance and inspection activities). Installation of cleanouts is anticipated to be required on the majority of lines in order to enable the City to access them. Cleanout installation alone for 50,000 service laterals would take more than 40 years based on completing five installations per day.

The inspection, maintenance, and rehabilitation of these private service laterals would represent a major ongoing expense for the City. A preliminary estimate of the 20-year cost of ownership to the City for this privately owned infrastructure is approximately \$237 million.

In addition to the economic cost of ownership, there are several other challenges involved with assuming ownership of this infrastructure that are not readily quantifiable. Other identified considerations involved with assuming ownership of sewer laterals are listed below:

- The full regulatory impacts of assuming ownership of the private service laterals is unclear, but it would likely increase the City's risk in this area. It is anticipated this would significantly increase the number of backups the City is considered responsible for by regulatory entities and could potentially increase the risk of regulatory enforcement.
- Whenever a building backup occurs due to a blockage in a private service lateral, an investigation would need to be completed in order to determine if it was caused by a blockage in the city-owned portion of the lateral, or in the privately owned portion (outside the public right-of-way or easement).
- The City would be responsible for providing location information for these service laterals whenever utility locates are called in prior to digging. The City would need to develop detailed mapping of the location of these laterals to facilitate locates. The City would also need to expend additional resources (either additional staff or increased contract costs) on an ongoing basis to administer the location of these service laterals. Note that service laterals are typically shallower than the public sewer and are more susceptible to being damaged during construction and utility installation efforts.
- Service lateral rehabilitation costs presented in the table at the end of this section are based on estimated contracted renewal costs. Assuming ownership of this infrastructure may also necessitate the City adding additional repair crews and equipment to execute emergency repairs of structurally failed service laterals.

Because the City is focused on securing long-term funding for maintenance and replacement/renewal of the existing public sewer system, the high financial cost to the City to take over ownership of these private systems and other challenges associated with assuming ownership of these private systems the Project Team suggests that the City not adopt this MTFI recommendation.

6. The City should continue investigating and rehabilitating the sewers in the “I&I Pilot Study Area”.

The I&I Pilot Study Area was an area identified for a pilot study in 2008. This area was expanded to become Flat Branch Basin D. Post flow monitoring of this area was conducted and a report was provided to Council in September 2014 that demonstrated a 19% reduction in peak flow and a 48% reduction in total volume. Since that time, more of the system in the area has been rehabilitated. At this time, additional funding for this area should be limited to providing assistance for backflow prevention and private I/I reduction. A very large amount of funding could be spent in this area with no further significant reduction in the amount of I/I entering the City's system. The financial resources should more appropriately be spent following the IMP recommendations for system renewal and public I/I (see **Section 3.3 of Attachment K**) and the system capacity enhancement and private I/I (see **Section 3.4 of Attachment K**). The Optimized alternative assumes approximately \$44 million and \$60 million in funding for these program elements over the 20-year planning period, respectively.

7. The City should implement a sanitary sewer backflow prevention program that would provide financial assistance to qualifying property owners.

This MTFI recommendation aligns with IMP recommendations for building backup alleviation. The Optimized alternative assumes \$500,000 funding for this program element. This program was approved by Council in 2017. Additional discussion of this recommendation is included in **Section 3.5 of Attachment K**.

Preliminary Estimate of 20-Year Cost of Ownership for all Service Lateral Connection Points and the Portion of Service Laterals Located in the Public Right-of-Way and Easements		
Description	Unit	Value
Assumptions on Lateral Assets in Right-of-Way		
Total Service Laterals Managed by City	#	50,000
Total Estimated Length of Portion of Laterals Managed by City	LF	1,750,000
	MI	236.7
Service Lateral Maintenance Program (Cleaning)		
Lateral Cleaning Frequency	YR	5
Cleaning Unit Cost	\$/LF	1
Cleaning Truck w/ Specialized Equipment	\$/EA	250,000
Cleaning Truck Replacement Schedule	YR	10
Install Cleanouts to Access Lateral (Assume 75%)	EA	\$1,800
Cleaning Crew – Operator FTE	\$/YR	44,000
Cleaning Crew – Lead Jet Operator	\$/YR	52,000
Subtotal – 20-YR Cleaning Cost	\$	76,920,000
Service Lateral Inspection Program (CCTV)		
CCTV Unit Cost	\$/LF	1.25
Two CCTV Trucks With Special Equipment to Televisе Laterals	\$	500,000
CCTV Truck Replacement Schedule	YR	10
Lateral CCTV Frequency	YR	10
CCTV Crew – Operator FTE (2 Operators)	\$/YR	88,000
CCTV Crew – CCTV Tech (2 Techs)	\$/YR	124,000
Subtotal – 20-YR CCTV Cost	\$	9,615,000
Service Lateral Rehabilitation Program (CCTV)		
Assumed Rehabilitation Percentage	%	50
Rehabilitation Unit Cost (Lateral and Connection)	\$/EA	6,000
Subtotal – 20-YR Rehabilitation Cost	\$	150,000,000
Preliminary Estimate - Total 20-YR Cost of Ownership		\$237,000,000

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BUILT ENVIRONMENT: HOUSING, TRANSPORTATION, & STORMWATER MANAGEMENT

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to...

Housing



MEDIUM-HIGH

Warming temperatures will likely increase demand for air conditioning, which most homes and apartments have, but the increase in energy costs may be difficult for households, especially low-income ones, to bear. Heavier rains may cause more local flooding, which could cause damage and limit mobility for some neighborhoods in more flood-prone areas of the city.

Transportation



LOW-MEDIUM

Flooding is not a significant concern for Columbia now, but more heavy rain events in the future may increase the risk of local flooding, potentially blocking roadways and trails. The high reliance on personal vehicles and limited transit services across the metro area limits residents' options for getting around, especially during times of extreme events.

