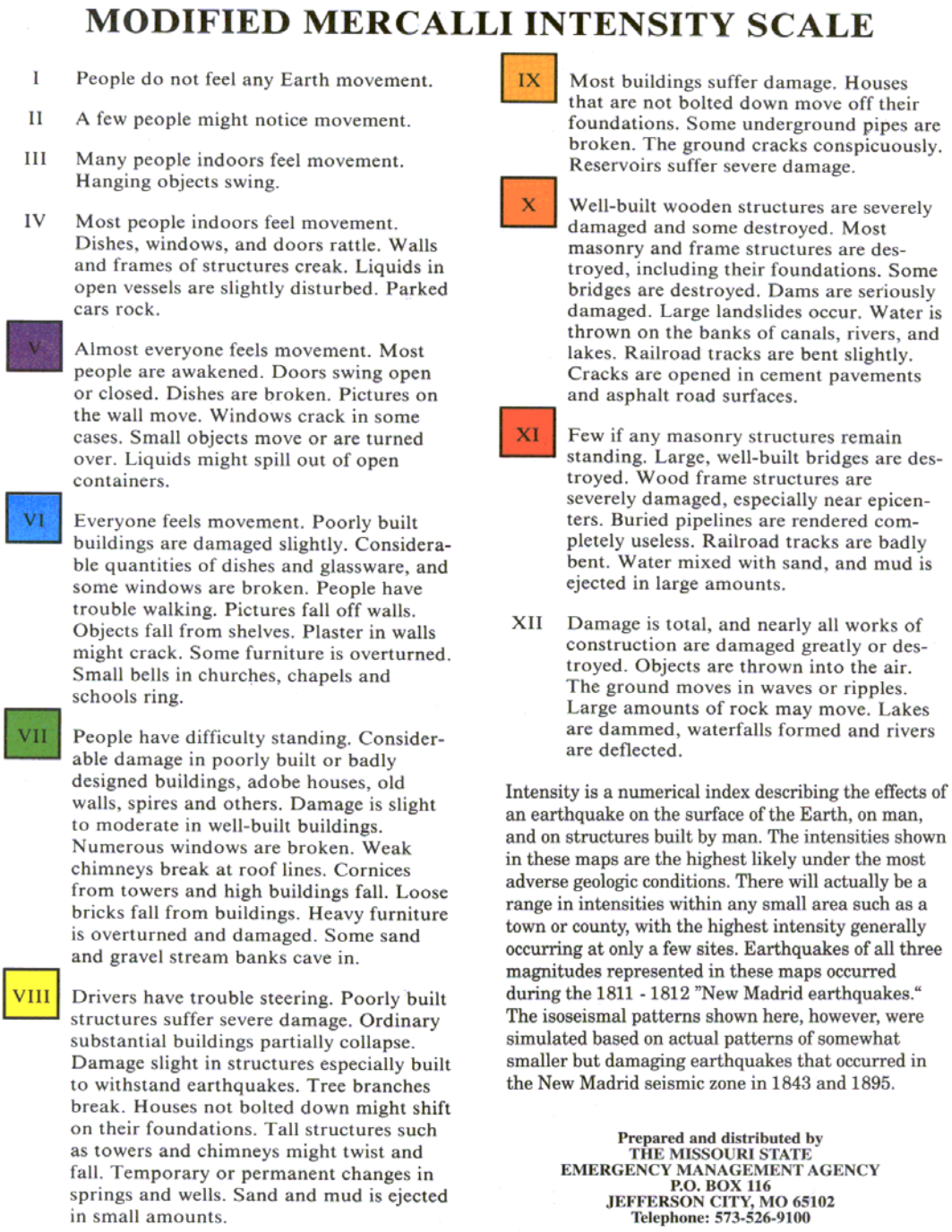
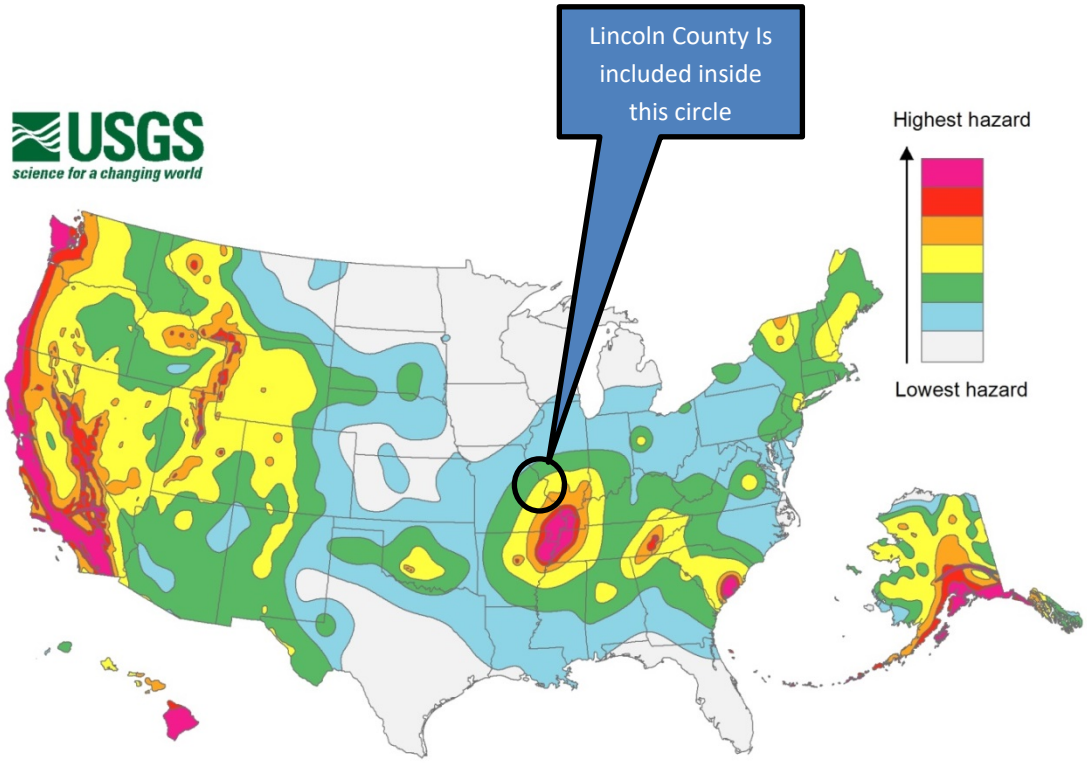
Figure 3.7. Modified Mercalli Intensity Scale



The figure below illustrates seismicity in the United States. The Lincoln County planning area is enclosed in the lower right-hand side of the circle annotated below. As shown by the previous figure, the green area represents category VII on the Modified Mercalli Intensity Scale which encompasses all of Lincoln County.

Figure 3.8. United States Seismic Hazard Map



Source: United States Geological Survey at http://earthquake.usgs.gov/hazards/products/conterminous/2014/HazardMap2014_lg.jpg

Previous Occurrences

Two earthquake zones -- the New Madrid Seismic Zone and the South Central Illinois Seismic Zone -- could affect Lincoln County because of their close proximity and underlying geological strata. Of these, the New Madrid poses the greatest threat. During the winter of 1811-1812 three earthquakes estimated to have been magnitude 7.5 or greater were centered in the New Madrid fault in southeast Missouri. Thousands of aftershocks continued for years.

Significant earthquakes, each about magnitude 6, occurred in 1843 near Marked Tree, Arkansas, and on October 31, 1895 near Charleston, Missouri. In November 1968 a magnitude 5.5 earthquake centered in southeastern Illinois caused moderate damage to chimneys and walls at Hermann, St. Charles, St. Louis, and Sikeston, Missouri. The felt areas include all or portions of 23 states. Other earthquakes have occurred throughout southeastern parts of Missouri. Smaller, but still destructive, earthquakes are even more likely, according to the Missouri Seismic Safety Commission.

According to Homefacts.com there has been just one earthquake registered within 30 miles of Troy since 1931 when recordkeeping began.

Probability of Future Occurrence

There have been no earthquakes recorded in Lincoln County for 85 years thereby the probability of an earthquake occurring in Lincoln County as zero in any given year. Homefacts.com calculates the probability of a magnitude 5.0 or greater earthquake within the next 50 years at .74%

Impact of Future Development

Future development is not likely to increase the risk of earthquakes but it will contribute to additional exposure in the event of an earthquake.

Vulnerability

Potential Losses to Existing Development

The following earthquake loss data for Lincoln County was taken from the 2013 Missouri State Hazard Mitigation Plan. The first table shows loss for the entire county and the subsequent table reflects the effects of an earthquake that affects just 2% of the county.

Table 3.20. Earthquake Loss Summary for All Areas of Lincoln County Affected

Building Loss	$ 333,000
Income Loss	$ 79,000
Total Economic Loss to Buildings	$ 412,000

Source: 2013 Missouri State Hazard Mitigation Plan

Table 3.21. Earthquake Loss Summary for 2% of Areas of Lincoln County Affected

Structural Damage	$ 44,630
Non-Structural Damage	$ 132,924
Contents Damage and Inventory Loss	$ 45,359
Income Loss	$ 50,319
Total Economic Loss to Buildings	$ 273,227

Source: 2013 Missouri State Hazard Mitigation Plan

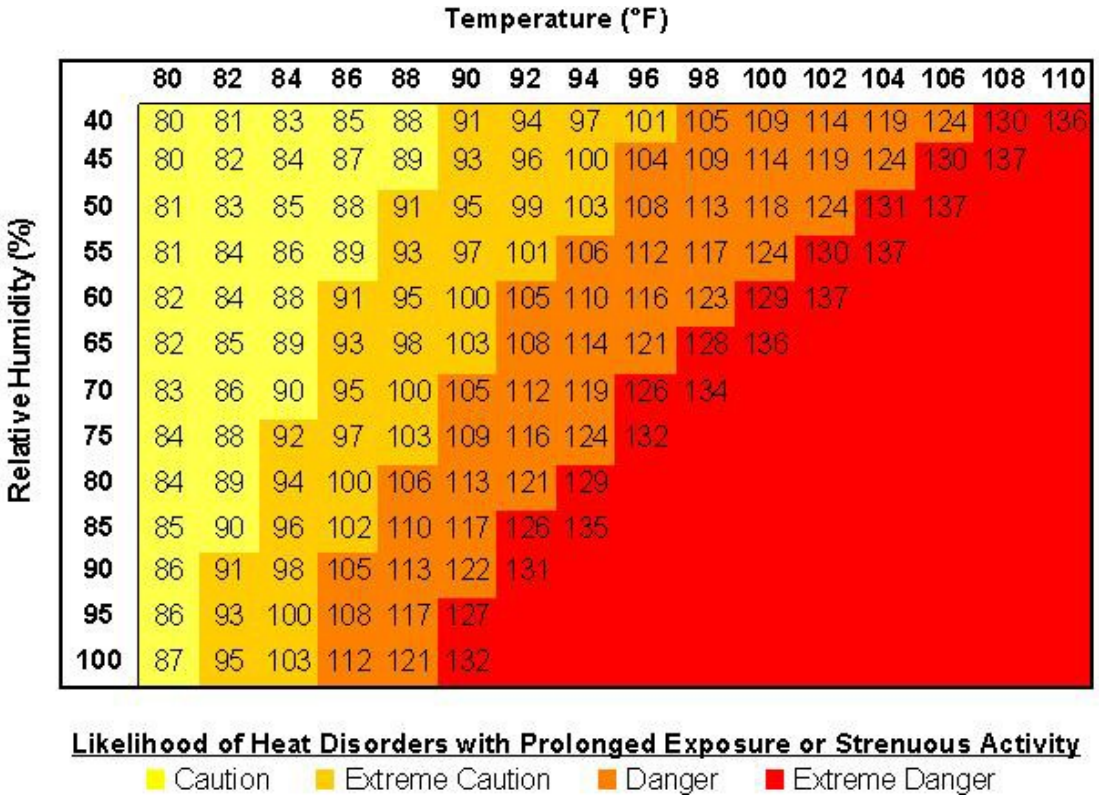
3.4.4 Extreme Heat

Hazard Profile

Extreme temperature events, both hot and cold, can impact human health and mortality, natural ecosystems, agriculture and other economic sectors. This section profiles extreme heat. Extreme cold events are profiled later in this section. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature.

In addition, the NWS recently 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. Figure below shows the NWS Heat index scale. To find the Heat Index from the table, see the relative humidity along the left side of the table and the air temperature along the top. Where the two intersect is the Heat Index for any given time of day. The Heat Index Chart shown below uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 3.9. Heat Index (HI) Chart



Source: National Weather Service (NWS)

Note: Exposure to direct sun can increase Heat Index values by as much as15°F. The shaded zone above 105°F corresponds to a Heat Index that may cause increasingly severe heat disorders with continued exposure and / or physical activity.

Geographic Location

Extreme heat is an area-wide hazard event and the risk of extreme heat does not vary across the planning area.

Severity/Magnitude/Extent

Extreme heat can cause stress to crops and animals. In addition, extreme heat can strain electricity delivery infrastructure during peak use of air conditioning. Another type of infrastructure damage from extreme heat is road damage. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

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

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

Table 3.22. 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:NationalWeatherServiceHeatIndexProgram,www.weather.gov/os/heat/index.shtml

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

Previous Occurrences

The following table is a summary of extreme heat events listed for Lincoln County and taken from the National Climatic Data Center (NCDC) database for events back to August 5, 2007. Extreme heat

events listed prior to August 2007 were taken from the Lincoln County 2012 HMP. The early data appears to cover the entire St. Louis region, whereas the new data appears to be just for Lincoln County. This is apparent as the new data shows just 1 death and 23 injuries due to heat, whereas the older data records many more fatalities and injuries. Regardless, there were 32 heat events recorded in Lincoln County during the past 22 years resulting in at least 1 death in the county and at least 23 injuries. Limitations are due to how the data is collected and aggregated and are complicated by Lincoln County's inclusion in the St. Louis Metropolitan Statistical Index. State data is included below the chart for a more generalized look at the effects of extreme heat.

Table 3.23. Heat Wave Summary Across Lincoln County (June 1994 – April 2016)

Date	Heat Index	Deaths	Injuries	Property Damage
6/12/1994	100+	4	55	$ -
7/17/1995	120	20	225	$75,000
7/28/1995	NA	0	120	$15,000
8/1/1995	110-120	9	230	$ -
7/18/1998	110	0	1	$ -
7/31/1999	105-115	0	3	$ -
8/28/2000	105-110	0	7	$ -
9/1/2000	105-110	0	3	$ -
7/7/2001	105-110	0	0	$ -
7/17/2001	110-115	0	0	$ -
7/29/2001	110-115	0	0	$ -
8/1/2001	105	0	0	$ -
7/29/2001	105-110	0	4	$ -
8/1/2001	105	0	0	$ -
8/7/2001	102-110	0	0	$ -
8/21/2001	105-110	0	4	$ -
7/8/2002	105-110	0	0	$ -
7/20/2002	105-115	0	0	$ -
7/26/2002	105-115	0	1	$ -
8/1/2002	N/A	0	1	$ -

Date	Heat Index	Deaths	Injuries	Property Damage
7/1/2003	N/A	0	0	$ -
8/15/2003	105	0	0	$ -
8/24/2003	105-110	0	0	$ -
7/20/2005	105-120	1	0	$ -
7/17/2006	105-110	0	0	$ -
7/29/2006	105-110	0	0	$ -
8/1/2006	NA	0	0	$ -
7/1/2011	105	0	0	$ -
7/10/2011	105-110	0	0	$ -
8/6/2011	105-107	0	0	$ -
8/31/2011	105	0	0	$ -
9/1/2011	105	0	0	$ -

Source: National Climatic Data Center

According to the 2013 State HMP, DHSS initiated statewide hyperthermia death surveillance in 1980 in response to a summer heat wave that resulted in the death of 295 individuals. The program defines hyperthermia as physician-diagnosed heat exhaustion, heat stroke, or hot weather/natural environment as a contributing factor in a death. In 2005 and 2006, 25 Missourians died each year from heat-related illnesses. Missouri's heat-related deaths are primarily in the urban, more densely populated areas of St. Louis City, St. Louis County, and Jackson County (Kansas City) (Missouri DHSS, 2013). There was one death in Lincoln County in 2005.

In August 2007, Missouri experienced a heat wave that lasted approximately 21 days and resulted in 34 hyperthermia deaths. The heat wave started August 2 with a heat index of 101 in Cape Girardeau and spread across the State. By August 7, the five cities that DHSS receives daily heat data on from the National Weather Service were experiencing heat indices of 103 or higher. The heat index remained in the upper 90s or higher in at least one of the five areas until August 25.

Public and private emergency response plans were implemented across the State. These responses included opening cooling centers, distributing ice, water, and people checking door-to-door for persons in danger from the heat. Without this quick and intensive response, public health officials believe mortality from the August 2007 heat wave would have been much greater. Fortunately, hot weather during the summer of 2008 was much more sporadic and less prolonged, resulting in 10 deaths statewide.

In 2012, an intense heat wave plagued the Midwest, setting record maximum temperatures in both St. Louis and Columbia in Missouri. The heat wave began at the end of June and extended past the July 4th holiday, occurring during a drought that ranged in severity from moderate to severe. In the St. Louis metropolitan area, 18 heat-related deaths occurred in total (NWS, 2012).

According to the USDA Risk Management Agency, insured crop losses throughout the State of Missouri as a result of excessive heat for the eleven year period of 1998 – 2008 totaled $13,751,457. Excessive heat ranked 6th in the State for insured crop losses. From 2000 to 2010, drought and heat were the source of about 31% of the crop losses in Missouri by indemnity payments (Milhollin, 2012). Also, hot winds in Missouri totaled $885,893 in insured crop losses from the same timeframe.