Stormwater management



MEDIUM

The city's stormwater infrastructure may not be able to handle the amount of runoff that is expected in the future, and considerable resources would be needed to make needed upgrades.

Vulnerability Ranking

LOW

LOW-MEDIUM

MEDIUM

MEDIUM-HIGH

HIGH



Housing

Of the 46,184 occupied housing units in Columbia, 47% are owned by residents and the remaining 53% are rented [1]. In recent years, the number of multi-family housing units in Columbia has been rapidly increasing. This trend is considered to be driven by relatively rapid growth of the Columbia metropolitan area population, which increased by more than 11% between 2010 and 2016 [2]. During that same period, total enrollment at the University of Missouri Columbia increased by approximately 2.5%, accounting for some, but not all, of this change [3]. Also driving this trend may be changing expectations and desires among students for off-campus housing with amenities in close proximity to campus, as well as relatively low permitting costs. Annual population growth in Columbia is anticipated to slow slightly in the future, but will likely maintain a rate that would continue driving the construction of multi-family housing.

The average Columbia resident earning the median annual income for the region spends 26% of their income on housing costs, which is slightly under the national average. Lower-income households whose annual income is 80% of the regional median income—representing about one-third of Columbia's community—spend 32% of their income on housing [4]. The Columbia Housing Authority helps low-income households overcome this cost burden by providing subsidized housing or affordable housing vouchers to over 1,900 households in Columbia and Boone County, representing 9% of the city's rental market [5]. Meanwhile, the City of Columbia has been working to increase investments in historically under-resourced neighborhoods and help low- and moderate-income households build wealth through its first-time home buyer assistance program [6].

Warmer temperatures and more cooling needs

Climate change is expected to increase air temperatures in Columbia, with summertime highs reaching nearly 104°F and nightly lows staying above 80°F by 2080 [7]. Asphalt and other features in the urban environment may make temperatures warmer in the city due to the urban heat island effect. Under these conditions, there will likely be greater demand for homes and apartments with air conditioning (A/C), natural shading, passive cooling design, and other features that provide relief from the heat. Residents may use A/C more often, leading to increased energy use, higher household cooling costs, and greenhouse gas emissions. Larger A/C units with more capacity may be needed to counteract extreme heat, but these units may be less efficient on days when that capacity is not needed. Good insulation in homes and apartment buildings will be needed to maximize efficiency and reduce unnecessary costs; cooler roofs and other strategies can also help. Households with lower annual incomes may be less likely to have air conditioning and may need financial assistance to install and operate air conditioning units and improve insulation in their homes.

Heavier rainfall and flooding

Columbia is also expected to have more frequent heavy rainfall events in the future, which will increase the risk of local flooding to homes and apartment buildings, especially those located in flood zones [7]. Structures that are sufficiently elevated above average flood levels in the current climate may not be high enough for the larger floods that are expected to occur in the future. Thirty residential structures are located in the floodway, but about 300 more are in areas at risk of flooding during bigger events that have historically happened every 100 years [8]. A total of 1,050 residential structures, including five public housing communities, are at risk of being affected by 500-year flood events [8]. Flooding may cause sanitary sewer backups around some residential structures, potentially making them uninhabitable until water recedes and the area is cleaned up. Heavy rain events will also require larger gutters, downspouts, bioswales, and other on-site infrastructure to manage higher volumes of stormwater.



There are five public housing communities located in areas at risk of being affected by floods that have historically occurred every 500 years: Jesse Wrench, Lower Jesse Wrench, Frank Coleman, Oak Towers, and Bear Creek [8]. Lower-income residents may face challenges in recovering from flooding if they do not have insurance or sufficient resources to fix damages to their home or property.

Lynn Street Cottages and the Columbia Community Land Trust

The City of Columbia has been working alongside neighborhood and community members to redevelop the block of Garth, Sexton, Oak, and Lynn with affordable housing and improved infrastructure. The project includes the development of eight affordable owner-occupied homes with near net-zero energy usage design and universal design features. The homes were developed in a cottage housing style arrangement to increase the density of the development. The development also included significant stormwater improvements to benefit the surrounding neighborhood.

The Lynn Cottages development also coincided with the City's creation of the Columbia Community Land Trust (CCLT). The CCLT is a separate 501(c)3 with a governance structure that includes membership from the community at large, neighborhood members, and CCLT homeowners. The CCLT's main purpose is to steward the City's investments in affordable housing, which will be done by maintaining ownership of the land beneath the homes and authorizing its approved use through a 99-year ground lease. The CCLT will ensure the homes remain affordable, owner-occupied, and well-maintained for generations to come. This kind of long-term planning is especially important as we prepare for anticipated climate change impacts.



Transportation

Columbia's residents mostly rely on private vehicles to get around. Over two-thirds (78%) of residents drive alone to work, 9% carpool, 5% walk, and only 1% take public transit [9]. The annual cost of car ownership is over 18% of the average Columbia resident's annual income [4]. Columbia's public transit system is relatively small compared to cities of similar size due to budgetary constraints. Columbia is not alone in this situation—public transportation is poorly funded statewide. Columbia's pedestrian infrastructure includes 555 miles of sidewalks in the metro area, but funding constraints have also left some neighborhoods without any sidewalks, possibly inhibiting mobility and accessibility to transit, and raising potential safety concerns during flooding events.



Under future climate conditions, heavier rain events may pose a higher risk of flooding and damage to transportation infrastructure [7, 10]. Local street flooding may become more widespread if stormwater pipes prove too small to handle heavier rain events. Roads will need to be designed with larger pipes and inlets to efficiently move stormwater off the streets, which could increase costs for construction and ongoing maintenance. Heavier rains are likely to destabilize streambanks and increase erosion, threatening bridges, trails, and other structures along waterways. These impacts will require more labor and equipment to clear rock, mud, and debris and repair damaged infrastructure—all of which increase costs. Flooding also affects walking and biking, especially on trails built in floodplains. Since bike lanes are typically built close to street gutters, they may be unusable if streets are flooded. Roadways are not expected to be significantly impacted from erosion since it is currently a minor issue and mudslides are extremely rare.