Probability of Future Occurrence

Regardless of data limitations regarding loss of life, injury, and property loss; the number of heat related events is accurate with 32 events spanning 22 years. Extrapolating this data shows an average of 1.5 heat events per year.

Vulnerability

Potential Losses to Existing Development

As Lincoln County becomes more urban and agricultural related activities diminish the effects of extreme heat reduces for crops and livestock while it increases for personnel.

Impact of Future Development

Population growth can result in increases in the age-groups that are most vulnerable to extreme heat. Population growth also increases the strain on electricity infrastructure and water sources, as more electricity and water are needed to accommodate the growing population.

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

Table 3.24. County Population Under Age 5 and Over Age 65, 2010 Census Data

Jurisdiction	% Under Age 5	Population 5 and Under	% 65 and Older	Population 65 and Older
Lincoln County	6.8%	3,643	11.6%	6,203
Chain of Rocks	9.4%	12	4.7%	6
Elsberry	6.3%	116	19.4%	358

Jurisdiction	% Under Age 5	Population 5 and Under	% 65 and Older	Population 65 and Older
Foley	1.9%	2	9.3%	10
Fountain N Lakes	9.9%	30	9.3%	28
Hawk Point	12.6%	92	8.2%	60
Moscow Mills	12.8%	320	6.4%	160
Old Monroe	5.6%	15	9.7%	26
Silex	1.2%	1	19.0%	16
Troy	9.0%	986	12.3%	1,360
Truxton	2.9%	2	8.8%	6
Winfield	7.1%	122	10.0%	172
Whiteside	0.0%	-	29.3%	22

Source: U.S. Census Bureau,(*) includes entire population of each city or county

Problem Statement

All areas of Lincoln County are at equal risk to the hazards of extreme heat; however, those areas with larger numbers of elderly among the population may be more vulnerable. Nursing homes are scattered throughout Lincoln County and there are various retirement communities as well with residents over the age of 65.

3.4.5 Flooding

Hazard Profile

Hazard Description

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

Flooding caused by dam failure is discussed in a previous section and will not be addressed here.

A flash flood occurs when water levels rise at an extremely fast rate as a result of intense rain fall over a brief period, sometimes combined with rapid snow melt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Flash flooding can happen in Special Flood Hazard Areas

(SFHAs) as delineated by the National Flood Insurance Program (NFIP), and can also happen in areas not associated with floodplains.

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

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

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

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

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed characteristics, modeling techniques, monitoring, and advanced warning systems has increased the warning time for flash floods.

Geographic Location

Flash flooding can occur in any low lying area of Lincoln County which is adjacent to rivers and creeks during periods of heavy rain when ground is saturated. Many rural roads within the county are dependent upon low water crossings which are not navigable during periods of high water. There are 37 low water crossings in Lincoln County any one of which can be inundated anytime three or more inches of rain falls within a short interval and ground is saturated. During times of flash flooding, these low water crossings can present a risk to life and property if an attempt to cross is made.

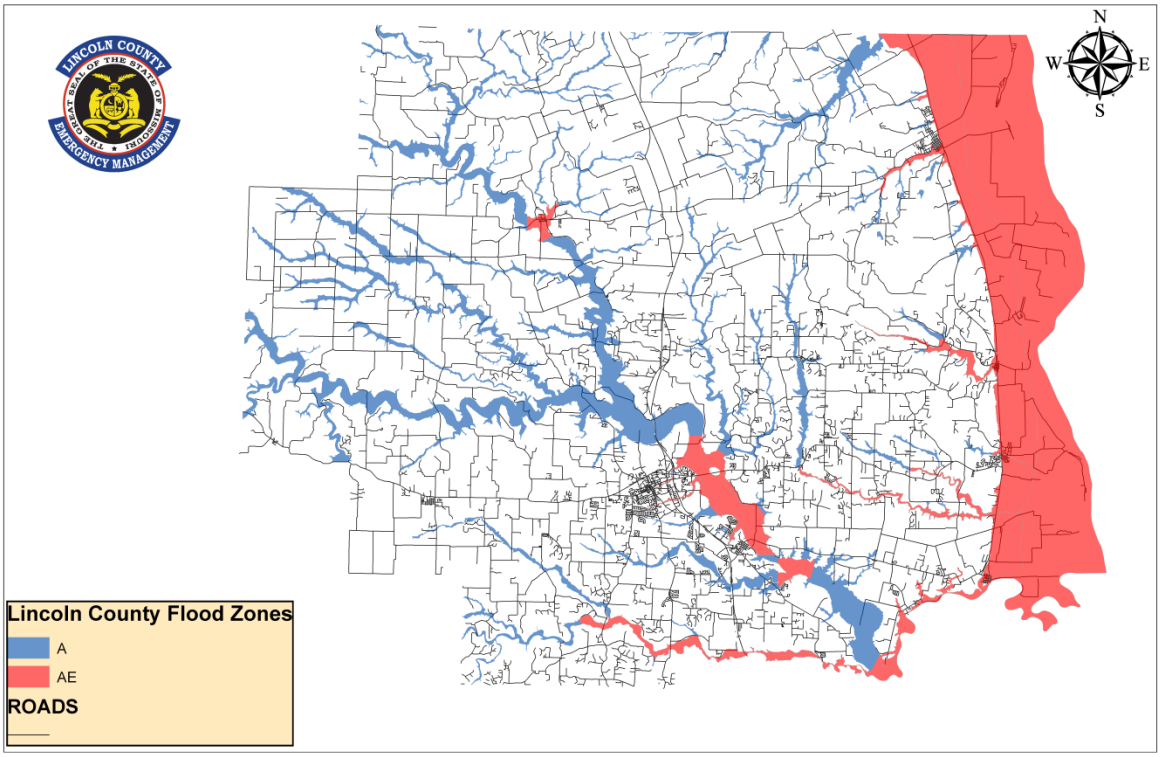
Lincoln County faces two major risk factors for flooding; the Mississippi River and Cuivre River basins. The Mississippi River basin drains the eastern third of the county. The river's floodplain, 3-4 miles wide, runs the length of the county's eastern border. The communities of Elsberry, Foley, Winfield, and Old Monroe line the edge of the floodplain along Missouri Highway 79. The Cuivre River basin drains the rest of the county.

Several individual communities are situated near streams or rivers. The Cuivre River, narrow and flashy, runs south and west of Silex and east of Moscow Mills. Both Chain of Rocks and Old Monroe lie next to the river. Town Branch and Buchanan Creek run through Troy. Bobs Creek and McLean Creek drain into the Mississippi at Winfield. Whiteside lies beside a tributary of Sandy Creek, which also runs west and north around Foley to reach the Mississippi. Lost Creek runs through southern Elsberry while the Old Kings Lake Creek runs north to south through the middle of the Mississippi floodplain.

Secondly, drainage is a major factor due to the predominately clay soils, which cover the rest of the county. With no place to go, the water will find the lowest elevations; often areas 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. Combined with flooding due to overwhelmed storm and sanitary sewers, tremendous flows of water often accompany storm events in these developed areas. Typically, the water backs into basements, damages mechanical systems and can create serious public health and safety concerns.

The figure below illustrates a 100-year flood zone map of Lincoln County. See Appendix D for alphabetized FIRM maps of each participating Lincoln County community.

Figure 3.10. Lincoln County Flood Map



According to NCDC there were 14 flood events in Lincoln County between January 1, 2000 and June 30, 2016. Flood events are typically associated with the Mississippi River. The following table shows these events.

Table 3.25. Lincoln County NCDC Flood Event Locations, January 2000 – June 2016

Date	Type	Location	Deaths	Injury	Property Damage	Crop Damage
6/20/2000	Flood	All Lincoln County	0	0	$ -	$ -
4/16/2001	Flood	All Lincoln County	0	0	$ -	$ -
5/01/2001	Flood	All Lincoln County	0	0	$ -	$ -
4/28/2002	Flood	All Lincoln County	0	0	$ -	$ -
5/1/2002	Flood	All Lincoln County	0	0	$ -	$ -
5/6/2002	Flood	All Lincoln County	0	0	$ -	$ -
8/27/2007	Flood	Winfield	0	0	$ -	$ -
6/4/2008	Flood	Dameron	0	0	$ 1,600,000	$ -
7/16/2008	Flood	Elsberry	0	0	$ -	$ -
6/14/2010	Flood	Dameron	0	0	$ -	$ -
4/16/2013	Flood	Dameron	0	0	$50,000	$15,000
6/1/2013	Flood	Dameron	0	0	$3,000	$ -
12/27/2015	Flood	Truxton	0	0	$240,000	$ -
1/1/2016	Flood	Truxton	0	0	$ -	$ -

Source: National Climatic Data Center

According to NCDC there were 26 flash flood events in Lincoln County between January 1, 1994 and June 30, 2016. The following table shows these events.

Table 3.26. Lincoln County NCDC Flash Flood Event Locations, January 2000 – June 2016

Date	Type	Location	Deaths	Injury	Property Damage	Crop Damage
6/24/2000	Flash Flood	All Lincoln County	0	0	$ -	$ -
5/7/2002	Flash Flood	All Lincoln County	0	0	$ -	$ -
5/12/2002	Flash Flood	All Lincoln County	0	0	$ -	$ -
5/10/2003	Flash Flood	Southern Lincoln County	0	0	$ -	$ -
6/25/2003	Flash Flood	Eastern Lincoln County	0	0	$ -	$ -
7/18/2003	Flash Flood	All Lincoln County	0	0	$ -	$ -
6/18/2008	Flash Flood	Cap Au Gris	0	0	$ 75,000	$ -
6/19/2008	Flash Flood	Apex	0	0	$ 500,000	$ -
6/27/2008	Flash Flood	Cap Au Gris	0	0	$ 500,000	$ -
7/27/2008	Flash Flood	Troy	0	0	$ -	$ -
9/14/2008	Flash Flood	Louisville	0	0	$ -	$ -
6/10/2009	Flash Flood	Old Monroe	0	0	$ -	$ -
10/8/2009	Flash Flood	Elsberry	0	0	$ -	$ -
10/29/2009	Flash Flood	Old Monroe	0	0	$ -	$ -
7/20/2010	Flash Flood	Elsberry	0	0	$ -	$ -
8/12/2010	Flash Flood	Troy	0	0	$ -	$ -
6/26/2011	Flash Flood	Millwood	0	0	$ -	$ -
7/3/2011	Flash Flood	Troy	0	0	$ -	$ -
5/20/2013	Flash Flood	Chain of Rocks	0	0	$ -	$ -
9/2/2014	Flash Flood	Troy	0	0	$ -	$ -
10/2/2014	Flash Flood	Davis	0	0	$ -	$ -
6/18/2015	Flash Flood	Louisville	0	0	$ -	$ -
6/21/2015	Flash Flood	Elsberry	0	0	$ -	$ -

Date	Type	Location	Deaths	Injury	Property Damage	Crop Damage
6/25/2015	Flash Flood	Louisville	0	0	$ -	$ -
12/26/2015	Flash Flood	Elsberry	0	0	$ -	$ -
12/28/2015	Flash Flood	Elsberry	0	0	$ -	$ -

Source: National Climatic Data Center

Severity/Magnitude/Extent

Missouri has a long and active history of flooding over the past century, according to the 2013 State Hazard Mitigation Plan. Flooding along Missouri's major rivers generally results in slow-moving disasters. River crest levels are forecast several days in advance, allowing community's downstream sufficient time to take protective measures, such as sandbagging and evacuations. Nevertheless, floods exact a heavy toll in terms of human suffering and losses to public and private property. By contrast, flash flood events in recent years have caused a higher number of deaths and major property damage in many areas of Missouri; even though Lincoln County has not suffered any deaths during the years 2011-2012.

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

Public health concerns may result from flooding, requiring disease and injury surveillance. Community sanitation to evaluate flood-affected food supplies may also be necessary. Private water and sewage sanitation could be impacted, and vector control (for mosquitoes and other entomology concerns) may be necessary. The Lincoln County Health Department received a grant from SEMA in 2015 for vector control directly related to June 2015 flooding.

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

National Flood Insurance Program (NFIP) Participation

Lincoln County and eight of its communities participate in the National Flood Insurance Program as shown in the table below. Four communities do not participate; Fountain N' Lakes, Hawk Point, Truxton, and Whiteside. None of the aforementioned communities are actually within a floodplain, even though each has a FIRM Map representing them in Appendix D. The second table below shows the NFIP Policy and Claim Statistics for Lincoln County and its communities.

Table 3.27. NFIP Participation in Lincoln County

Community ID Number	Community Name	NFIP Participant (Y / N)	Current Effective Map Date	Regular-Emergency Program Entry Date
290750	Village of Chain of Rocks	Y	9/29/2010	8/9/2011
290209	City of Elsberry	Y	9/29/2010	5/2/1977
290210	City of Foley	Y	9/29/2010	3/1/1978
290869	Lincoln County	Y	9/29/2010	3/15/1984
290211	City of Old Monroe	Y	9/29/2010	8/15/1978
290546	City of Moscow Mills	Y	9/29/2010	6/26/2006
290212	Village of Silex	Y	9/29/2010	9/16/1982
290641	City of Troy	Y	9/29/2010	5/5/1981
290213	City of Winfield	Y	9/29/2010	11/17/1982

Source: NFIP Community Status Book, 9/26/2013;http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book;

Table 3.28. NFIP Policy and Claim Statistics as of May 31, 2016

Community	Policies in Force	Insurance in Force	Closed Losses	Total Payments
Chain of Rocks	1	$ 32,000	2	$ 94,774
Elsberry	20	$ 1,657,000	48	$ 466,253
Foley	29	$ 1,801,300	163	$ 2,415,285
Incorporated County	216	$ 26,441,300	1505	$ 23,526,988
Moscow Mills	10	$ 868,000	NA	NA
Old Monroe	55	$ 6,934,600	99	$ 993,799
Silex	8	$ 388,900	64	$ 1,584,376
Troy	17	$ 3,141,500	8	$ 113,219
Winfield	31	$ 2,740,000	145	$ 3,034,002

Source: NFIP Community Status Book, 5/31/2016; http://bsa.nfipstat.fema.gov/reports/reports.html
*Closed Losses are those flood insurance claims that resulted in payment. Loss statistics are for the period from 1/1/1978 to 3/31/2016.

Repetitive Loss/Severe Repetitive Loss Properties

Repetitive Loss Properties are those properties with at least two flood insurance payments of $5,000 or more in a 10-year period. According to the Flood Insurance Administration, jurisdictions included in the planning area have a combined total of 250 repetitive loss properties dating back through 1982.

As of February 29, 2016, all properties have been mitigated, leaving no un-mitigated repetitive loss properties. The table below is a summary of Lincoln County Repetitive Loss Properties. There are 43 Severe Repetitive Loss Properties in the planning area. There are 5 in Foley, 6 in Old Monroe, 1 in Winfield and 1 in Silex. The remaining 30 are in unincorporated portions of the county.