Meanwhile, warmer temperatures and extreme heat may weaken pavement and other types of material, lower long-term durability, and require more maintenance. Warmer temperatures may have negative health impacts on people who use active transportation or public transit, making it more difficult for them to get around. On the other hand, warmer winters in the long term may mean fewer instances of freezing and thawing and less demand for some types of maintenance.

Columbia residents who rely on walking or biking, who do not have a personal vehicle, or who cannot drive may be more exposed to extreme heat and poor air quality from smog or airborne allergens. People with respiratory or cardiac conditions, older adults, pregnant women, and children may be especially sensitive to these conditions. Demand for Go COMO fixed bus routes, Para-Transit, and Tiger Line may increase among these community members. During severe rain events, especially when transportation infrastructure is damaged or service is interrupted, people with limited mobility including older adults and people with disabilities may need additional Para-Transit services to get to places of shelter and address basic needs. The sparse nature of the transit system could be a significant liability during such events.

Regional growth and development

Columbia's population grew by nearly 40% between 2000 and 2016 (from 84,531 to 117,165) [2]. The city is projected to continue growing by approximately 1.5% each year to exceed 200,000 by 2050 [14]. With this growth has come inner city redevelopment and increased housing prices, which could push lower-income and minority populations to the fringes of the city where there are fewer resources, transportation options, and walkable or bikeable infrastructure.





Stormwater management

Columbia's existing stormwater infrastructure will likely be challenged by more frequent and higher intensity storms due to the age and condition of structures and pipes, though much of the infrastructure has yet to be visually assessed for its conditions [11]. Extreme events may lead to more flash flooding with higher volumes of water, which will be difficult for undersized pipes to handle. These events may lead to stormwater infrastructure failures, which have occurred in recent years [12]. Since Columbia's sewer infrastructure is separate from its stormwater drainage infrastructure, it is less vulnerable to contamination during heavy rain events compared to St. Louis, Kansas City, and other cities that have combined systems [13]. Still, the City's stormwater infrastructure will need greater capacity to manage the projected heavier flows, and some houses may be affected by sewer backups during heavy rains.



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HEALTH, SAFETY & WELL-BEING

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to...

Heat stress



HIGH

Warmer temperatures and more extreme heat may lead to higher risk of heat-related illness.


Air quality



HIGH

More days of poor air quality and greater exposure to allergens could exacerbate respiratory illnesses.

Vector-borne diseases



HIGH

Warmer temperatures may increase vector-borne diseases like West Nile Virus and Lyme disease.

Mental health



MEDIUM-HIGH

Exposure to more climate-related disasters may lead to more anxiety and other mental health consequences.

Vulnerability Ranking



Who is most at risk?

“Every American is vulnerable to the health impacts associated with climate change.” [1]

In general, children, older adults, women who are pregnant, outdoor workers, those with pre-existing illnesses, and those with weak social ties are more vulnerable to climate change-related health impacts. Low-income communities may have fewer options to respond and prepare for impacts, and may not have access to quality healthcare. The elderly, people with disabilities and mobility impairments, or families with mixed immigrant status may be less likely to leave their homes to seek aid. Columbia residents with Limited English Proficiency, which comprise of approximately 3.5% of the population, may need additional assistance to access information and prepare for and respond to health impacts [2]. The City is currently undertaking a community health assessment that will analyze primary and secondary data on various health issues to inform planning efforts.



Rising temperatures and heat stress

Across Missouri, by the 2050s, 10 to 20 more days per year will have highs over 95°F compared to 2016 [3]. By late century, Columbia could see maximum daily highs of 104°F, with summer nights that don't dip below 80°F [4].

Between 2013 and 2016, there were 20 reports of heat-related illnesses and three heat-related deaths in Boone County [5]. Higher temperatures and more extreme heat days could increase the risk of heat stress and heat-related illnesses, especially among people who already have certain health conditions, live in buildings without air conditioning or cannot afford it, or experience homelessness. Additional public cooling centers, beyond the 9 that are currently available, may be needed to accommodate more people [6]. With greater cooling demand, households and businesses may see a rise in their energy costs in the summer. More low-income households may need financial assistance to cover higher costs, placing greater demand on an already tight public services budget in Columbia. Additional support may be needed for the Voluntary Action Center to continue providing air conditioning units to low-income residents.

Outdoor workers—including construction crews, farmworkers, landscapers, as well as City on-site inspectors, environmental health workers, and street maintenance crews—could be more exposed to extreme heat. To protect these workers, certain safety precautions may need to be taken, such as starting work shifts earlier in the morning to avoid daily high temperatures or working shorter shifts (e.g., two 4-hour shifts instead of one



8-hour shift). Outdoor recreation and sporting event participants will also be more exposed to extreme heat, and may benefit from adjustments to event timing and other adaptation strategies.

With warmer temperatures and extreme heat, transportation may become more difficult for older adults; people who rely on walking, biking, or public transit; children who walk to school; or people with limited mobility. It may be harder for these groups to get to workplaces, school, and health care facilities during extreme heat events.

Extreme events

Risk to life may also increase with climate change. Flash flooding is a risk in Missouri, which poses a particular danger to people in cars on flooded roadways. In 2015, 27 people were killed by flooding in Missouri; 23 of them were in motor vehicles [17]. Climate change is expected to bring more heavy rainfall events, which increases the risk by reducing visibility.

During extreme heat, floods, drought, and other extreme or emergency weather conditions resulting in power outages, the Columbia community has higher demand for emergency response services. This requires more capacity and coordination among governments and service agencies to plan services for residents, especially meal delivery, provision of medicine, and other assistance for people with limited mobility or disabilities. In addition, extreme weather conditions make it harder for service providers to reach those in need, and to find locations for public heating and cooling centers that can accommodate more people.



Vector-borne diseases

Currently in Columbia, there is a low incidence of two of the most common U.S. vector-borne diseases: tick-borne Lyme disease and mosquito-borne West Nile virus. Between 2011 and 2015, there were three reported cases of Lyme disease and only one of West Nile virus in Columbia/Boone County [7]. Although Zika and Dengue viruses are not currently in Missouri, there is concern that they could spread north into the state under warmer conditions.

There is a greater incidence in Missouri of Rocky Mountain Spotted Fever, Ehrlichiosis and Anaplasmosis. In 2013, there were 398 cases of Ehrlichiosis and Anaplasmosis in Missouri [8].

As temperatures warm, disease spread through mosquitoes, ticks, and other vectors may become more prevalent in Columbia, as a longer warm season could increase populations of these

vectors known to carry certain diseases. Across the U.S., illnesses from mosquito, tick, and flea bites tripled from 2004 through 2014 [9].

The Vector Control Specialists who help manage mosquito populations engage in physically demanding work outdoors, so they are more exposed to extreme heat. In addition, heavy and extended rains during the spring postpones vector control efforts until the rains stop, allowing mosquito breeding to go unchecked. Under these conditions, environmental and public health workers could face heavier workloads and may need additional capacity, and costs would likely increase to support these efforts.

Education programs may be needed with local health providers to ensure they can recognize symptoms of vector-borne diseases as the incidence increases. There are few local infectious disease specialists meaning diagnosis and care must often be provided by primary care or urgent care physicians.

Poor air quality, allergens, and respiratory illnesses

Between 2012 and 2014, Boone County had 13 days when the air quality was considered unhealthy for higher risk populations, such as older adults, children, and people with respiratory disease [10]. In particular, poor air quality can exacerbate asthma conditions. In 2015, there were 725 asthma-related emergency room visits in Boone County [11]. In the future, warmer temperatures may lead to higher levels of ozone smog pollution, which can harm lung and heart health [12]. Columbia may experience more days each year with poor air quality, and air quality may be worse on those high-risk days. During these times, indoor air quality will also likely be lower as ozone enters buildings through windows, doors, cracks, and other openings. Given that people spend most of their time indoors, Columbia residents will be more exposed to indoor ozone for longer periods of time and may experience negative respiratory health effects as a result of indoor exposure [13].

With warmer temperatures, the pollen season may also become longer and more severe across Missouri [12]. These changes could worsen allergy symptoms and possibly contribute to asthma attacks. Additional capacity may be needed among health services to adequately serve the community's changing needs.

Indoor air quality may also be reduced with heavy rain events, more flooding, and higher outdoor humidity that increases moisture and humidity indoors, supporting more mold, dust, and other air contaminants [14]. This may worsen asthma symptoms and increase cases of respiratory infections. Extreme weather events and flooding may heighten this risk if power outages occur and turn off heating, ventilation, and air conditioning systems, reducing air flow and humidity control [15].

Poor outdoor and indoor air quality and increased exposure to allergens could disproportionately impact people who work outdoors, spend longer periods of time indoors, or already have certain health conditions, including allergies, asthma, and other respiratory conditions. Practices and procedures may be needed to protect Columbia residents from exposure on high-risk days.

Some communities in Columbia are more vulnerable to ozone smog pollution due to higher exposure and limited resources to prevent exposure and respond to health impacts. Neighborhoods will be more exposed if there is more vehicular traffic generating air pollution, more paved surfaces increasing surface air temperatures and heightening ozone levels, and less park space, vegetation, and tree canopy coverage, which remove ozone from the air.



Implications for food security

Climate change impacts, including drought, may limit food production in Missouri, across the U.S., and worldwide. Extreme events could also interrupt transportation of food. These impacts could mean higher prices at the grocery store and farmers' markets. Lower-income households may have difficulty bearing this higher cost burden and require public assistance. In the past, Columbia has seen higher demand for public services when economic conditions change. Boone County already has high levels of food uncertainty and very high participation in the national free and reduced school lunch program relative to the rest of the state, yet low participation in the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program [18]. Additional resources may be needed to close that gap and better serve these community members in need. Meanwhile, local farmers in the Columbia area could also face economic challenges with lower yields or losses of certain crops. In addition, more extreme weather events, like heat waves and heavy rainstorms, could make it more difficult for older adults and people with limited mobility to access grocery stores.



Implications for mental health

Climate change is expected to bring more extreme temperatures and other severe weather. Even the threat of these conditions can impact an individual's mental health and the community at large, especially when they could cause loss of life, significant loss of resources, property or social support, or require relocation or other extensive changes to one's daily routine. Many people exposed to climate-related disasters experience serious mental health consequences, such as post-traumatic stress disorder (PTSD), depression, and general anxiety. It has been documented that in the wake of a disaster, instances of domestic violence and drug and alcohol abuse increase. Some studies also show a link between higher temperatures and increased rates of suicide [16]. As higher temperatures and extreme weather become more common in Columbia, it will be important for the community to have tools and strategies to handle stress when these conditions occur, and for mental health providers to have sufficient resources and capacity to prepare their patients for these changes. Affordability of mental health services is currently a challenge for many adults in Columbia, indicating that financial support may be needed in the future. In addition, further development of the mental health workforce will likely be important, as Columbia is already experiencing a shortage of mental health workers.

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OPEN SPACE AND AGRICULTURE

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to...

Trees and open space



LOW-MEDIUM

A warming climate and drought will stress trees, and provide more favorable conditions for disease, pests, and invasive vegetation that could be difficult to contain and manage. Existing habitats will be increasingly threatened under future conditions.