Table 3.29. Lincoln County Repetitive Loss Properties

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
ELSBERRY	1	Residential	2	$31,877.75	$6,503.93	$38,381.68	$19,190.84	2
ELSBERRY	1	Residential	2	$29,021.57	$3,400.00	$32,421.57	$16,210.79	2
ELSBERRY	1	Residential	3	$3,367.29	$423.50	$3,790.79	$1,263.60	3
ELSBERRY	1	Residential	9	$39,990.11	$8,691.52	$48,681.63	$5,409.07	9
ELSBERRY	1	Residential	3	$23,578.14	$12,224.58	$35,802.72	$11,934.24	3
ELSBERRY	1	Residential	5	$63,080.93	$3,674.80	$66,755.73	$13,351.15	5
ELSBERRY	1	Residential	2	$2,884.49	$247.50	$3,131.99	$1,566.00	2
ELSBERRY	1	Residential	2	$14,319.16	$5,545.72	$19,864.88	$9,932.44	2
ELSBERRY	1	Residential	4	$46,996.90	$14,266.07	$61,262.97	$15,315.74	4
ELSBERRY	1	Residential	2	$23,772.21	$8,652.40	$32,424.61	$16,212.31	2
ELSBERRY	1	Residential	7	$36,080.77	$229.00	$36,309.77	$5,187.11	7
ELSBERRY	1	Residential	3	$29,207.65	$0.00	$29,207.65	$9,735.88	3
ELSBERRY	1	Residential	2	$16,477.73	$4,798.75	$21,276.48	$10,638.24	2
ELSBERRY	1	Residential	2	$2,610.38	$1,000.00	$3,610.38	$1,805.19	2
ELSBERRY	1	Residential	3	$60,646.60	$17,126.33	$77,772.93	$25,924.31	3
ELSBERRY	1	Residential	2	$27,375.55	$2,809.84	$30,185.39	$15,092.70	2
FOLEY	1	Residential	2	$20,000.00	$22,286.60	$42,286.60	$21,143.30	2
FOLEY	1	Residential	2	$30,164.89	$5,200.00	$35,364.89	$17,682.45	2
FOLEY	1	Residential	4	$31,946.83	$15,617.98	$47,564.81	$11,891.20	4
FOLEY	1	Residential	2	$14,843.14	$3,714.70	$18,557.84	$9,278.92	2
FOLEY	1	Non-Resid	4	$79,137.50	$7,713.28	$86,850.78	$21,712.70	4
FOLEY	1	Residential	2	$22,110.12	$0.00	$22,110.12	$11,055.06	2
FOLEY	1	Residential	2	$11,809.17	$5,282.70	$17,091.87	$8,545.94	2
FOLEY	1	Residential	4	$112,629.90	$16,626.25	$129,256.15	$32,314.04	4
FOLEY	1	Residential	3	$5,547.88	$1,676.55	$7,224.43	$2,408.14	3
FOLEY	1	Residential	2	$13,260.95	$12,600.00	$25,860.95	$12,930.48	2
FOLEY	1	Non-Resid	2	$16,104.57	$2,100.00	$18,204.57	$9,102.29	2
FOLEY	1	Residential	2	$4,238.88	$0.00	$4,238.88	$2,119.44	2
FOLEY	1	Non-Resid	4	$36,201.33	$26,038.64	$62,239.97	$15,559.99	4
FOLEY	1	Non-Resid	2	$7,787.66	$21,516.00	$29,303.66	$14,651.83	2
FOLEY	1	Residential	6	$47,576.22	$15,890.63	$63,466.85	$10,577.81	6
FOLEY	1	Residential	3	$26,047.06	$615.00	$26,662.06	$8,887.35	3
FOLEY	1	Residential	4	$51,625.40	$0.00	$51,625.40	$12,906.35	4

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
FOLEY	1	Residential	2	$9,921.42	$12,417.32	$22,338.74	$11,169.37	2
FOLEY	1	Residential	4	$26,557.37	$460.00	$27,017.37	$6,754.34	4
FOLEY	1	Residential	4	$17,036.38	$1,447.85	$18,484.23	$4,621.06	4
FOLEY	1	Non-Resid	2	$9,543.69	$7,479.57	$17,023.26	$8,511.63	2
FOLEY	1	Residential	2	$7,734.80	$126.78	$7,861.58	$3,930.79	2
FOLEY	1	Residential	4	$44,589.35	$7,700.87	$52,290.22	$13,072.56	4
FOLEY	1	Residential	2	$39,602.74	$0.00	$39,602.74	$19,801.37	2
FOLEY	1	Residential	2	$6,653.43	$9,800.00	$16,453.43	$8,226.72	2
LINCOLN COUNTY	1	Residential	2	$17,800.74	$0.00	$17,800.74	$8,900.37	2
LINCOLN COUNTY	1	Residential	2	$17,605.90	$4,000.00	$21,605.90	$10,802.95	2
LINCOLN COUNTY	1	Residential	4	$71,644.90	$14,924.30	$86,569.20	$21,642.30	4
LINCOLN COUNTY	1	Residential	3	$22,012.41	$2,200.00	$24,212.41	$8,070.80	3
LINCOLN COUNTY	1	Residential	2	$39,287.24	$25,000.00	$64,287.24	$32,143.62	2
LINCOLN COUNTY	1	Residential	3	$26,595.66	$4,638.60	$31,234.26	$10,411.42	3
LINCOLN COUNTY	1	Residential	2	$66,183.86	$14,800.00	$80,983.86	$40,491.93	2
LINCOLN COUNTY	1	Residential	4	$22,672.45	$9,870.97	$32,543.42	$8,135.86	4
LINCOLN COUNTY	1	Residential	4	$36,394.63	$8,714.70	$45,109.33	$11,277.33	4
LINCOLN COUNTY	1	Residential	4	$70,276.47	$15,540.02	$85,816.49	$21,454.12	4
LINCOLN COUNTY	1	Residential	2	$12,930.35	$2,600.00	$15,530.35	$7,765.18	2
LINCOLN COUNTY	1	Residential	11	$85,401.23	$15,933.48	$101,334.71	$9,212.25	11
LINCOLN COUNTY	1	Residential	8	$46,216.28	$7,935.80	$54,152.08	$6,769.01	8
LINCOLN COUNTY	1	Residential	9	$79,911.22	$17,913.37	$97,824.59	$10,869.40	9
LINCOLN COUNTY	1	Residential	3	$83,066.77	$24,007.08	$107,073.85	$35,691.28	3
LINCOLN COUNTY	1	Residential	3	$25,752.03	$2,500.00	$28,252.03	$9,417.34	3
LINCOLN COUNTY	1	Residential	4	$18,309.30	$9,977.14	$28,286.44	$7,071.61	4
LINCOLN COUNTY	1	Residential	2	$27,711.52	$2,590.00	$30,301.52	$15,150.76	2
LINCOLN COUNTY	1	Residential	11	$46,620.25	$27,582.47	$74,202.72	$6,745.70	11
LINCOLN COUNTY	1	Residential	13	$262,630.76	$57,556.14	$320,186.90	$24,629.76	13
LINCOLN COUNTY	1	Residential	5	$87,015.08	$8,700.00	$95,715.08	$19,143.02	5
LINCOLN COUNTY	1	Residential	3	$25,983.94	$2,200.00	$28,183.94	$9,394.65	3
LINCOLN COUNTY	1	Residential	4	$39,010.06	$12,998.91	$52,008.97	$13,002.24	4
LINCOLN COUNTY	1	Residential	3	$38,860.15	$0.00	$38,860.15	$12,953.38	3
LINCOLN COUNTY	1	Residential	3	$36,276.22	$13,685.09	$49,961.31	$16,653.77	3
LINCOLN COUNTY	1	Residential	2	$23,279.90	$5,000.00	$28,279.90	$14,139.95	2
LINCOLN COUNTY	1	Residential	3	$24,442.45	$1,399.84	$25,842.29	$8,614.10	3
LINCOLN COUNTY	1	Residential	4	$15,143.37	$2,300.00	$17,443.37	$4,360.84	4
LINCOLN COUNTY	1	Residential	2	$13,572.93	$1,254.95	$14,827.88	$7,413.94	2
LINCOLN COUNTY	1	Residential	2	$9,677.77	$1,136.39	$10,814.16	$5,407.08	2
LINCOLN COUNTY	1	Residential	3	$48,695.34	$15,607.29	$64,302.63	$21,434.21	3
LINCOLN COUNTY	1	Residential	27	$154,360.04	$16,713.88	$171,073.92	$6,336.07	27

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
LINCOLN COUNTY	1	Residential	5	$53,834.59	$10,398.34	$64,232.93	$12,846.59	5
LINCOLN COUNTY	1	Residential	5	$53,250.78	$20,045.99	$73,296.77	$14,659.35	5
LINCOLN COUNTY	1	Residential	7	$14,143.65	$10,583.74	$24,727.39	$3,532.48	7
LINCOLN COUNTY	1	Residential	9	$48,871.98	$21,298.79	$70,170.77	$7,796.75	9
LINCOLN COUNTY	1	Residential	2	$6,757.51	$568.92	$7,326.43	$3,663.22	2
LINCOLN COUNTY	1	Residential	2	$5,611.59	$1,878.88	$7,490.47	$3,745.24	2
LINCOLN COUNTY	1	Residential	11	$86,390.45	$28,527.65	$114,918.10	$10,447.10	11
LINCOLN COUNTY	1	Residential	2	$11,532.32	$4,183.87	$15,716.19	$7,858.10	2
LINCOLN COUNTY	1	Residential	2	$17,520.82	$3,900.00	$21,420.82	$10,710.41	2
LINCOLN COUNTY	1	Residential	7	$32,203.62	$8,577.92	$40,781.54	$5,825.93	7
LINCOLN COUNTY	1	Residential	4	$165,507.58	$31,903.26	$197,410.84	$49,352.71	4
LINCOLN COUNTY	1	Residential	2	$1,315.26	$1,372.65	$2,687.91	$1,343.96	2
LINCOLN COUNTY	1	Residential	3	$44,595.79	$7,000.00	$51,595.79	$17,198.60	3
LINCOLN COUNTY	1	Residential	2	$14,781.99	$2,000.00	$16,781.99	$8,391.00	2
LINCOLN COUNTY	1	Residential	5	$42,776.52	$19,777.40	$62,553.92	$12,510.78	5
LINCOLN COUNTY	1	Residential	4	$48,363.62	$8,901.51	$57,265.13	$14,316.28	4
LINCOLN COUNTY	1	Residential	4	$11,005.43	$1,250.95	$12,256.38	$3,064.10	4
LINCOLN COUNTY	1	Residential	2	$14,237.45	$3,370.94	$17,608.39	$8,804.20	2
LINCOLN COUNTY	1	Residential	4	$9,195.31	$2,924.20	$12,119.51	$3,029.88	4
LINCOLN COUNTY	1	Residential	3	$6,282.07	$2,008.00	$8,290.07	$2,763.36	3
LINCOLN COUNTY	1	Residential	4	$37,646.06	$10,729.79	$48,375.85	$12,093.96	4
LINCOLN COUNTY	1	Residential	5	$19,402.66	$1,160.69	$20,563.35	$4,112.67	5
LINCOLN COUNTY	1	Residential	5	$57,356.69	$20,537.35	$77,894.04	$15,578.81	5
LINCOLN COUNTY	1	Residential	4	$116,146.70	$29,332.42	$145,479.12	$36,369.78	4
LINCOLN COUNTY	1	Residential	8	$64,045.58	$14,559.49	$78,605.07	$9,825.63	8
LINCOLN COUNTY	1	Residential	2	$18,525.34	$6,049.00	$24,574.34	$12,287.17	2
LINCOLN COUNTY	1	Residential	2	$25,989.99	$5,448.50	$31,438.49	$15,719.25	2
LINCOLN COUNTY	1	Residential	3	$27,537.62	$4,848.60	$32,386.22	$10,795.41	3
LINCOLN COUNTY	1	Residential	4	$5,023.01	$5,664.44	$10,687.45	$2,671.86	4
LINCOLN COUNTY	1	Residential	2	$7,476.44	$645.50	$8,121.94	$4,060.97	2
LINCOLN COUNTY	1	Residential	3	$11,926.63	$9,252.18	$21,178.81	$7,059.60	3
LINCOLN COUNTY	1	Residential	5	$26,426.17	$10,805.50	$37,231.67	$7,446.33	5
LINCOLN COUNTY	1	Residential	2	$13,514.73	$1,465.00	$14,979.73	$7,489.87	2
LINCOLN COUNTY	1	Non-Resid	2	$10,000.00	$3,176.41	$13,176.41	$6,588.21	2
LINCOLN COUNTY	1	Residential	2	$1,491.09	$3,732.28	$5,223.37	$2,611.69	2
LINCOLN COUNTY	1	Residential	2	$17,202.46	$11,584.55	$28,787.01	$14,393.51	2
LINCOLN COUNTY	1	Residential	2	$10,000.00	$211.70	$10,211.70	$5,105.85	2
LINCOLN COUNTY	1	Residential	2	$6,672.65	$350.00	$7,022.65	$3,511.33	2
LINCOLN COUNTY	1	Residential	2	$9,065.43	$718.00	$9,783.43	$4,891.72	2
LINCOLN COUNTY	1	Residential	2	$9,381.42	$9,611.89	$18,993.31	$9,496.66	2

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
LINCOLN COUNTY	1	Residential	2	$10,090.82	$8,601.21	$18,692.03	$9,346.02	2
LINCOLN COUNTY	1	Non-Resid	2	$22,743.94	$1,656.40	$24,400.34	$12,200.17	2
LINCOLN COUNTY	1	Residential	4	$29,046.53	$11,572.89	$40,619.42	$10,154.86	4
LINCOLN COUNTY	1	Residential	4	$21,898.38	$8,031.46	$29,929.84	$7,482.46	4
LINCOLN COUNTY	1	Residential	3	$44,764.44	$8,600.00	$53,364.44	$17,788.15	3
LINCOLN COUNTY	1	Residential	2	$63,346.53	$13,380.83	$76,727.36	$38,363.68	2
LINCOLN COUNTY	1	Residential	3	$9,720.23	$0.00	$9,720.23	$3,240.08	3
LINCOLN COUNTY	1	Residential	2	$47,908.44	$11,698.51	$59,606.95	$29,803.48	2
LINCOLN COUNTY	1	Residential	2	$3,094.70	$7,129.15	$10,223.85	$5,111.93	2
LINCOLN COUNTY	1	Residential	3	$40,982.05	$11,630.20	$52,612.25	$17,537.42	3
LINCOLN COUNTY	1	Residential	2	$6,541.01	$4,916.75	$11,457.76	$5,728.88	2
LINCOLN COUNTY	1	Residential	2	$48,363.15	$16,600.00	$64,963.15	$32,481.58	2
LINCOLN COUNTY	1	Residential	3	$14,555.00	$4,625.00	$19,180.00	$6,393.33	3
LINCOLN COUNTY	1	Residential	3	$23,692.57	$4,537.55	$28,230.12	$9,410.04	3
LINCOLN COUNTY	1	Residential	3	$32,441.05	$10,000.00	$42,441.05	$14,147.02	3
LINCOLN COUNTY	1	Residential	23	$87,061.90	$515.50	$87,577.40	$3,807.71	23
LINCOLN COUNTY	1	Commercial	2	$40,187.55	$4,355.00	$44,542.55	$22,271.28	2
LINCOLN COUNTY	1	Residential	2	$13,211.32	$5,600.00	$18,811.32	$9,405.66	2
LINCOLN COUNTY	1	Residential	2	$26,815.00	$10,720.00	$37,535.00	$18,767.50	2
LINCOLN COUNTY	1	Residential	5	$35,294.39	$12,376.85	$47,671.24	$9,534.25	5
LINCOLN COUNTY	1	Residential	2	$36,894.13	$11,600.00	$48,494.13	$24,247.07	2
LINCOLN COUNTY	1	Residential	2	$33,248.63	$13,766.20	$47,014.83	$23,507.42	2
LINCOLN COUNTY	1	Commercial	2	$14,787.00	$5,000.00	$19,787.00	$9,893.50	2
LINCOLN COUNTY	1	Residential	2	$21,812.50	$4,000.00	$25,812.50	$12,906.25	2
LINCOLN COUNTY	1	Residential	2	$27,721.45	$15,210.00	$42,931.45	$21,465.73	2
LINCOLN COUNTY	1	Residential	3	$101,926.20	$20,816.16	$122,742.36	$40,914.12	3
LINCOLN COUNTY	1	Residential	3	$36,552.48	$8,750.19	$45,302.67	$15,100.89	3
LINCOLN COUNTY	1	Residential	2	$3,053.81	$1,788.67	$4,842.48	$2,421.24	2
LINCOLN COUNTY	1	Residential	3	$34,654.94	$16,427.43	$51,082.37	$17,027.46	3
LINCOLN COUNTY	1	Residential	2	$10,675.98	$2,439.00	$13,114.98	$6,557.49	2
LINCOLN COUNTY	1	Residential	3	$20,439.93	$9,094.41	$29,534.34	$9,844.78	3
LINCOLN COUNTY	1	Residential	3	$73,521.07	$9,269.85	$82,790.92	$27,596.97	3
LINCOLN COUNTY	1	Residential	3	$24,429.00	$3,982.25	$28,411.25	$9,470.42	3
LINCOLN COUNTY	1	Residential	2	$8,963.35	$0.00	$8,963.35	$4,481.68	2
LINCOLN COUNTY	1	Residential	4	$192,996.28	$60,000.00	$252,996.28	$63,249.07	4
LINCOLN COUNTY	1	Residential	2	$40,455.70	$10,322.87	$50,778.57	$25,389.29	2
LINCOLN COUNTY	1	Residential	2	$58,098.98	$13,400.00	$71,498.98	$35,749.49	2
LINCOLN COUNTY	1	Residential	2	$12,900.14	$8,924.95	$21,825.09	$10,912.55	2
LINCOLN COUNTY	1	Residential	4	$70,768.49	$4,906.31	$75,674.80	$18,918.70	4
LINCOLN COUNTY	1	Residential	4	$39,056.32	$8,900.00	$47,956.32	$11,989.08	4

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
LINCOLN COUNTY	1	Residential	2	$8,812.30	$1,485.00	$10,297.30	$5,148.65	2
LINCOLN COUNTY	1	Residential	2	$14,034.40	$1,000.00	$15,034.40	$7,517.20	2
LINCOLN COUNTY	1	Residential	4	$33,673.67	$10,000.00	$43,673.67	$10,918.42	4
LINCOLN COUNTY	1	Residential	3	$28,111.84	$5,000.00	$33,111.84	$11,037.28	3
LINCOLN COUNTY	1	Residential	2	$19,457.31	$3,505.36	$22,962.67	$11,481.34	2
LINCOLN COUNTY	1	Residential	5	$176,606.21	$20,500.00	$197,106.21	$39,421.24	5
LINCOLN COUNTY	1	Residential	6	$24,326.85	$5,502.10	$29,828.95	$4,971.49	6
LINCOLN COUNTY	1	Residential	5	$52,687.74	$17,472.78	$70,160.52	$14,032.10	5
LINCOLN COUNTY	1	Residential	4	$32,522.30	$11,158.65	$43,680.95	$10,920.24	4
LINCOLN COUNTY	1	Residential	3	$9,211.29	$0.00	$9,211.29	$3,070.43	3
LINCOLN COUNTY	1	Residential	10	$28,336.19	$2,576.82	$30,913.01	$3,091.30	10
LINCOLN COUNTY	1	Residential	5	$13,023.85	$0.00	$13,023.85	$2,604.77	5
LINCOLN COUNTY	1	Residential	30	$269,141.97	$53,974.82	$323,116.79	$10,770.56	30
LINCOLN COUNTY	1	Residential	3	$9,411.85	$5,333.50	$14,745.35	$4,915.12	3
LINCOLN COUNTY	1	Residential	11	$83,515.98	$15,522.19	$99,038.17	$9,003.47	11
LINCOLN COUNTY	1	Residential	2	$41,406.40	$11,810.87	$53,217.27	$26,608.64	2
LINCOLN COUNTY	1	Residential	4	$26,349.37	$4,004.91	$30,354.28	$7,588.57	4
LINCOLN COUNTY	1	Residential	2	$24,218.10	$3,700.00	$27,918.10	$13,959.05	2
LINCOLN COUNTY	1	Residential	2	$9,753.51	$2,466.86	$12,220.37	$6,110.19	2
LINCOLN COUNTY	1	Residential	2	$26,032.01	$2,200.00	$28,232.01	$14,116.01	2
LINCOLN COUNTY	1	Residential	2	$21,452.14	$5,000.00	$26,452.14	$13,226.07	2
LINCOLN COUNTY	1	Residential	8	$79,682.35	$35,476.36	$115,158.71	$14,394.84	8
LINCOLN COUNTY	1	Residential	3	$33,856.71	$14,161.33	$48,018.04	$16,006.01	3
LINCOLN COUNTY	1	Residential	3	$131,323.96	$16,100.00	$147,423.96	$49,141.32	3
LINCOLN COUNTY	1	Residential	2	$30,028.06	$0.00	$30,028.06	$15,014.03	2
LINCOLN COUNTY	1	Residential	3	$36,824.33	$15,188.60	$52,012.93	$17,337.64	3
LINCOLN COUNTY	1	Residential	2	$25,759.34	$0.00	$25,759.34	$12,879.67	2
LINCOLN COUNTY	1	Residential	2	$24,734.82	$2,366.98	$27,101.80	$13,550.90	2
LINCOLN COUNTY	1	Residential	2	$40,906.62	$3,766.71	$44,673.33	$22,336.67	2
LINCOLN COUNTY	1	Commercial	6	$103,071.51	$143,567.21	$246,638.72	$41,106.45	6
LINCOLN COUNTY	1	Residential	3	$115,082.21	$18,166.05	$133,248.26	$44,416.09	3
LINCOLN COUNTY	1	Residential	2	$35,665.62	$0.00	$35,665.62	$17,832.81	2
LINCOLN COUNTY	1	Residential	3	$101,389.03	$25,000.00	$126,389.03	$42,129.68	3
LINCOLN COUNTY	1	Residential	2	$32,597.18	$13,677.11	$46,274.29	$23,137.15	2
LINCOLN COUNTY	1	Residential	2	$25,580.19	$0.00	$25,580.19	$12,790.10	2
LINCOLN COUNTY	1	Residential	2	$28,284.67	$4,698.83	$32,983.50	$16,491.75	2
LINCOLN COUNTY	1	Residential	3	$24,517.32	$7,160.56	$31,677.88	$10,559.29	3
LINCOLN COUNTY	1	Residential	2	$86,646.81	$16,210.71	$102,857.52	$51,428.76	2
LINCOLN COUNTY	1	Residential	2	$0.00	$13,771.34	$13,771.34	$6,885.67	2
LINCOLN COUNTY	1	Residential	2	$29,689.97	$10,000.00	$39,689.97	$19,844.99	2

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
LINCOLN COUNTY	1	Residential	11	$29,616.17	$403.50	$30,019.67	$2,729.06	11
LINCOLN COUNTY	1	Residential	12	$28,650.30	$6,609.98	$35,260.28	$2,938.36	12
LINCOLN COUNTY	1	Residential	4	$13,308.08	$0.00	$13,308.08	$3,327.02	4
LINCOLN COUNTY	1	Residential	4	$11,920.01	$0.00	$11,920.01	$2,980.00	4
LINCOLN COUNTY	1	Non-Resid	2	$0.00	$9,668.86	$9,668.86	$4,834.43	2
LINCOLN COUNTY	1	Residential	3	$61,516.77	$2,237.77	$63,754.54	$21,251.51	3
LINCOLN COUNTY	1	Residential	3	$53,039.95	$0.00	$53,039.95	$17,679.98	3
LINCOLN COUNTY	1	Residential	3	$7,300.08	$0.00	$7,300.08	$2,433.36	3
LINCOLN COUNTY	1	Residential	2	$4,574.21	$0.00	$4,574.21	$2,287.11	2
LINCOLN COUNTY	1	Residential	2	$37,776.31	$0.00	$37,776.31	$18,888.16	2
LINCOLN COUNTY	1	Residential	2	$17,606.35	$0.00	$17,606.35	$8,803.18	2
LINCOLN COUNTY	1	Residential	2	$33,493.41	$10,417.98	$43,911.39	$21,955.70	2
LINCOLN COUNTY	1	Commercial	2	$311,830.30	$0.00	$311,830.30	$155,915.15	2
LINCOLN COUNTY	1	Residential	2	$44,364.01	$0.00	$44,364.01	$22,182.01	2
LINCOLN COUNTY	1	Residential	4	$33,117.83	$1,469.33	$34,587.16	$8,646.79	4
LINCOLN COUNTY	1	Residential	5	$10,059.74	$0.00	$10,059.74	$2,011.95	5
LINCOLN COUNTY	1	Residential	2	$29,132.82	$0.00	$29,132.82	$14,566.41	2
LINCOLN COUNTY	1	Non-Resid	2	$19,174.97	$0.00	$19,174.97	$9,587.49	2
LINCOLN COUNTY	1	Residential	2	$116,600.00	$0.00	$116,600.00	$58,300.00	2
LINCOLN COUNTY	1	Residential	2	$64,457.63	$21,646.58	$86,104.21	$43,052.11	2
LINCOLN COUNTY	1	Non-Resid	2	$55,799.03	$30,000.00	$85,799.03	$42,899.52	2
LINCOLN COUNTY	1	Residential	2	$21,740.46	$8,556.88	$30,297.34	$15,148.67	2
LINCOLN COUNTY	1	Residential	2	$4,746.81	$0.00	$4,746.81	$2,373.41	2
MOSCOW MILLS	1	Residential	5	$26,849.26	$20,061.95	$46,911.21	$9,382.24	5
OLD MONROE	1	Residential	3	$55,799.90	$29,561.59	$85,361.49	$28,453.83	3
OLD MONROE	1	Residential	2	$32,450.23	$0.00	$32,450.23	$16,225.12	2
OLD MONROE	1	Residential	2	$7,764.84	$1,383.75	$9,148.59	$4,574.30	2
OLD MONROE	1	Residential	3	$21,844.00	$9,779.28	$31,623.28	$10,541.09	3
OLD MONROE	1	Non-Resid	2	$0.00	$7,934.04	$7,934.04	$3,967.02	2
OLD MONROE	1	Residential	2	$6,194.62	$3,064.75	$9,259.37	$4,629.69	2
OLD MONROE	1	Residential	3	$4,671.84	$3,918.00	$8,589.84	$2,863.28	3
OLD MONROE	1	Residential	2	$13,854.18	$7,413.81	$21,267.99	$10,634.00	2
OLD MONROE	1	Residential	3	$18,361.08	$0.00	$18,361.08	$6,120.36	3
OLD MONROE	1	Residential	4	$47,855.76	$7,548.99	$55,404.75	$13,851.19	4
OLD MONROE	1	Residential	4	$26,454.18	$6,940.30	$33,394.48	$8,348.62	4
OLD MONROE	1	Residential	3	$28,276.09	$7,836.60	$36,112.69	$12,037.56	3
OLD MONROE	1	Residential	4	$39,618.91	$13,366.32	$52,985.23	$13,246.31	4
OLD MONROE	1	Residential	3	$14,683.09	$4,477.00	$19,160.09	$6,386.70	3
OLD MONROE	1	Residential	5	$153,614.08	$65,296.25	$218,910.33	$43,782.07	5
OLD MONROE	1	Residential	2	$13,949.57	$2,600.00	$16,549.57	$8,274.79	2

Jurisdiction	# Properties	Type of Property	# Mitigated	Building Payments	Content Payments	Total Payments	Ave Payments	# Losses
OLD MONROE	1	Residential	5	$51,588.36	$0.00	$51,588.36	$10,317.67	5
OLD MONROE	1	Residential	2	$15,962.53	$2,417.73	$18,380.26	$9,190.13	2
SILEX	1	Residential	5	$43,571.83	$5,405.50	$48,977.33	$9,795.47	5
SILEX	1	Residential	3	$69,587.65	$9,410.97	$78,998.62	$26,332.87	3
SILEX	1	Commercial	2	$25,282.08	$100.00	$25,382.08	$12,691.04	2
SILEX	1	Non-Resid	2	$75,829.91	$29,772.91	$105,602.82	$52,801.41	2
TROY	1	Residential	2	$6,772.55	$479.50	$7,252.05	$3,626.03	2
TROY	1	Residential	2	$4,574.11	$5,506.00	$10,080.11	$5,040.06	2
TROY	1	Non-Resid	3	$86,275.69	$0.00	$86,275.69	$28,758.56	3
WINFIELD	1	Residential	3	$61,890.08	$4,600.00	$66,490.08	$22,163.36	3
WINFIELD	1	Residential	2	$14,452.62	$0.00	$14,452.62	$7,226.31	2
WINFIELD	1	Residential	2	$7,368.04	$3,248.00	$10,616.04	$5,308.02	2
WINFIELD	1	Residential	3	$5,280.65	$2,716.56	$7,997.21	$2,665.74	3
WINFIELD	1	Residential	2	$9,539.10	$1,100.00	$10,639.10	$5,319.55	2
WINFIELD	1	Residential	6	$79,563.34	$21,552.32	$101,115.66	$16,852.61	6
WINFIELD	1	Residential	2	$44,615.20	$10,000.00	$54,615.20	$27,307.60	2
WINFIELD	1	Non-Resid	2	$21,296.29	$800.00	$22,096.29	$11,048.15	2
WINFIELD	1	Non-Resid	2	$40,550.86	$21,000.00	$61,550.86	$30,775.43	2

Source: Flood Insurance Administration as of February 29, 2016

Previous Occurrences

The largest disaster to impact Lincoln County in recent years was the Great Flood of 1993. Flooding covered the eastern part of the county along its 25-mile border with the Mississippi River. Two major Mississippi River levees were breached by the relentless volume of water. In addition, heavy and frequent rain events along the Cuivre River and the North Fork of the Cuivre River caused flash flooding on the western side of the county.

During the 1994 flood, the Cuivre River also flooded farmland and parts of Old Monroe. East of Troy, where the flood stage is 21 feet, the river crested at 33 feet. At Old Monroe, with flood stage at 24 feet, the crest reached 32.9 feet.

During June 2008 the Mississippi overflowed 90% of the levees in eastern Lincoln County, rushing into Foley and other towns. The Army Corps of Engineers estimated the river would have reached 39.2 feet, which is 13-14 feet above flood stage for many communities in the county. In total, up to 350 homes were flooded and most residents east of highway 79 left their homes. Four homes were destroyed and 161 more homes received major damage. MoDOT closed 37 roads in eastern Missouri and railroad lines, barges, and river locks and dams were shut down.

Within the past 15 years flood events have not resulted in any deaths or injuries within Lincoln County. However, while not included in the table below, flooding was severe during June and December 2015 and resulted in U.S. 61 and MO 79 being closed a total of 12 times due to high water. Some roads and bridges required extensive maintenance as a result of the flooding.

The table below summarizes FEMA Declared Flood Events from the past 20 years.

Table 3.30. Lincoln County FEMA Declared Flood Events Summary,1996 to 2016

Declaration No.	Event	Date Declared
FEMA-1631-DR	Severe Winter Storms and Flooding	March 16, 2006
FEMA-1675-DR	Severe Winter Storms and Flooding	January 14, 2007
FEMA-1749-DR	Severe Storms and Flooding	March 19, 2008
FEMA-1773-DR	Severe Storms and Flooding	June 25, 2008
FEMA-1809-DR	Severe Storms, Tornados, and Flooding	November 13, 2008
FEMA-4130-DR	Severe Storms, Straight Line Winds, Tornadoes and Flooding	July 18, 2013
FEMA-4238-DR	Severe Storms, Straight Line Winds, Tornadoes and Flooding	August 7, 2015
FEMA-4250-DR	Severe Storms, Straight Line Winds, Tornadoes and Flooding	January 21, 2016

Source: NCDC, data accessed June 2, 2016

Probability of Future Occurrence

There were eight declared floods in the 20 years between 1996 and June 2016 making the probability of a declared flood event every 2.5 years, or, a 40% chance each year. NCDC data shows just 3 flash floods for Lincoln County between the years of 1990 and 2015 making the likelihood of a flash flood one in every 3.25 years, or 12% in any given year. It should be noted that NOAA alerts the Lincoln County planning area for flash floods dozens of times per year and each alert brings the possibility of loss of life or property damage depending on the circumstances.

Vulnerability

Vulnerability Overview

HAZUS data from March 2013 estimates there are 17,820 buildings in Lincoln County which have an aggregate total replacement cost of $2,485,000,000 in 2006 dollars. This number includes essential facilities such as a hospital, 23 schools, 15 fire stations, nine police stations, and one emergency operations center. HAZUS estimates a 100-year flood would moderately damage 388 building and destroy 259. It is estimated that two police stations and three fire stations would be unusable for a period of time and that 1,260 displaced people will seek temporary shelter.

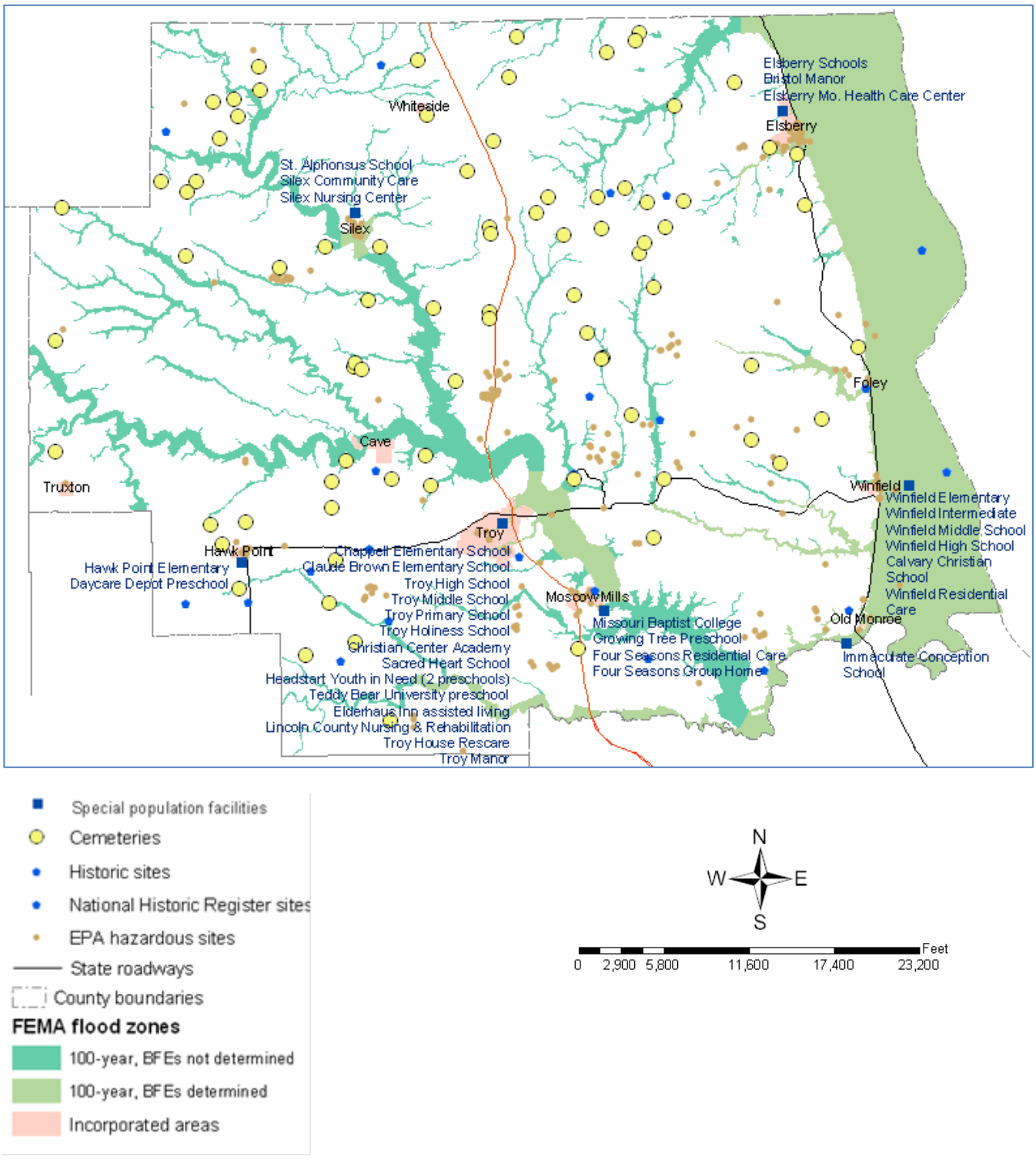
Table 3.31. HAZUS Loss Forecast for 100-Year Flood in Lincoln County

Direct Building Loss	Business Interruption	Total Economic Loss
$ 165,280,000	$ 1,190,000	$ 166,470,000

Source: 2013 Missouri State Hazard Mitigation Plan

The Hazards U.S. Multi-Hazard (HAZUS-MH) was used to generate a one percent annual flood, or 100-year flood, event for major rivers and creeks in the County. The software produces a flood polygon and flood depth grid that represents the 100-year flood. While not as accurate as official flood maps these floodplain boundaries are for use in GIS-based loss estimation. The figure below shows the critical facilities within the county.

Figure 3.11. Critical Facilities in 100-Year Flood Plain



Potential Losses to Existing Development

The Mississippi River Floodplain remains agricultural in nature with family farms sparely distributed within them. However, this real estate is desirable for development with portions of Winfield, Foley,

Old Monroe, and Elsberry resting within the flood plain along Missouri Highway 79 adjacent to the River. In addition, Silex and Moscow Mills are vulnerable to the Cuivre River. The Cuivre's flood plain bumps directly against the city limits of Troy.