Agriculture



MEDIUM

Increasing drought, warmer temperatures, and changes in precipitation threaten the quality and quantity of crop yields and make crops more prone to pests and disease. However, technologies and innovation offer the potential for more resilient crops. Transitioning to different crops suitable to the new climate also remains a possibility.

Vulnerability Ranking

LOW

LOW-MEDIUM

MEDIUM

MEDIUM-HIGH

HIGH



Trees and open space

Across the City of Columbia, approximately 36% of land has tree canopy cover, according to the Urban Forest Master Plan [1]. A broad range of species is represented in this area, including upland species like oaks, maples, and hickory, and lowland species like sycamore and willow, as well as non-native and invasive species like elm [1].

Along Columbia's streets, the trees found in right-of-ways are considerably diverse, with the most common species being eastern redbud (8% of the inventoried population), ash varieties (12%), American sweetgum (4%) and sugar maple (3%) [1]. Nearly three-fourths of Columbia's street trees are in fair condition, meaning that additional stressors may worsen their conditions [1].

Columbia also has 3,375 acres of parks and green spaces and over 64 miles of trails in the community-wide system [2].

Average temperatures are expected to increase in Columbia as they will across the Midwest. By 2050, average temperatures will be 4°F higher or even warmer [3]. As temperatures warm, hardiness zones will change. Growers use hardiness zones (1 to 10), which are based on the average minimum temperature in the winter, to determine which plants are most suitable to the local climate. Columbia is currently in hardiness zone 6a (average annual minimum winter temperature of -10 to -5°F) [4]. Between 2000 and 2010, some parts of Missouri went up one hardiness zone level, and in the next 30 years, most of Missouri is projected to be in Zone 7 with an average minimum winter temperature of 1 to 10°F [5]. By 2070, hardiness zones may shift even more as minimum annual temperatures

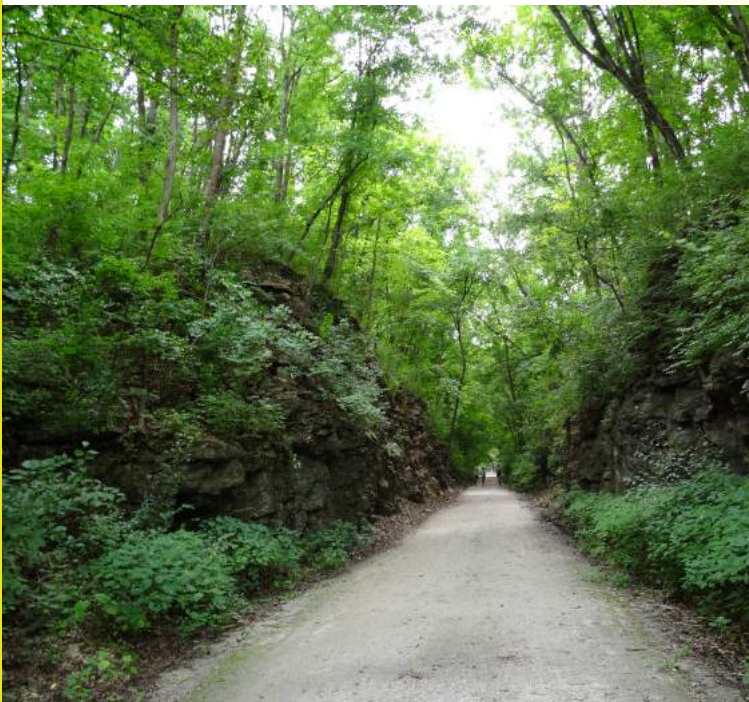


in Missouri may increase by 7 to 11°F or more compared to the 1971-2000 average [6]. With these changes, some species of trees and shrubs may no longer be suitable to plant along Columbia's streets and in parks and open spaces, while some cold-intolerant species may become suitable. The net change in species suitability may impact the biodiversity of trees and shrubs—for better or for worse—compared to what Columbia's climate currently supports.

Columbia's urban landscape could potentially exacerbate the negative impacts from warmer temperatures. The urban heat island effect is the tendency for developed urban areas to be hotter than surrounding rural areas because roads, buildings, and other dry impermeable surfaces have replaced open land and vegetation. Across the U.S., the urban heat island effect has led to an average increase in urban temperatures of 5.2°F [7]. There is some indication that the urban heat island effect may be occurring in Columbia as well [8]. In a warming climate, resources may be needed to plant more trees as well as maintain current trees to help mitigate the urban heat island effect.

Periods of extreme heat and summertime drought are expected to become more common in Missouri, which will make it more difficult to establish new plantings and may reduce survival rates. Columbia experienced the impact of drought in 2012 when some trees died due to low soil moisture and high soil temperatures [9]. More staff time and resources will be needed to water and maintain new plantings, add more mulch to surround trees, and replace plantings if they do not survive. These impacts will likely increase maintenance and operational costs. Species that are more tolerant to dry conditions—including hawthorn, swamp white oak, Kentucky coffee tree, and eastern red cedar—may fare better [10].

Plants and trees are more susceptible to disease and insects—such as oak wilt and the non-native, invasive Emerald Ash Borer—as a result of warming temperatures and drought, which stress them [11]. Thousand cankers disease, which is lethal to black walnut trees, is also of concern for potentially causing economic losses, but it has not yet been observed in Missouri [12]. Oak wilt is a lethal fungal disease that especially



Invasive species that have been observed in Columbia's parks and public right-of-ways are listed below.

- | | |
|--|--|
| <p>Species of significant concern:</p> <ul style="list-style-type: none"> • Bush honeysuckles • Callery or Bradford pear • Common and cut-leaved teasel • Japanese honeysuckle • Japanese hops • Japanese knotweed • Johnson grass • Reed canary grass • Sericea lespedeza • Wintercreeper | <p>Other species:</p> <ul style="list-style-type: none"> • Autumn olive • Black locust • Burning bush • Crown vetch • Multiflora rose • Musk thistle |
|--|--|

affects red oak species and has been observed in Boone County in recent years [11].