Critical facilities within a 100-year flood plain include a hospital, 23 schools, 15 fire stations, nine police stations, and one emergency operations center.

Figure 3.12. Total Exposure to Lincoln County Due to Levee Failure/Flooding

Structure Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Losses
$116,090,040	$103,608,822	$3,386,544	$223,085,406	$1,608,912	$224,694,318

Source: 2013 Missouri State Hazard Mitigation Plan

Impact of Future Development

Development upstream, in the form of additional levees, creates the greatest impact to Mississippi River flooding in Lincoln County due to channeling additional water into waterways. The county regulates development within incorporated areas located in the floodplain of the Mississippi River. Flash floods will continue to impact residents choosing to live in rural communities and areas where low water crossings are required to access their homes. There is anticipated to be little or no increase in run off created by potential development.

Problem Statement

Lincoln County faces two major risk factors for flooding; flooding from the Mississippi River and flash flooding by numerous smaller rivers and creeks, principally, the Cuivre River. According to the federal government's Flood Insurance Rating Maps (FIRM), for Lincoln County 22% of the land lies within the 100-year floodplain. The majority of that 22% lies directly adjacent to Mississippi and Cuivre Rivers. Flooding, particularly flash flooding, in the planning area's rivers and creeks will continue to be an issue due to the geography.

Flow frequency analysis, based on historical annual peak discharges, and the provisional December 2015 peak discharge as measured by the U.S. Geological Survey stream gauges located throughout the State of Missouri, provides additional insight into flood frequency. One gauge was located in Lincoln County, on the Cuivre River at a point near Troy. According to FEMA's Flood Frequency Analysis dated February 29, 2016; data collected indicate a flood of the magnitude of the December 2015 to January 2016 could occur every four years. A flood of this magnitude could result in a water level of 28 feet at the Cuivre River bridge over US 61 at Troy.

3.4.6 Levee Failure

Hazard Profile

Hazard Description

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

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

> **Overtopping: When a Flood Is Too Big**
>
> Overtopping occurs when flood waters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.
>
> **Breaching: When a Levee Gives Way**
>
> A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

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

Geographic Location

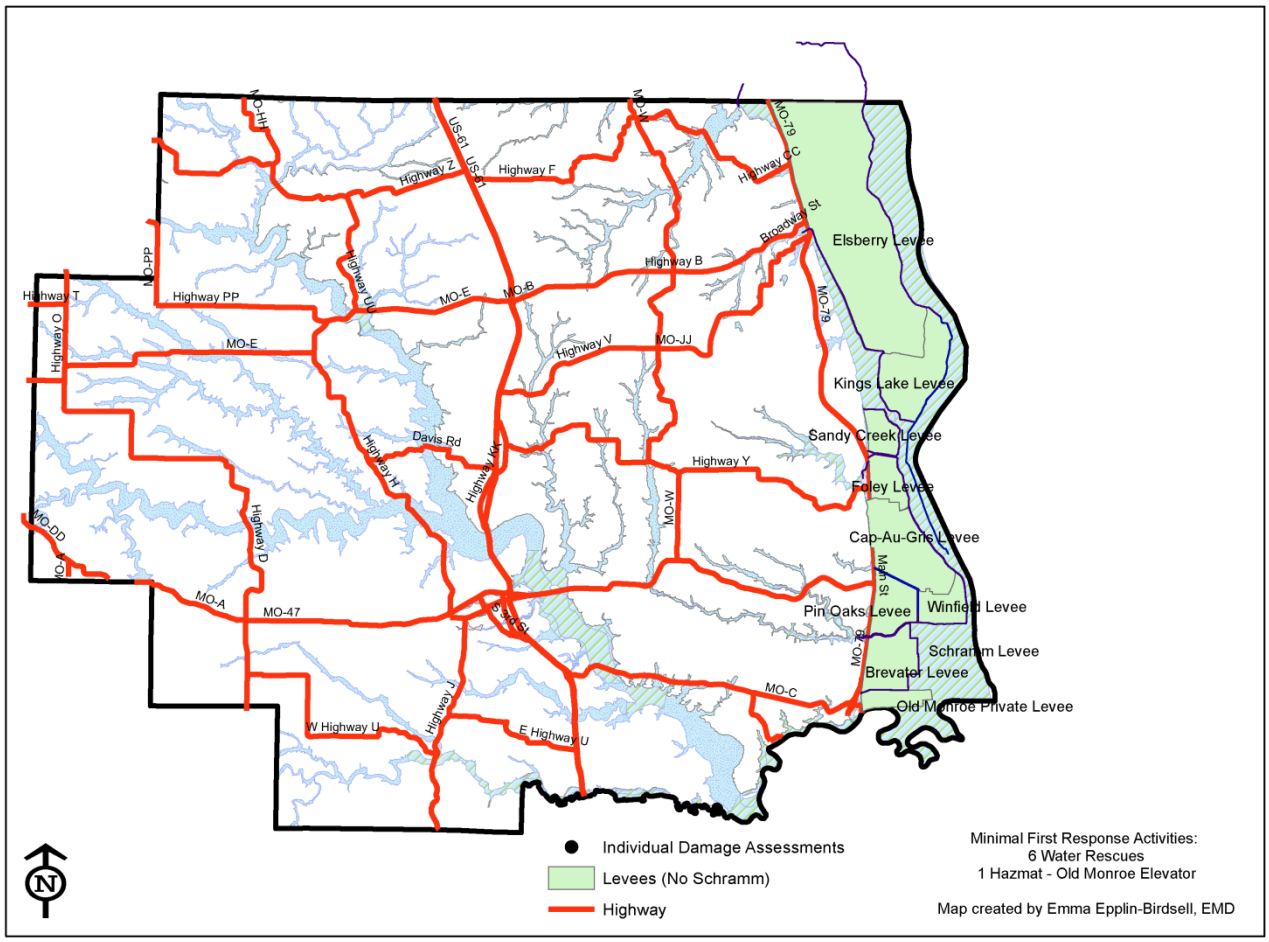
Missouri is a state with many levees. Currently, there is no single comprehensive inventory of levee systems in the state. Levees have been constructed across the state by public entities and private entities with varying levels of protection, inspection oversight, and maintenance. The lack of a comprehensive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

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

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

Lincoln County has 11 drainage and levee districts; the Brevator District, the Winfield District, the Foley District, Sandy Creek District, King's Lake District, Schram Levee, Old Monroe private, Old Monroe Public, Pin Oak District, Cap Au Gris District, and the Elsberry District. Eight of these districts are regulated by the US Army Corps of Engineers, while two are private and one is public.

Figure 3.13. Certified Levees and Missouri River Levees in Lincoln County



Source: Lincoln County Emergency Management Agency, 2015

Severity/Magnitude/Extent

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

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

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

Both Routine and Periodic Inspections result in a rating for operation and maintenance. Each levee segment receives an overall segment inspection rating of Acceptable, Minimally Acceptable, or Unacceptable. The table below defines the three ratings. The only USACE inspected levee in the planning area is the Tuque Creek levee which was inspected in October of 2012 and found to be minimally acceptable by the Corps.

Table 3.32. Definitions of the Three Levee System Ratings

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

Source: U.S. Corps of Engineers

Previous Occurrences

There were more than 1,000 Federal and non-Federal levee breaches during the Great Flood of 1993. From June to August 1993, rainfall totals surpassed greater than 24 inches of rain fell on northern and central Missouri. These amounts were approximately 200-350 percent greater than normal. The Missouri River crested at 48.87 feet at Kansas City on July 27. This crest moved down the Missouri River setting new records at Boonville, Jefferson City, Hermann, St. Charles, and other locations. The first levee was overtopped on June 7, but levee failures soon became common. Levee failures resulted in large amounts of sediments deposited in some inundated areas, and large quantities of sediments were scoured from other inundated areas. In Lincoln County, the Winfield/Pin Oak levee was breached in June of 2015 and in December, the Brevator and Old Monroe Public levees were breached. In St. Louis, out of 42 Federal levees, 12 of them failed or overtopped and out of 47 non-Federal levees, 39 failed (U. S. Geological Survey).

Towns along the Mississippi River from Illinois to Missouri were building barriers in an attempt to hold back rising floodwaters by mid-June. As many as 27 levees were in jeopardy of overflowing as the river was projected to rise (NCDC)

Heavy rains throughout Iowa and Missouri during June 2008 caused flooding along the Mississippi River drainage system within the USACE, St. Louis District in Missouri and Illinois. Heavy rainfall in April and May saturated the Midwest causing much of the additional heavy rains in June to develop directly into runoff. Rainfall totals over Missouri and Iowa ranged from 8-15 inches during the months of May and June. The saturated soil combined with the heavy rains created near record river levels throughout the northern portion of the St. Louis District.

The Mississippi overflowed 90 percent of the levees in eastern Lincoln County, rushing into Foley, and other towns around the county in June, 2008. The Army Corp of Engineers estimated that the river would have reached 39.2 feet, which is 13 to 14 feet above flood stage for many communities in Lincoln County. The average water level in Lincoln County was 34.3 feet, which is about eight feet above flood stage. On June 6, 2008 floodwaters opened a 150-foot breach in a primary levee along the Mississippi River in Winfield. The breach allowed floodwaters to claim dozens of homes and large tracts of farmland and put pressure on a secondary levee. The breach also prompted Lincoln County emergency officials to order the evacuation of residents east of Winfield.

Probability of Future Occurrence

Three levee failures during the last 26 years produces a probability of occurrence as once every 8.6 years.

Vulnerability

Potential Losses to Existing Development

The Mississippi River Floodplain remains agricultural in nature with family farms sparely distributed within them. The Cities of Elsberry, Foley, Winfield and Old Monroe lie within the Mississippi's Floodplain and are frequently at risk of flooding due to levee failure or overtopping. In a worst case scenario, Old Monroe could completely flood. Critical facilities at risk include Missouri Highway 79 as well as infrastructure associated with the above towns. The table below shows worst case exposure to the county.

Figure 3.14. Total Exposure to Lincoln County Due to Levee Failure/Flooding

Structure Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Losses
$116,090,040	$103,608,822	$3,386,544	$223,085,406	$1,608,912	$224,694,318

Source: 2013 Missouri State Hazard Mitigation Plan

Impact of Future Development

Development upstream, in the form of additional levees, creates the greatest impact to Mississippi River flooding in Lincoln County due to channeling additional water into waterways. The county

regulates development within incorporated areas located in the floodplain of the Mississippi River. Flash floods and levee failures will continue to impact residents choosing to live in rural areas where low water crossings are required to access their homes. There is anticipated to be little or no increase in run off created by potential development; however, that could change within 15 years due to the potential development of a multi-hub transportation center, including a port, along the Mississippi in Lincoln County.

Hazard Summary by Jurisdiction

As stated above, the agricultural areas, along with the cities of eastern Lincoln County depend on levees to hold back flood waters.

Problem Statement

Levee failure poses a signature risk to residents, businesses, and transportation corridors in Lincoln County located along the Mississippi River and its associated levees. While flooding and associated levee failure in Lincoln County will continue, loss of life and property, outside of that of crops, will remain unlikely. Flooding, particularly flash flooding, and levee failure associated with the flooding in the planning area's rivers and creeks will continue to be an issue due the geography.

3.4.7 Sinkholes

Hazard Profile

Hazard Description

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

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

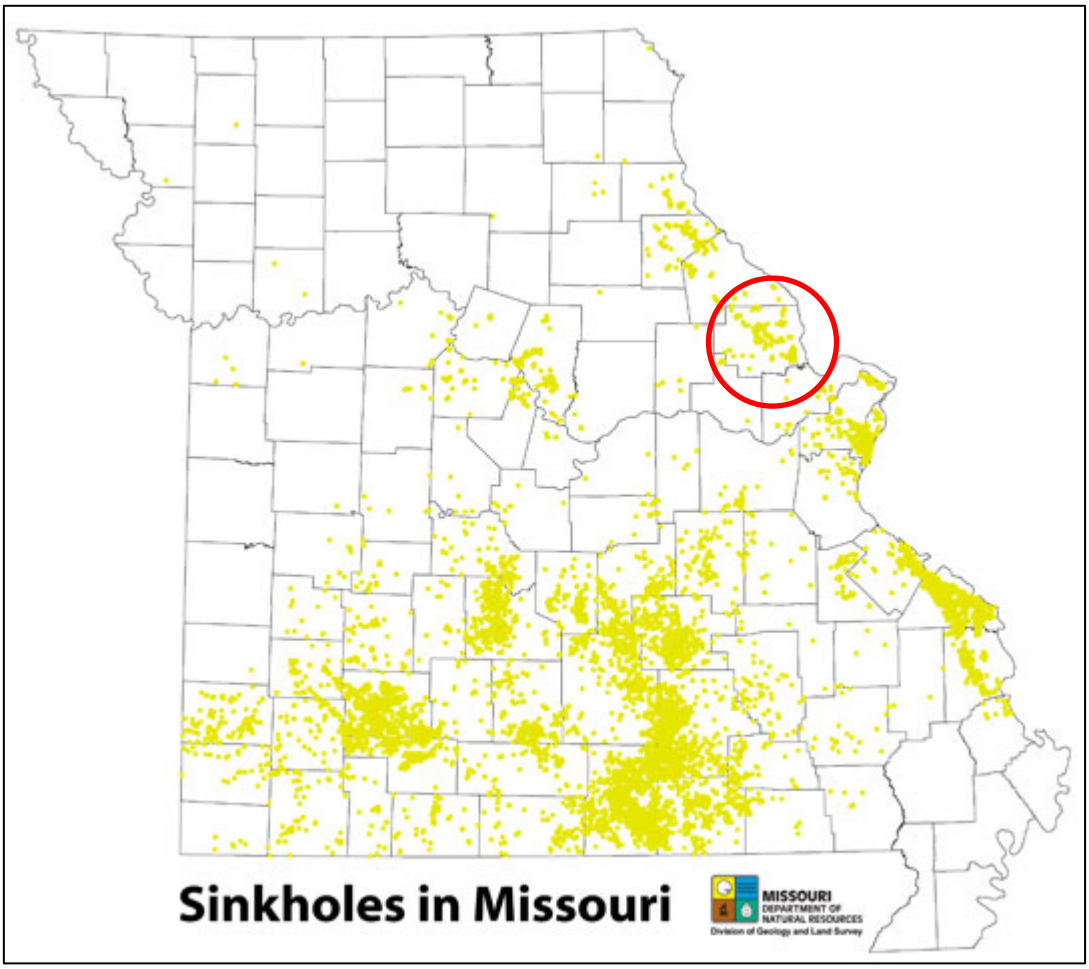
In the case of sinkholes, the rock below the surface is rock that has been dissolving by circulating groundwater. As the rock dissolves, spaces and caverns form, and ultimately the land above the spaces collapse. In Missouri, sinkhole problems are usually a result of surface materials above openings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

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

Geographic Location

The figure below shows sink holes scattered across the county with a higher concentration in the center and northern portions of the county where there is a mix of limestone/shale and dolomite/limestone which contributes to the formation of sink holes. There is no recorded instance of damage caused by sink holes in Lincoln County. Most sink holes are in unincorporated areas.

Figure 3.15. Location of Sink Holes in Lincoln County



Source: Missouri Department of Natural Resources

Severity/Magnitude/Extent

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

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

Previous Occurrences

Sink holes occur naturally in Lincoln County and can develop nearly anywhere. There is no record of property damage or personal injuries due to sink holes in the county.

Probability of Future Occurrence

There are no records available in the planning area from which to derive quantifiable probabilities.

Vulnerability

Lincoln County is vulnerable to damage to property and personal injury due to sink holes.

Potential Losses to Existing Development

The location of current sink holes and sink hole prone areas is well known to current property owners and developers who avoid construction in those areas. Potential losses are slight due to the rural locations of the sink holes.

Impact of Future Development

Builders avoid construction in known sink hole areas thereby avoiding potential risk.

Problem Statement

There is potential risk to Lincoln County residents due to sink holes. However, most sink holes are found in uninhabited rural areas and construction in sink hole prone areas is avoided. Therefore, the risk is nearly non-existent.

3.4.8 Thunderstorms/High Winds/Lightning/Hail

Hazard Profile

Hazard Description

Thunderstorms

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

High Winds

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

Lightning

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

Hail

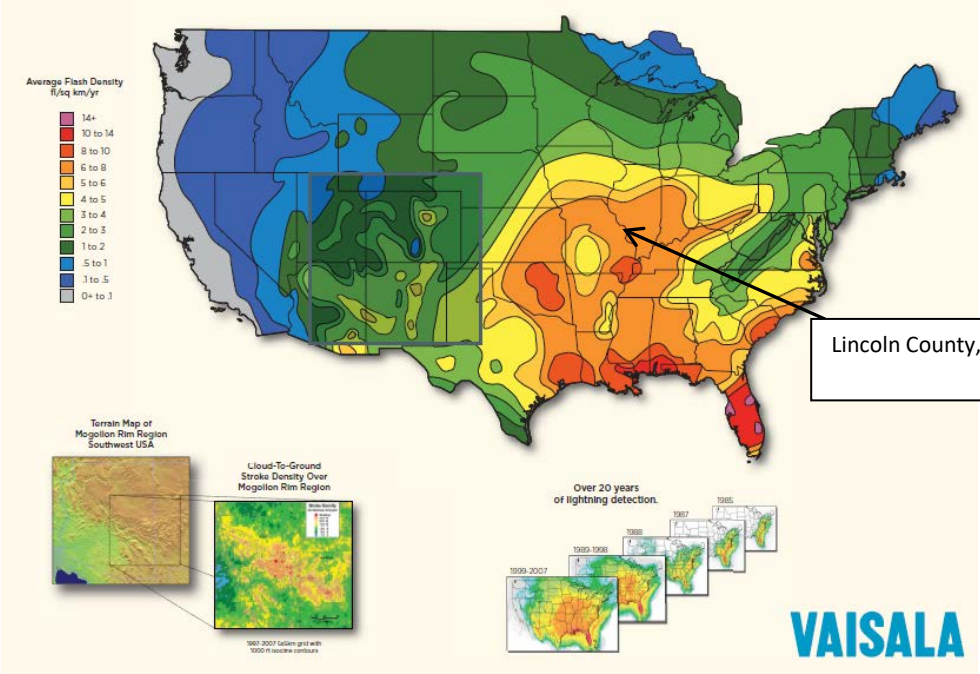
According to the National Oceanic and Atmospheric Administration (NOAA), hail is precipitation that is formed when thunderstorm updrafts carry raindrops upward into extremely cold atmosphere causing them to freeze. The raindrops form into small frozen droplets. They continue to grow as they come into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

At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 miles per hour, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 miles per hour. According to the NOAA, the largest hailstone in diameter recorded in the United States was found in Vivian, South Dakota on July 23, 2010. It was eight inches in diameter, almost the size of a soccer ball. Soccer-ball-sized hail is the exception, but even small pea-sized hail can do damage.

Geographic Location

Thunderstorms, high winds, hail, and lightning are county-wide hazards and can occur anywhere throughout the state of Missouri. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas. In addition, damages are more likely to occur in more densely populated urban areas.

Figure 3.16. Location and Frequency of Lightning in the U.S.A.



Source: National Weather Service,
http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf

Figure 3.17. Wind Zones in the United States

Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, http://www.weather.gov/media/bis/FEMA_SafeRoom.pdf

Severity/Magnitude/Extent

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

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

Most lightning damages occur to electronic equipment located inside buildings. But structural damage can also occur when a lightning strike causes a building fire. In addition, lightning strikes can cause damages to crops if fields or forested lands are set on fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes.

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

Table 3.33. Tornado and Storm Research Organization Hail Storm Intensity Scale

Intensity Category	Inches Diameter	Size Description	Typical Damage Impacts
Hard Hail	0.2-0.4	Pea	No damage
Potentially Damaging	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	1.2-1.6	Pigeon's egg	Wide spread glass damage, vehicle bodywork damage
Destructive	1.6-2.0	Golf ball	Whole sale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	2.4-3.0	Tennis ball	Severe roof damage, risk of serious injuries
Destructive	3.0-3.5	Large orange	Severe damage to aircraft bodywork
Super Hailstorms	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hail Storms	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

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

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

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

The onset of thunderstorms with lightning, high wind, and hail is generally rapid. Duration is less than six hours and warning time is generally six to twelve hours. Nationwide, lightning kills 75 to 100 people each year. Lightning strikes can also start structural and wildland fires, as well as damage electrical systems and equipment. According to the USDA Risk Management Agency, between the years of 2005 and 2016 there were no crop damages paid due to thunderstorms. Damages due to Lightning, High Winds, and Hail are listed in the tables below.

Table 3.34. Crop Insurance Claims Paid in Lincoln County From High Winds, 2005-2015

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Corn	Excessive Winds	$768
2006	Corn	Excessive Winds	$768
2009	Corn	Excessive Winds	$13,417
2011	Corn	Excessive Winds	$19,937
Total			$34,890

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

Table 3.35. Crop Insurance Claims Paid in Lincoln County From Lightning, 2005-2015

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2008	Soybeans	Other – Lightning	$112
2009	Soybeans, Wheat	Other – Lightning	$17,694
2012	Corn	Other – Lightning	$109,691
2013	Corn, Wheat	Other – Lightning	$13,263
Total			$140,760

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

Table 3.36. Crop Insurance Claims Paid in Lincoln County From Hail, 2005-2015

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2006	Wheat	Hail	$1042
2009	Corn, Soybeans	Hail	$15,319
2011	Soybeans	Hail	$7,883
2015	Wheat	Hail	$7,589
Total			$31,833

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

Previous Occurrences

The following figures show reported thunderstorm and hail events from January 2005 through December 2015 along with the magnitude of the event (when available), and any associated deaths, injuries, or damage. There were no reports in the NCDC data for lighting and strong wind events. These events are likely under-reported judging from the lack of data from NCDC.

Table 3.37. Thunderstorm Events, 2005-2015

Date	Event	Magnitude (Kts)	Deaths	Injuries	Property Damage	Crop Damage
6/10/2005	Thunderstorm Wind	52	0	0	$ -	$ -
6/10/2005	Thunderstorm Wind	52	0	0	$ -	$ -
6/13/2005	Thunderstorm Wind	50	0	0	$ -	$ -
6/13/2005	Thunderstorm Wind	50	0	0	$ -	$ -
6/13/2005	Thunderstorm Wind	52	0	0	$ -	$ -
6/13/2005	Thunderstorm Wind	55	0	0	$ -	$ -
9/13/2005	Thunderstorm Wind	55	0	0	$ -	$ -
4/2/2006	Thunderstorm Wind	60	0	0	$ -	$ -
6/10/2006	Thunderstorm Wind	50	0	0	$ -	$ -
7/19/2006	Thunderstorm Wind	55	0	0	$ -	$ -
7/19/2006	Thunderstorm Wind	61	0	0	$ -	$ -
7/21/2006	Thunderstorm Wind	60	0	0	$ -	$ -
7/21/2006	Thunderstorm Wind	60	0	0	$ -	$ -
7/21/2006	Thunderstorm Wind	60	0	0	$ -	$ -
7/21/2006	Thunderstorm Wind	52	0	0	$ -	$ -
7/17/2007	Thunderstorm Wind	60	0	0	$ 5,000	$ -
7/17/2007	Thunderstorm Wind	60	0	0	$ -	$ -
8/12/2007	Thunderstorm Wind	60	0	0	$ -	$ -
10/18/2007	Thunderstorm Wind	56	0	0	$ -	$ -
7/27/2008	Thunderstorm Wind	56	0	0	$ -	$ -
8/5/2008	Thunderstorm Wind	52	0	0	$ -	$ -
8/5/2008	Thunderstorm Wind	56	0	0	$ -	$ -
12/27/2008	Thunderstorm Wind	56	0	0	$ -	$ -
6/10/2009	Thunderstorm Wind	48	0	0	$ 3,000	$ -
6/27/2009	Thunderstorm Wind	70	0	0	$ -	$ -
7/23/2009	Thunderstorm Wind	52	0	0	$ -	$ -
6/19/2010	Thunderstorm Wind	52	0	0	$ -	$ -
8/12/2010	Thunderstorm Wind	52	0	0	$ -	$ -
8/12/2010	Thunderstorm Wind	56	0	0	$ -	$ -
10/26/2010	Thunderstorm Wind	52	0	0	$ -	$ -
5/22/2011	Thunderstorm Wind	52	0	0	$ -	$ -
5/23/2011	Thunderstorm Wind	52	0	0	$ -	$ -
5/25/2011	Thunderstorm Wind	52	0	0	$ -	$ -
5/25/2011	Thunderstorm Wind	52	0	0	$ -	$ -
6/10/2011	Thunderstorm Wind	56	0	0	$ -	$ -
7/3/2011	Thunderstorm Wind	56	0	0	$ -	$ -
10/17/2012	Thunderstorm Wind	53	0	0	$ -	$ -
1/29/2013	Thunderstorm Wind	56	0	0	$ -	$ -

Date	Event	Magnitude (Kts)	Deaths	Injuries	Property Damage	Crop Damage
5/30/2013	Thunderstorm Wind	56	0	0	$ -	$ -
5/31/2013	Thunderstorm Wind	52	0	0	$ -	$ -
5/31/2013	Thunderstorm Wind	52	0	0	$ -	$ -
11/17/2013	Thunderstorm Wind	56	0	0	$ -	$ -
11/17/2013	Thunderstorm Wind	61	0	0	$ -	$ -
4/24/2014	Thunderstorm Wind	56	0	0	$ -	$ -
4/28/2014	Thunderstorm Wind	52	0	0	$ -	$ -
6/21/2014	Thunderstorm Wind	52	0	0	$ -	$ -
7/7/2014	Thunderstorm Wind	56	0	0	$ -	$ -
7/7/2014	Thunderstorm Wind	56	0	0	$ -	$ -
4/9/2015	Thunderstorm Wind	56	0	0	$ -	$ -
TOTAL	**49**		**0**	**0**	**$ 8,000**	**0**

Source: NCDC

Table 3.38. Hail Events, 2005 - 2015

Date	Event	Magnitude (" Diameter)	Deaths	Injuries	Property Damage	Crop Damage
1/12/2005	Hail	1.75	0	0	$ -	$ -
5/11/2005	Hail	1	0	0	$ -	$ -
5/11/2005	Hail	0.77	0	0	$ -	$ -
10/20/2005	Hail	0.88	0	0	$ -	$ -
11/5/2005	Hail	1	0	0	$ -	$ -
11/5/2005	Hail	0.75	0	0	$ -	$ -
1/2/2006	Hail	1	0	0	$ -	$ -
1/2/2006	Hail	1	0	0	$ -	$ -
3/13/2006	Hail	1	0	0	$ -	$ -
3/13/2006	Hail	2	0	0	$ -	$ -
4/7/2006	Hail	0.75	0	0	$ -	$ -
4/30/2006	Hail	1.75	0	0	$ -	$ -
4/30/2006	Hail	0.75	0	0	$ -	$ -
5/24/2006	Hail	0.75	0	0	$ -	$ -
5/24/2006	Hail	0.75	0	0	$ -	$ -
5/24/2006	Hail	1.75	0	0	$ -	$ -
1/7/2008	Hail	0.75	0	0	$ -	$ -
2/4/2008	Hail	0.75	0	0	$ -	$ -
2/4/2008	Hail	0.88	0	0	$ -	$ -
2/4/2008	Hail	0.88	0	0	$ -	$ -
3/27/2008	Hail	0.75	0	0	$ -	$ -
3/27/2008	Hail	0.75	0	0	$ -	$ -

Date	Event	Magnitude (" Diameter)	Deaths	Injuries	Property Damage	Crop Damage
3/27/2008	Hail	0.75	0	0	$ -	$ -
3/27/2008	Hail	0.88	0	0	$ -	$ -
3/27/2008	Hail	0.75	0	0	$ -	$ -
4/22/2008	Hail	0.75	0	0	$ -	$ -
4/22/2008	Hail	0.75	0	0	$ -	$ -
5/13/2008	Hail	0.88	0	0	$ -	$ -
5/13/2008	Hail	0.75	0	0	$ -	$ -
5/30/2008	Hail	0.88	0	0	$ -	$ -
5/31/2008	Hail	1.75	0	0	$ -	$ -
7/29/2008	Hail	0.88	0	0	$ -	$ -
8/5/2008	Hail	0.75	0	0	$ -	$ -
8/5/2008	Hail	0.75	0	0	$ -	$ -
7/23/2009	Hail	1	0	0	$ -	$ -
5/3/2010	Hail	0.88	0	0	$ -	$ -
5/3/2010	Hail	1	0	0	$ -	$ -
5/3/2010	Hail	2	0	0	$ -	$ -
12/31/2010	Hail	1	0	0	$ -	$ -
4/19/2011	Hail	0.75	0	0	$ -	$ -
4/19/2011	Hail	1	0	0	$ -	$ -
4/19/2011	Hail	1.75	0	0	$ -	$ -
5/11/2011	Hail	0.88	0	0	$ -	$ -
5/22/2011	Hail	1.75	0	0	$ -	$ -
5/25/2011	Hail	0.75	0	0	$ -	$ -
5/25/2011	Hail	0.75	0	0	$ -	$ -
6/17/2011	Hail	1	0	0	$ -	$ -
3/15/2012	Hail	0.88	0	0	$ -	$ -
4/13/2012	Hail	0.75	0	0	$ -	$ -
4/28/2012	Hail	1	0	0	$ -	$ -
4/28/2012	Hail	1.75	0	0	$ -	$ -
9/7/2012	Hail	1.75	0	0	$ -	$ -
9/7/2012	Hail	0.88	0	0	$ -	$ -
9/25/2012	Hail	0.88	0	0	$ -	$ -
11/17/2013	Hail	0.88	0	0	$ -	$ -
4/13/2014	Hail	1.75	0	0	$ -	$ -
4/28/2014	Hail	0.75	0	0	$ -	$ -
4/28/2014	Hail	1.75	0	0	$ -	$ -
10/6/2014	Hail	2	0	0	$ -	$ -
4/9/2015	Hail	1.75	0	0	$ -	$ -
6/25/2015	Hail	1.75	0	0	$ -	$ -

Date	Event	Magnitude (" Diameter)	Deaths	Injuries	Property Damage	Crop Damage
6/29/2015	Hail	0.88	0	0	$ -	$ -
TOTAL	**62**		**0**	**0**	**$ -**	**$ -**

Source: NCDC

Probability of Future Occurrence

Each of these four events; Thunderstorm Winds, Hail, Lightning and High Winds are likely to happen anywhere in Lincoln County at nearly any time of the year. Lightning and high wind events appear to be under-reported; however it is uncertain why. The lack of data prevents an accurate trend analysis for lightning and high wind. The probability of severe thunderstorms is 4.9 events per year and for hail, 6.2 events per year.

Vulnerability

Lincoln County's total exposure of buildings and crops due to thunderstorms and high winds is $4.3B and its exposure to crop damage from the same hazards is $39.2M.

Potential Losses to Existing Development

There is significant potential of loss to existing development, particularly crops, which will take damage from events of less severity than is required to cause damage to structures. Figures in previous crop insurance claims paid tables support this statement.

Future Development

Additional development results in the exposure of more households and businesses vulnerable to damages from severe thunderstorms, high winds, lightning, and hail.

Hazard Summary by Jurisdiction

These hazards are area-wide. NCDC data does not indicate any particular community or area to have significantly higher losses as compared to another. The City of Troy is the county seat and the most populous of incorporated areas and would therefore be most at risk.

Problem Statement

The county, like the entire state of Missouri, is vulnerable to high winds, lightning, hail and thunderstorms.

3.4.9 Tornado

Hazard Profile

Hazard Description

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

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

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

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

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

Geographic Location

Tornados can occur anywhere in Lincoln County.

Severity/Magnitude/Extent

Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 miles per hour and damage paths can be more than one mile wide and 50 miles long. Tornadoes have been known to lift and move objects weighing more than 300 tons a distance of 30 feet, toss homes more than 300 feet from their foundations, and

siphon millions of tons of water from water bodies. Tornadoes also can generate a tremendous amount of flying debris or "missiles," which often become airborne shrapnel that causes additional damage. If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, roofs, and walls. However, the less spectacular damage is much more common.

Tornado magnitude is classified according to the EF-Scale; or the Enhanced Fujita Scale, based on the original Fujita Scale developed by Dr. Theodore Fujita, a renown severe storm researcher. The EF-Scale; shown below, attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original EF-Scale was implemented in the U.S. on February1,2007.

Table 3.39. Enhanced Fujita Scale for Tornado Damage

FUJITASCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest¼-mile (mph)	3 Second Gust (mph)	EF Nu	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over200

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

The table below is based on information from the NOAA Storm Prediction Center. The table shows the wind speeds for the EF scale and summary descriptions of potential damage. For the actual EF scale it is necessary to look up the damage indicator(type of structure damaged) and refer to the degrees of damage associated with that indicator. Information on the Enhanced Fujita Scale's damage indicators and degrees or damage is online at www.spc.noaa.gov/efscale/ef-scale.html.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 EF 0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes over turned 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 stories 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 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 300ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

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

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

Previous Occurrences

The 10 NCDC reported tornado events and damages for Lincoln County since 2005 are shown in the table below. Prior to that date, only really destructive tornadoes were recorded. There are limitations to the use of NCDC tornado data that must be noted. For example, one tornado may contain multiple segments as it moves geographically. A tornado that crosses a county line or state line is considered a separate segment for the purposes of reporting to the NCDC. Also, a tornado that lifts off the ground for less than five minutes or 2.5 miles is considered a separate segment. If the tornado lifts off the ground for greater than 5 minutes or 2.5 miles, it is considered a separate tornado. Tornadoes reported in Storm Data and the Storm Events Database are in segments.