While Emerald Ash Borer has not yet been observed in Columbia, infestations have been confirmed in counties just to the south of Boone County, making it likely that Emerald Ash Borer will spread to Columbia in the coming years [13]. In a warming climate, fewer instances of extremely low temperatures will likely allow Emerald Ash Borer populations to grow and spread. On the other hand, with more extreme weather, this insect may be less able to withstand cold snaps when they do occur [14]. In addition, once average highs exceed the current range that Emerald Ash Borer populations require to survive, these warm temperatures may limit their spread and survival [15]. In 2014, the City of Columbia leveraged a Tree Resource Improvement and Maintenance (TRIM) grant from the Missouri Department of Conservation to inventory ash trees in public spaces and develop an Emerald Ash Borer management plan in preparation for a potential infestation [16]. In addition, the City Parks Department is updating its inventory of ash trees in city parks. The statewide Emerald Ash Borer Action Plan represents another source of support to aid Columbia in preventing and preparing for Emerald Ash Borer [17].

Meanwhile, increased stress and potential loss of vegetation creates more opportunities for non-native and invasive plants to become established, and invasive plants may be able to adapt to new conditions faster than native plants can [18]. Even though native plants and ecosystems have adapted to changing climates in the past, the rate at which the climate is currently changing is projected to be faster than the historical rate at which these plants can adapt. The habitat quality of Columbia's natural areas, riparian corridors, and right-of-ways has already been compromised by invasive vegetation and has hindered the City's ability to manage these areas; climate change impacts will likely exacerbate these issues. These areas will require active management to build more biodiverse and resilient vegetation and wildlife communities that are able to withstand climate change impacts and outcompete invasive species.

Climate change also presents some opportunities, such as a longer planting window and a longer growing season, but more extreme conditions may counteract these possible benefits.



Community action to remove invasive bush honeysuckle

In 2016, members of the East Campus Neighborhood Association came together to remove invasive bush honeysuckle from their neighborhood. Bush honeysuckle interrupts the function of our natural ecosystems by outcompeting native vegetation, reducing biodiversity, and preventing forest regeneration. These impacts are exaggerated by climate change and will likely result in a less resilient community.

The group of thirty neighbors worked together to remove as much bush honeysuckle from their yards as possible. The only existing bush honeysuckle in the neighborhood was found along steep hillsides. The neighborhood partnered with the Missouri Department of Conservation on a wildlife diversity grant that awarded \$11,000 to hire a forestry consultant to remove and treat the remaining bush honeysuckle. This type of partnership with the conservation department is unprecedented and exemplifies Columbians' enthusiasm for being good stewards of our land, water, and wildlife resources.



Agriculture

On the 1,171 farms in Boone County in 2012, farmers most commonly grew soybeans, hay and other forage, corn, and winter wheat, and raised cattle and pigs, among other livestock [19]. The average farm had \$44,564 in sales that year [19]. In total, agriculture, forestry, and related industries contributed \$1 billion in sales to Boone County's economy in 2016 and represented over 6% of jobs [20].

As the climate changes, temperatures will increase in Columbia and change frost timing. It is projected that the last spring frost will happen one week earlier by 2050 than it does today, and the first fall frost will be slightly later [8]. Under these conditions, the timing of the growing season may shift and hardiness zones will continue to change. Farmers may have to adjust planting schedules and change or diversify crop types to adapt to these changes.

Warmer temperatures, especially during the summer, will likely place more stress on livestock and crops. Cows, for instance, tend to eat less food and grow more slowly in hotter conditions, and corn yields are projected to decrease with warmer summers [21]. Although longer growing seasons, combined with more carbon dioxide in the atmosphere—which acts as a fertilizer for plants—could increase yields of some crops, long-term agricultural productivity is expected to decline as the cumulative negative impacts of climate change offset these short-term benefits [22].

Ozone smog may increase with warmer air temperatures, and high ozone levels can slow plant growth and reduce yields of soybean and winter wheat. In some areas of Missouri, ozone levels have been high enough to potentially reduce crop yields [21]. High ozone levels can also harm lung and heart health. In Boone County, there were 13 days between 2012 and 2014 when air quality was considered unhealthy for sensitive

populations such as older adults, children, and people with respiratory disease [23]. Farmworkers may be more exposed to ozone smog because of the time spent outdoors.

Increasing summer drought could stress crops and lower the quality and quantity of yields. Farms growing corn may be more vulnerable to drought than soybean and wheat farms, but using drought-tolerant varieties can increase resilience to these conditions [24]. Drier conditions in the summer are expected to reduce soil moisture, which could lower agricultural productivity and increase the demand for irrigation [25]. The availability of water resources for irrigation may become a concern in the future as Columbia's population grows, especially if there are periods of prolonged drought.

Spring and fall precipitation is projected to increase in Columbia [8]. For agriculture, heavier rains during the spring can disrupt planting schedules, make it difficult for crops to become



established, and make diseases from fungus or bacteria more likely to occur. Addressing these impacts may require more labor and increase costs to farms.

All of these impacts from climate change can place more stress on crops, making them **more susceptible to pests and diseases**. Recent testing submissions to the University of Missouri's Plant Diagnostic Clinic suggest that corn, soybean, and wheat are all susceptible to disease, but disease prevalence may fluctuate from year to year and throughout a single growing season as environmental conditions change [26]. The Japanese beetle is one pest of concern. Even the potential benefit of larger yields from higher levels of carbon dioxide may be offset, as these conditions can lower plants' defenses against Japanese beetle and other insects, ultimately causing more damage than under current climate conditions [27]. Meanwhile, warmer temperatures and increased carbon dioxide may cause insect populations to grow and new types of pests to become

problematic. Japanese beetles in particular may be more likely to survive and cause more damage to soybean yields as the optimal time period for feeding on leaves is projected to increase nearly threefold by 2050 [28].