Table 3.40. Recorded Tornadoes in Lincoln County, January 2005 – December 2015

Date	Begin Location	End Location	Length (Miles)	Width (Yards)	E/EF Rating	Deaths	Injuries	Property Damage	Crop Damage
6/13/2005	MOSCOW MILLS	MOSCOW MILLS	0.2	50	F0	0	0	$ -	$ -
3/13/2006	OLNEY	DAMERON	24	300	F3	0	6	$ 2,500,000	$ -
3/13/2006	MILLWOOD	MILLWOOD	0.2	75	F1	0	0	$ -	$ -
10/2/2007	HAWK PT	HAWK PT	0.05	30	EF0	0	0	$ -	$ -
12/27/2008	DAVIS	HINES	1.12	40	EF1	0	0	$ -	$ -
4/23/2010	HAWK PT	HAWK PT	0.21	20	EF0	0	0	$ -	$ -
4/23/2010	SILEX	MILLWOOD	0.11	10	EF0	0	0	$ -	$ -
4/23/2010	SILEX	SILEX	0.14	10	EF0	0	0	$ -	$ -
1/29/2013	CHAIN OF ROCKS	CHAIN OF ROCKS	1.66	30	EF0	0	0	$ -	$ -

6/13/2015	HAWK PT	HAWK PT	1.95	50	EF1	0	0	$ -	$ -
TOTAL	**10**					**0**	**6**	**$ 2,500,000**	**$ -**

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

The next 10 figures show the paths of the above tornados along with details of the events. Each of the 10 figures were taken from the National Climatic Data Center, http://www.ncdc.noaa.gov/stormevents/

Figure 3.18. Details and Path of June 13, 2005 Tornado, Moscow Mills

National Centers for Environmental Information

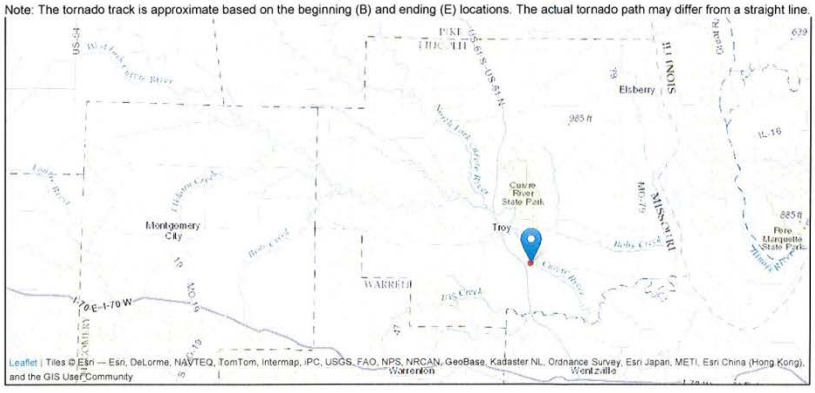
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**F0**
-- Length	**.2 Miles**
-- Width	**50 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**LAW ENFORCEMENT**
NCEI Data Source	**PDS**
Begin Date	**2005-06-13 16:25:00.0 CST**
Begin Lat/Lon	**38.95/-90.92**
End Date	**2005-06-13 16:25:00.0 CST**
End Location	**MOSCOW MILLS**
End Lat/Lon	**38.95/-90.92**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	
Crop Damage	
Event Narrative	**An off duty Sheriff Deputy reported a small tornado near Meyer Road and Highway C. There was no damage.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
MOSCOW MILLS	LINCOLN CO.	MO	06/13/2005	16:25	CST	Tornado	F0	0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

2-A

National Centers for Environmental Information

Storm Events Database

Event Details:

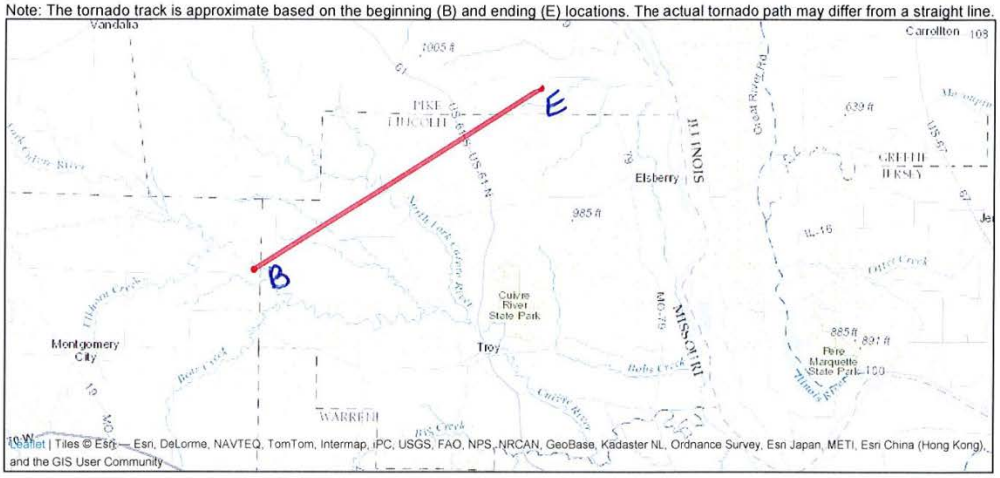
Event	**Tornado**
-- Scale	**F3**
-- Length	**24 Miles**
-- Width	**300 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**NWS STORM SURVEY**
NCEI Data Source	**PDS**
Begin Date	**2006-03-13 01:28:00.0 CST**
Begin Location	**2SW OLNEY**
Begin Lat/Lon	**39.07/-91.27**
End Date	**2006-03-13 01:46:00.0 CST**
End Location	**3WNW DAMERON**
End Lat/Lon	**39.25/-90.90**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**6/0**
Property Damage	**2.5M**
Crop Damage	
Event Narrative	**The tornado that formed in Montgomery County north of Bellflower moved into Lincoln County, strengthened, and caused extensive damage along Highway E on the north side of Olney. A home was completely destroyed as the tornado reached F3 intensity and was about 300 yards wide. The family at home escaped injury as they had taken shelter in the basement. About 1:35 am CST, the tornado destroyed a home and caused damage to a home business along Highway H northwest of Silex. At this point the tornado was a strong F2 and about 200 yards wide. A man in the home that was destroyed suffered a broken leg. At the home business, the home suffered roof damage and had the north side brick wall pulled off of the house. A large machine shed suffered extensive damage and a 50 foot travel trailer and the pickup truck it was attached too were blown onto their sides. The tornado continued northeast and primarily crossed over wildlife and conservation areas south of Whiteside. The tornado crossed US Highway 61 near the intersection with Highway F about 1:40 am CST and caused minor damage at a farm and a couple of homes. An old barn was destroyed, a metal shed was destroyed, a garage had the door buckled and windows blown out. A nearly constant trail of tree damage continued as the tornado approached the Lincoln Pike County line west of Dameron about 1:46 am CST.**

Figure 3.19. Details and Path of March 13, 2006 Tornado, Olney

(2-B)

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	6	2.700M	0.00K
BELLFLOWER	MONTGOMERY CO.	MO	03/13/2006	01:20	CST	Tornado	F2	0	0	200.00K	0.00K
OLNEY	LINCOLN CO.	MO	03/13/2006	01:28	CST	Tornado	F3	0	6	2.500M	0.00K
ANNADA	PIKE CO.	MO	03/13/2006	01:46	CST	Tornado	F0	0	0	0.00K	0.00K
Totals:								0	6	2.700M	0.00K

Figure 3.20. Details and Path of March 13, 2006 Tornado, Millwood

National Centers for Environmental Information

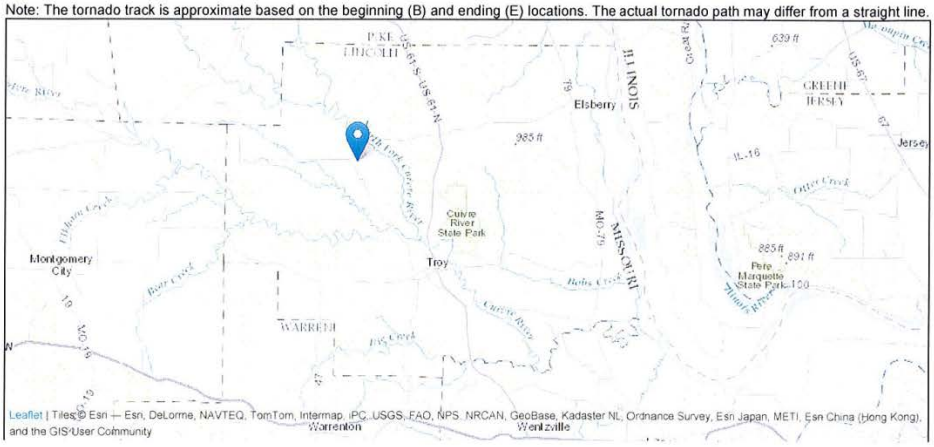
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**F1**
-- Length	**.2 Miles**
-- Width	**75 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**NWS STORM SURVEY**
NCEI Data Source	**PDS**
Begin Date	**2006-03-13 01:36:00.0 CST**
Begin Location	**1E MILLWOOD**
Begin Lat/Lon	**39.10/-91.08**
End Date	**2006-03-13 01:36:00.0 CST**
End Location	**1E MILLWOOD**
End Lat/Lon	**39.10/-91.08**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	
Crop Damage	
Event Narrative	**A small tornado hit along Highway E about 1 mile east of Millwood. A barn and 2 grain bins were destroyed. Several other buildings had roof damage.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD

Totals:							0	0	0.00K	0.00K
MILLWOOD	LINCOLN CO.	MO	03/13/2006	01:36	CST	Tornado F1	0	0	0.00K	0.00K
Totals:							0	0	0.00K	0.00K

Figure 3.21. Details and Path of October 2, 2007 Tornado, Hawk Point

National Centers for Environmental Information

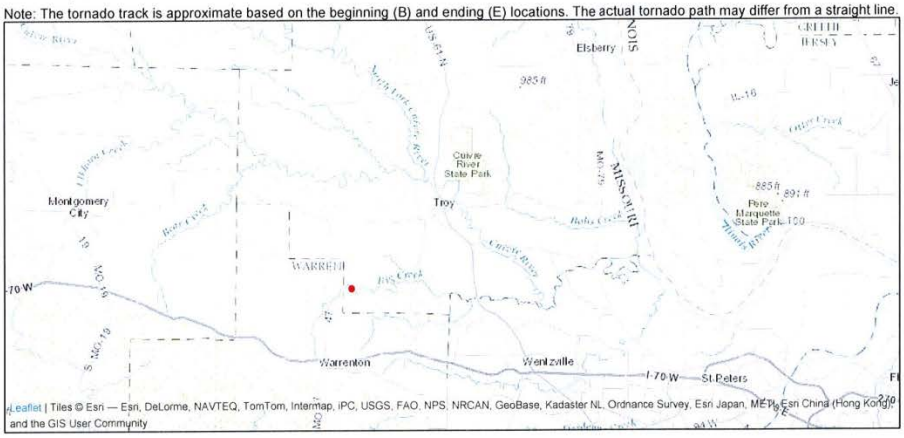
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**EF0**
-- Length	**0.05 Miles**
-- Width	**30 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**NWS Storm Survey**
NCEI Data Source	**CSV**
Begin Date	**2007-10-02 18:18:00.0 CST-6**
Begin Location	**5SSE HAWK PT**
Begin Lat/Lon	**38.8989/-91.099**
End Date	**2007-10-02 18:19:00.0 CST-6**
End Location	**5SSE HAWK PT**
End Lat/Lon	**38.8991/-91.0986**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	
Crop Damage	**0.00K**
Episode Narrative	**A strong cold front moved through the region, triggering showers and thunderstorms. Several low-topped supercells produced 8 tornadoes and straight line wind damage from central and northeast Missouri to west central Illinois during the evening of October 2nd.**
Event Narrative	**A tornado briefly touched down around 5 miles south southeast of Hawk Point, near Big Creek on North Rock Church Road. It damaged half a dozen trees. The tree tops were sheared off wtih tree limbs up to 2 feet in diameter thrown in different directions.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	2	310.00K	0.00K
WOODLAWN	MONROE CO.	MO	10/02/2007	15:45	CST-6	Tornado	EF2	0	1	60.00K	0.00K
GRANVILLE	MONROE CO.	MO	10/02/2007	15:49	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
NORTH FORK	MONROE CO.	MO	10/02/2007	15:57	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
NORTH FORK	MONROE CO.	MO	10/02/2007	16:00	CST-6	Thunderstorm Wind	70 kts. EG	0	0	50.00K	0.00K
ELY	MARION CO.	MO	10/02/2007	16:14	CST-6	Tornado	EF0	0	0	0.00K	0.00K
WOODLAND	MARION CO.	MO	10/02/2007	16:29	CST-6	Tornado	EF1	0	1	100.00K	0.00K
PALMYRA	MARION CO.	MO	10/02/2007	16:30	CST-6	Tornado	EF0	0	0	50.00K	0.00K
HANNIBAL MUNI ARPT	MARION CO.	MO	10/02/2007	16:35	CST-6	Tornado	EF0	0	0	0.00K	0.00K
BUELL	MONTGOMERY CO.	MO	10/02/2007	17:17	CST-6	Tornado	EF0	0	0	50.00K	0.00K
HAWK PT	LINCOLN CO.	MO	10/02/2007	18:18	CST-6	Tornado	EF0	0	0	0.00K	0.00K
Totals:								0	2	310.00K	0.00K

Figure 3.22. Details and Path of December 27, 2008 Tornado, Davis

National Centers for Environmental Information

Storm Events Database

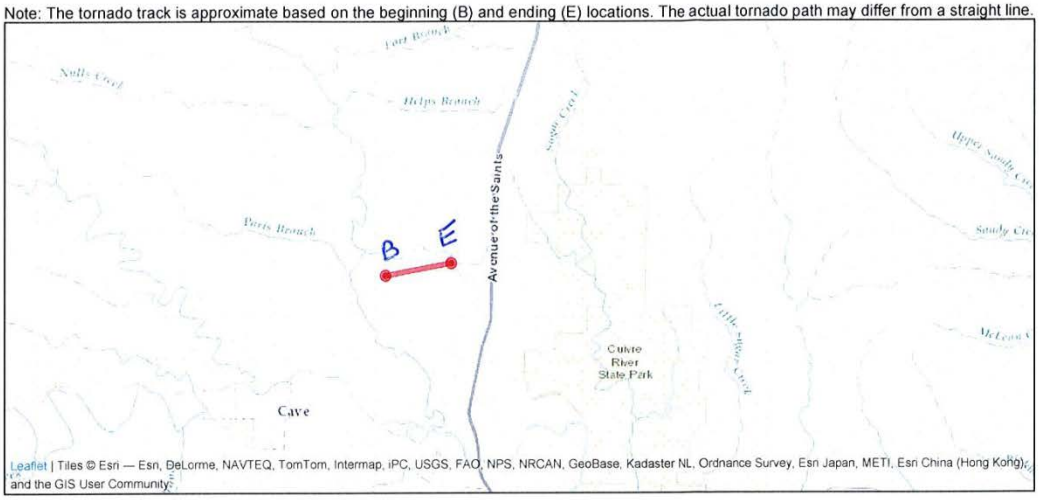
Event Details:

Event	**Tornado**
-- Scale	**EF1**
-- Length	**1.12 Miles**
-- Width	**40 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**NWS Storm Survey**
NCEI Data Source	**CSV**
Begin Date	**2008-12-27 11:10:00.0 CST-6**
Begin Location	**1SSE DAVIS**
Begin Lat/Lon	**39.0537/-91.0072**
End Date	**2008-12-27 11:12:00.0 CST-6**
End Location	**1NW HINES**
End Lat/Lon	**39.0566/-90.9866**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	**0.00K**
Crop Damage	**0.00K**
Episode Narrative	**A strong cold front moved through the region...triggering showers and thunderstorms. Some of the thunderstorms became severe with large hail, damaging winds, tornadoes and flash flooding reported.**
Event Narrative	**A tornado touched down 3 miles east of Davis in an open field west of a farmstead and destroyed a 2 story barn. Six by six supports from the barn where driven into the ground near the farm house. The home was about 60 yards to the northeast of the barn and was heavily damaged by the tornado. As the tornado travelled to the east, a couple of new homes sustained minor roof damage on Penrod Road. It continued to the east northeast and damaged three additional machine sheds as well as numerous trees before lifting and dissipating.**

 SB

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
SHELBINA	SHELBY CO.	MO	12/27/2008	01:07	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
EWING	LEWIS CO.	MO	12/27/2008	09:20	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
COLUMBIA	BOONE CO.	MO	12/27/2008	09:26	CST-6	Hail	0.88 in.	0	0	0.00K	0.00K
CANTON	LEWIS CO.	MO	12/27/2008	09:35	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
CENTER	RALLS CO.	MO	12/27/2008	10:03	CST-6	Tornado	EF0	0	0	0.00K	0.00K
RUSH HILL	AUDRAIN CO.	MO	12/27/2008	10:03	CST-6	Tornado	EF1	0	0	0.00K	0.00K
FLINTHILL	RALLS CO.	MO	12/27/2008	10:07	CST-6	Tornado	EF0	0	0	0.00K	0.00K
VANDALIA	AUDRAIN CO.	MO	12/27/2008	10:08	CST-6	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
BOWLING GREEN	PIKE CO.	MO	12/27/2008	10:37	CST-6	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
NEW FLORENCE	MONTGOMERY CO.	MO	12/27/2008	10:41	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
JONESBURG	MONTGOMERY CO.	MO	12/27/2008	10:58	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
DAVIS	LINCOLN CO.	MO	12/27/2008	11:08	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
DAVIS	LINCOLN CO.	MO	12/27/2008	11:10	CST-6	Tornado	EF1	0	0	0.00K	0.00K
CUBA	CRAWFORD CO.	MO	12/27/2008	12:32	CST-6	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
STEELVILLE	CRAWFORD CO.	MO	12/27/2008	12:32	CST-6	Thunderstorm Wind	50 kts. MG	0	0	0.00K	0.00K
BEAUFORT	FRANKLIN CO.	MO	12/27/2008	12:45	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
BOURBON	CRAWFORD CO.	MO	12/27/2008	12:45	CST-6	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
NEW MELLE	ST. CHARLES CO.	MO	12/27/2008	13:17	CST-6	Flash Flood		0	0	0.00K	0.00K
WASHINGTON MEM ARPT	FRANKLIN CO.	MO	12/27/2008	13:17	CST-6	Flash Flood		0	0	0.00K	0.00K
CHESTERFIELD	ST. LOUIS CO.	MO	12/27/2008	13:40	CST-6	Flash Flood		0	0	0.00K	0.00K
FENTON	ST. LOUIS CO.	MO	12/27/2008	13:50	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
HILLSBORO	JEFFERSON CO.	MO	12/27/2008	14:18	CST-6	Flash Flood		0	0	0.00K	0.00K
FARMINGTON	ST. FRANCOIS CO.	MO	12/27/2008	15:07	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
ST LOUIS	ST. LOUIS (C) CO.	MO	12/27/2008	15:07	CST-6	Flash Flood		0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