Growers will likely need to plant drought- and pest-resistant crop varieties, implement water conservation measures, use more efficient irrigation strategies, or take other actions to adapt to future conditions. Those with limited resources may need financial assistance to continue their agricultural livelihoods. As climate change impacts may reduce crop yields, farmers in Columbia may face economic challenges. In addition, food production in Missouri, across the U.S., and beyond may decrease, leading to increases in food costs for the Columbia community.

Urban agriculture

In a city like Columbia, the abundance of people and access to irrigation create an opportunity for fruit and vegetable production. Small acreages managed with intensive practices can yield an extremely high volume (and value) of agricultural products [29]. The potential for well-organized agricultural practices to produce a significant amount of a city and a region's food supply has proven by "The Intervale," a 350-acre farm in Vermont that has helped to build a wide network of growers, distributors, and eaters in that region. Many labor-intensive crops are particularly well-suited for an urban production setting.

Backyard gardens and community gardens provide a distributed production model that engages a lot of people. The benefits include not only the direct yields from the gardens, but also a range of secondary benefits such as outdoor education, beginning farmer training, community safety via passive neighborhood watch, pollinator biodiversity, soil health/water holding capacity, and much more. Collaboration on urban gardens can build social cohesion, which enhances community resilience to climate change and other stressors.

The Columbia Center for Urban Agriculture, Community Garden Coalition, Grow Well Missouri, Columbia Farmers Market, and others are working on many urban agriculture and farmer projects like those mentioned above. One specific example is the Agriculture Park; phase one construction is scheduled for 2018. This project has the potential to bring together many of the stakeholders in the farming, food service, education, health care, and civic sectors.

Urban gardens will need to be ready for the climate change impacts that will face all local agriculture, and look for ways to use water efficiently, but they can also enhance food security and contribute to climate resilience in other ways.





Native roadside vegetation

The Public Works Department has partnered with the Sustainability Office to begin converting non-native right-of-way vegetation to native plants. These sites consist of green space in roundabouts, medians, and along our roads. Native habitat patches, oftentimes consisting of glade- or prairie-adapted wildflowers and grasses, typically require mowing only once per year once established, while non-native vegetation needs regular mowing, weed-eating, and blowing. Less maintenance with motorized equipment reduces the carbon emissions generated from these activities. Vegetation along roundabouts and along our roads also helps to manage stormwater, which will be important as heavy rain events happen more often.

Thus far, Public Works has converted several sites to native vegetation and is measuring the effectiveness of this strategy to conserve resources and provide habitat, with the technical and logistical assistance of the Sustainability Office. Public Works has also hired staff to map and assess all other public right-of-way property to determine the number of acres suitable for conversion. In conjunction with this effort, Public Works staff are developing an integrated vegetation management plan (IVMP) that will guide Public Works to manage noxious weeds and invasive vegetation in these areas as well as to support biodiverse habitat patches to benefit wildlife, such as monarch butterfly and native bee populations that have faced severe declines in recent years.

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WATER SUPPLY AND QUALITY

As the climate continues to change, in the next 30 years Columbia communities are likely to face vulnerabilities related to...

Drinking water supply and drought



LOW-MEDIUM

While warming temperatures, increasing drought, and other changes in precipitation may limit water resources and increase demand, Columbia's water supply is likely sufficient to meet demands even under future conditions, though investments may be needed to expand water infrastructure.

Surface water quality



LOW-MEDIUM

More heavy rain events will likely negatively impact water quality in Columbia's streams and lakes, which could harm habitats and limit recreational opportunities. However, Columbia's drinking water supply is largely protected from stormwater pollution due to the local groundwater hydrology.

Vulnerability Ranking

LOW

LOW-MEDIUM

MEDIUM

MEDIUM-HIGH

HIGH

Drinking water quality



LOW

Since Columbia's drinking water source is well-protected from stormwater pollution, it is unlikely to be harmed by more heavy rain events in the future. While the city's drinking water currently exceeds quality standards, some activities unrelated to climate change may pose a degree of contamination risk.



Drinking water supply and drought

Columbia residents use approximately 5 billion gallons of drinking water each year. Since the early 1970s, the city's total daily demand for water, on average, has gradually increased by about 7 million gallons partly due to more customers as the city's population has grown [1]. However, the increase in demand has been contained thanks to water conservation efforts, as the average Columbia resident now uses less water per day than in the past [1].

Columbia draws its water supply for residential, commercial, and irrigation uses entirely from the McBaine aquifer—a portion of the Missouri River alluvial aquifer that is located in an area protected by a levee system managed by the McBaine Levee District. Columbia's annual use is about one-tenth of the 44 billion gallons of water stored in the McBaine aquifer [2]. Columbia pumps its

water from the aquifer through 15 wells dispersed across an area known as the McBaine Bottoms and treats the water before delivering it to residents [2]. But the geology of the aquifer makes some of the water inaccessible—meaning there is a natural limit to drinking water supply from the aquifer. In addition, as we withdraw water from the McBaine aquifer, it has to be regularly re-charged or replaced by precipitation, the Missouri River, and other surface waters [3].

The Missouri River and its floodplain also provide water for over half of Missouri residents, not to mention the residents in the nine other states that are partially or fully located in the Missouri River watershed [4]. Withdrawing water from the river for different needs—from residential drinking water to agricultural irrigation—must be balanced with keeping water in the river for downstream communities, groundwater recharge, and other natural ecosystem functions.

Although Columbia considers its current supply reliable and the City has a backup storage of water for emergencies, Columbia's water demand is projected to grow in the future [5]. By 2040, peak daily water demand is expected to be nearly twice as much as the demand in 2016 [1]. Climate change will also bring new risks. For example:

- **Increasing drought:** In the future, as summer drought becomes more common across Missouri and the Midwest, water management in the Missouri River watershed will become more challenging [6]. Under drier conditions, there may be less water available in reservoirs along the Missouri River and its tributaries, which are important to managing streamflow and contribute to recharging of the McBaine aquifer [4]. The change in precipitation patterns may also reduce aquifer recharge. The result may be limitations on Columbia's water supply, meaning less water may be available for the community's irrigation needs in the summer.
- **Warmer temperatures:** By the 2050s, average temperatures in Columbia will be regularly above what has been considered normal since 1970 [7]. Warmer temperatures will increase evaporation of surface water, reduce soil moisture, and increase demand for irrigation.
- **Heavier rain events:** Projections of future precipitation show that we can expect more frequent heavy rain events [7]. These events may pose a higher risk of flooding, which can damage water infrastructure and disrupt the delivery of drinking water to residents. Although the City's water production plant and wells are protected by levees that are actively managed and have already undergone upgrades to protect against flooding, they are still vulnerable to extreme flooding events like those that occurred in 1993. In addition, flooding can damage or inundate roads, limiting access to these facilities.

As water demand increases and climate change impacts may place more stress on infrastructure and facilities, it is important for regular maintenance and improvements to be completed to maximize efficiency and supply. To this end, the City assessed the condition of infrastructure at the McBaine Water Treatment Plant, well field, and the West Ash Booster Pump Station in 2016 and incorporated the needed equipment replacements and upgrades identified in the assessment into the water utility's capital improvement plan.

Three types of customers in Columbia have the greatest water needs and may be negatively impacted by water supply constraints: 1) industrial customers, such as Columbia Foods, 3M, and Linen King; 2) hospitals and healthcare facilities, including Boone Hospital and the Veterans Administration Hospital; and 3) educational facilities, including Columbia Public Schools and The University of Missouri.





Surface water quality

Columbia's nearby surface water bodies include over 100 lakes and approximately 300 miles of streams, including its six major streams: Hinkson Creek, Hominy Branch, Grindstone Creek, Gans Creek, Little Bonne Femme, and Flat Branch [8].

When precipitation does not soak into the ground, it runs off as stormwater into Columbia's storm drain pipes and is discharged into the nearest waterway, such as Hinkson Creek, Flat Branch Creek, or Bear Creek—all of which eventually flow into the Missouri River. This stormwater is not treated, meaning that any oil, grease, pet waste, chemicals, fertilizers, and other pollutants on roads, sidewalks, lawns, and the urban landscape can potentially contaminate our waterways, decreasing surface water quality. Some of the streams running through Columbia, including Hinkson Creek, Hominy Branch, and Gans Creek, as well as some lakes have been designated as impaired waterways by the U.S. Environmental Protection Agency due to water quality concerns [8]. Restoring these waterways to a better condition is essential to supporting vibrant, healthy ecosystems as well as healthy human populations. To reduce pollution from stormwater runoff and protect surface water quality, the City of Columbia, Boone County, and the University of Missouri work together to develop, implement, and enforce a stormwater management program and plan.

As the climate changes, more heavy rain events in Columbia may increase the risk of pollution from stormwater runoff, which is expected to wash more nitrogen and phosphorus from agriculture

and other activities into nearby streams and lakes, contributing to more algal growth that can be toxic [9]. Heavier rain may cause flooding, which can also increase the risk of surface water pollution by causing overflows at waste treatment plants. These impacts could potentially expose more people to contaminated water in their recreational use of streams and lakes. Exposure to contaminated water may lead to increased incidents of water-borne diseases.

Heavier rain events may also destabilize and erode stream banks, especially if there is little vegetation to hold the soil in place. Erosion causes sediment to enter streams, reducing surface water quality and harming habitats.



Drinking water quality

Columbia's drinking water supply is largely protected from stormwater pollution due to the groundwater hydrology of the McBaine Aquifer, which collects water from precipitation that has been naturally filtered through the Earth's surface. The current quality of Columbia's drinking water exceeds the federal standards for lead, copper, fluoride, and other regulated substances [10]. However, several activities and infrastructure unrelated to climate change pose a contamination risk, including tampering with wells, seepage from the city's wastewater treatment discharge wetlands, petroleum pipelines running through the well field, and land use activity [11].





Photo credit: Boone County

City spotlight: Hinkson Creek

Hinkson Creek flows through Columbia. It has experienced water quality problems like those in other urban area streams; these include contamination from urban stormwater flows and siltation from nearby construction sites [12]. In some places, particularly in the upper watershed, its banks have been scoured by high-velocity flows after heavy rains, which is expected to occur more often as the climate changes [13].

The University of Missouri has hosted a monitoring project on the creek. Climate stations, stream gauges, and sediment samplers were put on five bridges [12]. This project was aimed at helping to understand how Hinkson Creek responds to precipitation events. This kind of information will be useful for better understanding how the creek and surrounding areas will be impacted by climate change in addition to land use change.

Today, an effort is underway to improve water quality in Hinkson Creek by using a science-based approach guided by a local stakeholder committee. It assesses the entire stream system, including the creek and other parts of the watershed. Improving the ecosystem should help support the return of the biological community to a fully functioning level as well as address other pollutants that may be contributing to water

quality issues. A Collaborative Adaptive Management (CAM) approach is being used to allow a wide range of actions to be investigated. Each of these actions is expected to contribute to reaching the water quality goals; some of these activities may reduce peak stormwater runoff, others may reduce the pollution in the runoff; both can contribute to the solution by improving the water quality and supporting the biological community. By learning as we implement actions, we hope to find the most effective approaches to address the water quality challenges in the watershed.

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