Figure 3.23. Details and Path of April 23, 2010 Tornado, Hawk Point

National Centers for Environmental Information

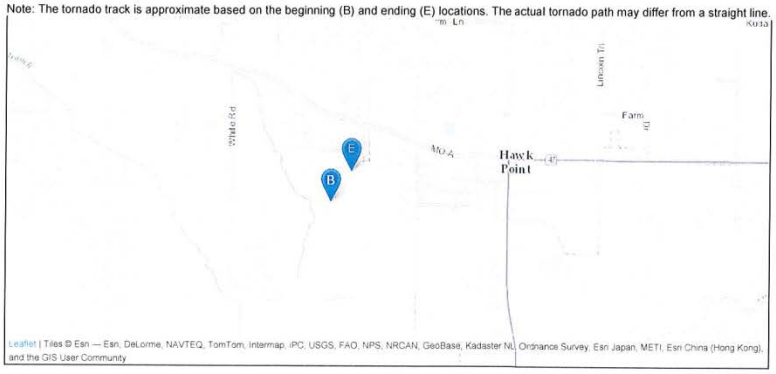
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**EF0**
-- Length	**0.21 Miles**
-- Width	**20 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**Trained Spotter**
NCEI Data Source	**CSV**
Begin Date	**2010-04-23 18:29:00.0 CST-6**
Begin Location	**1W HAWK PT**
Begin Lat/Lon	**38.97/-91.1486**
End Date	**2010-04-23 18:30:00.0 CST-6**
End Location	**1W HAWK PT**
End Lat/Lon	**38.9725/-91.1464**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	**0.00K**
Crop Damage	**0.00K**
Episode Narrative	**Storms formed south of a warm front and moved north, interacting with the frontal boundary. Some of the storms produced brief tornado touch downs, while others produced very heavy rainfall.**
Event Narrative	**A tornado briefly touched down in a field. No damage was reported.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
PENDLETON	WARREN CO.	MO	04/23/2010	17:40	CST-6	Tornado	EF0	0	0	0.00K	0.00K
NEW TRUXTON	WARREN CO.	MO	04/23/2010	18:11	CST-6	Tornado	EF0	0	0	0.00K	0.00K
HAWK PT	LINCOLN CO.	MO	04/23/2010	18:29	CST-6	Tornado	EF0	0	0	0.00K	0.00K
SILEX	LINCOLN CO.	MO	04/23/2010	18:48	CST-6	Tornado	EF0	0	0	0.00K	0.00K
CALIFORNIA	MONITEAU CO.	MO	04/23/2010	19:10	CST-6	Flash Flood		0	0	0.00K	0.00K
SILEX	LINCOLN CO.	MO	04/23/2010	19:14	CST-6	Tornado	EF0	0	0	0.00K	0.00K
MIDWAY	BOONE CO.	MO	04/23/2010	20:13	CST-6	Flash Flood		0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

Figure 3.24. Details and Path of April 23, 2010 Tornado, Silex/Millwood

National Centers for Environmental Information

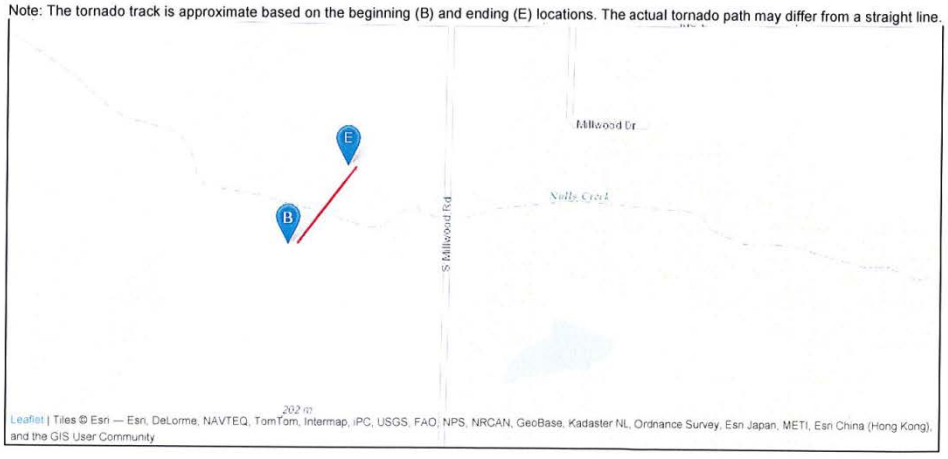
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**EF0**
-- Length	**0.11 Miles**
-- Width	**10 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**Storm Chaser**
NCEI Data Source	**CSV**
Begin Date	**2010-04-23 18:48:00.0 CST-6**
Begin Location	**3SW SILEX**
Begin Lat/Lon	**39.0993/-91.1096**
End Date	**2010-04-23 18:49:00.0 CST-6**
End Location	**0W MILLWOOD**
End Lat/Lon	**39.1006/-91.1083**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	**0.00K**
Crop Damage	**0.00K**
Episode Narrative	**Storms formed south of a warm front and moved north, interacting with the frontal boundary. Some of the storms produced brief tornado touch downs, while others produced very heavy rainfall.**
Event Narrative	**A tornado briefly touched down in a field. No damage was reported.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
PENDLETON	WARREN CO.	MO	04/23/2010	17:40	CST-6	Tornado	EF0	0	0	0.00K	0.00K
NEW TRUXTON	WARREN CO.	MO	04/23/2010	18:11	CST-6	Tornado	EF0	0	0	0.00K	0.00K
HAWK PT	LINCOLN CO.	MO	04/23/2010	18:29	CST-6	Tornado	EF0	0	0	0.00K	0.00K
SILEX	LINCOLN CO.	MO	04/23/2010	18:48	CST-6	Tornado	EF0	0	0	0.00K	0.00K
CALIFORNIA	MONITEAU CO.	MO	04/23/2010	19:10	CST-6	Flash Flood		0	0	0.00K	0.00K
SILEX	LINCOLN CO.	MO	04/23/2010	19:14	CST-6	Tornado	EF0	0	0	0.00K	0.00K
MIDWAY	BOONE CO.	MO	04/23/2010	20:13	CST-6	Flash Flood		0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

Figure 3.25. Details and Path of April 23, 2010 Tornado, Silex

National Centers for Environmental Information

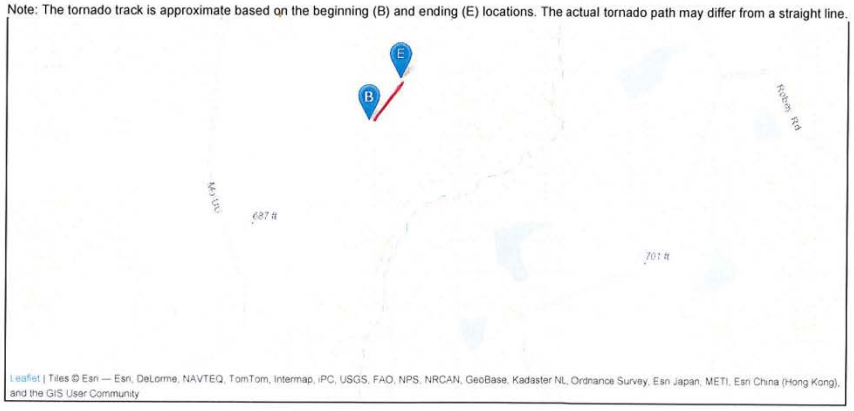
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**EF0**
-- Length	**0.14 Miles**
-- Width	**10 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**Trained SPOTTER**
NCEI Data Source	**CSV**
Begin Date	**2010 :14:00.0 CST-6**
Begin Location	**2NNE SILEX**
Begin Lat/Lon	**39.1583/-91.0586**
End Date	**2010-04-23 19:15:00.0 CST-6**
End Location	**2NNE SILEX**
End Lat/Lon	**39.1598/-91.0571**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	**0.00K**
Crop Damage	**0.00K**
Episode Narrative	**Storms formed south of a warm front and moved north, interacting with the frontal boundary. Some of the storms produced brief tornado touch downs, while others produced very heavy rainfall.**
Event Narrative	**A tornado briefly touched down in a field. No damage was reported.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
PENDLETON	WARREN CO.	MO	04/23/2010	17:40	CST-6	Tornado	EF0	0	0	0.00K	0.00K
NEW TRUXTON	WARREN CO.	MO	04/23/2010	18:11	CST-6	Tornado	EF0	0	0	0.00K	0.00K
HAWK PT	LINCOLN CO.	MO	04/23/2010	18:29	CST-6	Tornado	EF0	0	0	0.00K	0.00K
SILEX	LINCOLN CO.	MO	04/23/2010	18:48	CST-6	Tornado	EF0	0	0	0.00K	0.00K
CALIFORNIA	MONITEAU CO.	MO	04/23/2010	19:10	CST-6	Flash Flood		0	0	0.00K	0.00K
SILEX	LINCOLN CO.	MO	04/23/2010	19:14	CST-6	Tornado	EF0	0	0	0.00K	0.00K
MIDWAY	BOONE CO.	MO	04/23/2010	20:13	CST-6	Flash Flood		0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

Figure 3.26. Details and Path of January 29, 2014 Tornado, Chain of Rocks

National Centers for Environmental Information

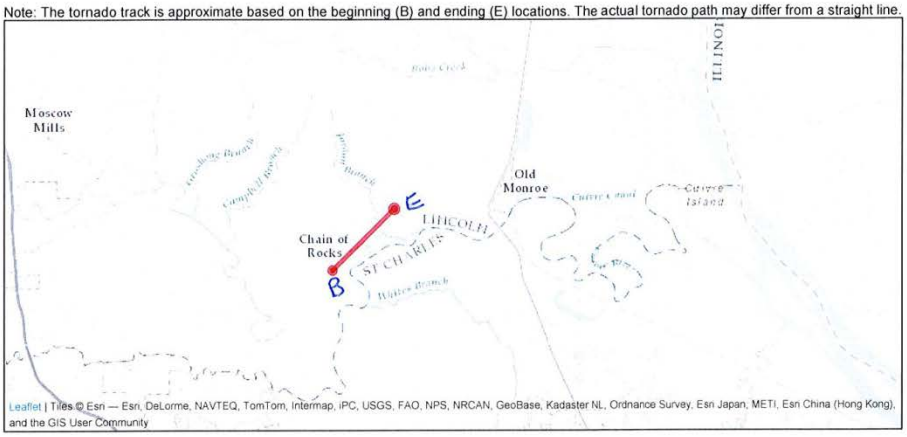
Storm Events Database

Event Details:

Event	Tornado
-- Scale	EF0
-- Length	1.68 Miles
-- Width	30 Yards
State	MISSOURI
County/Area	LINCOLN
WFO	LSX
Report Source	NWS Storm Survey
NCEI Data Source	CSV
Begin Date	2013-01-29 15:36:00.0 CST-6
Begin Location	1SW CHAIN OF ROCKS
Begin Lat/Lon	38.9113/-90.8305
End Date	2013-01-29 15:37:00.0 CST-6
End Location	1NE CHAIN OF ROCKS
End Lat/Lon	38.9282/-90.7987
Deaths Direct/Indirect	0/0 (fatality details below, when available...)
Injuries Direct/Indirect	0/0
Property Damage	
Crop Damage	0.00K
Episode Narrative	A strong cold front moved through the region, triggering showers and thunderstorms. Some of the thunderstorms produced large hail, damaging winds and a couple of tornadoes.
Event Narrative	A tornado touched down along Sycamore Bend Road just southwest of Chain of Rocks. A clear path of tree damage was found south of Sycamore Bend Road, where small branches were snapped from most of the trees within a path that was approximately 20 to 30 yards wide. Some minor roof damage was also noted in this area. The top of one pine tree was snapped off and the tree top was thrown to the northeast. The tornado crossed Sycamore Bend Road and continued northeastward along Jordan Road. A few tree trunks were snapped and several large branches were snapped among the trees along both sides of the road near the Jordan Branch Creek. Minor roof damage was found to several residences along Jordan Road north of the creek. The tornado lifted just south of Highway C.

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
ST MARTIN	COLE CO.	MO	01/29/2013	12:45	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
HOLTS SUMMIT	CALLAWAY CO.	MO	01/29/2013	13:00	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
WILLIAMSBURG	CALLAWAY CO.	MO	01/29/2013	13:30	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
ARGYLE	OSAGE CO.	MO	01/29/2013	14:20	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
BYRON	OSAGE CO.	MO	01/29/2013	14:30	CST-6	Hail	0.88 in.	0	0	0.00K	0.00K
JUDGE	OSAGE CO.	MO	01/29/2013	14:40	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
CONCORD HILL	WARREN CO.	MO	01/29/2013	15:14	CST-6	Tornado	EF1	0	0	0.00K	0.00K
FLINT HILL	ST. CHARLES CO.	MO	01/29/2013	15:29	CST-6	Thunderstorm Wind	52 kts. EG	0	0	0.00K	0.00K
CHAIN OF ROCKS	LINCOLN CO.	MO	01/29/2013	15:36	CST-6	Tornado	EF0	0	0	0.00K	0.00K
OLD MONROE	LINCOLN CO.	MO	01/29/2013	15:37	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

Figure 3.27. Details and Path of June 13, 2015 Tornado, Hawk Point

National Centers for Environmental Information

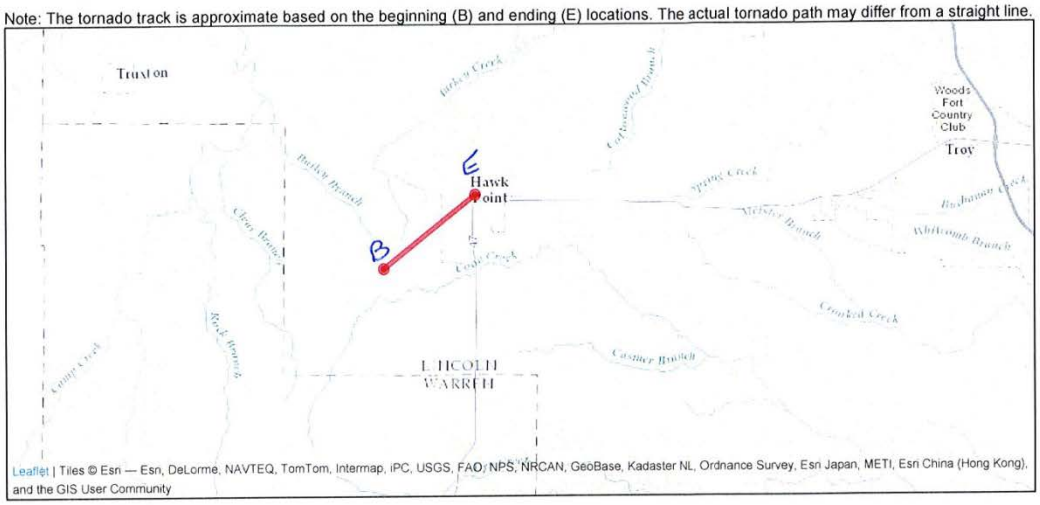
Storm Events Database

Event Details:

Event	**Tornado**
-- Scale	**EF1**
-- Length	**1.95 Miles**
-- Width	**50 Yards**
State	**MISSOURI**
County/Area	**LINCOLN**
WFO	**LSX**
Report Source	**NWS Storm Survey**
NCEI Data Source	**CSV**
Begin Date	**2015-06-13 17:45:00.0 CST-6**
Begin Location	**2WSW HAWK PT**
Begin Lat/Lon	**38.9572/-91.1576**
End Date	**2015-06-13 17:50:00.0 CST-6**
End Location	**0N HAWK PT**
End Lat/Lon	**38.9748/-91.1292**
Deaths Direct/Indirect	**0/0** (fatality details below, when available...)
Injuries Direct/Indirect	**0/0**
Property Damage	**0.00K**
Crop Damage	**0.00K**
Episode Narrative	**As a cold front approached the region, thunderstorms developed ahead of it producing some severe weather.**
Event Narrative	**A weak tornado formed on the leading edge of a line of thunderstorms as it approached the town of Hawk Point in Lincoln County, Missouri. The tornado touched down at a farm home where 3 trees were uprooted or snapped. Minor damage occurred at the home, but an outbuilding was completely destroyed with large debris thrown over 100 yards into an adjacent farm field. The tornado continued on the ground for another almost 2 miles, causing relatively minor damage to homes in the town of Hawk Point. Several large trees were uprooted as well, however the ground was very wet due to previous rains. The tornado severely damaged a business on the north side of town, but the damage was likely exacerbated by implosion of a garage bay door, allowing the roof to be lifted off and one exterior wall to collapse. The tornado lifted shortly thereafter. No injuries or deaths were reported. The tornado was rated EF1 with a max path width of 50 yards. The tornado path length was 1.95 miles.**

Event Map:

Note: The tornado track is approximate based on the beginning (B) and ending (E) locations. The actual tornado path may differ from a straight line.



All events for this episode:

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
PROVIDENCE	BOONE CO.	MO	06/13/2015	15:55	CST-6	Thunderstorm Wind	56 kts. EG	0	0	0.00K	0.00K
HAWK PT	LINCOLN CO.	MO	06/13/2015	17:45	CST-6	Tornado	EF1	0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

Probability of Future Occurrence

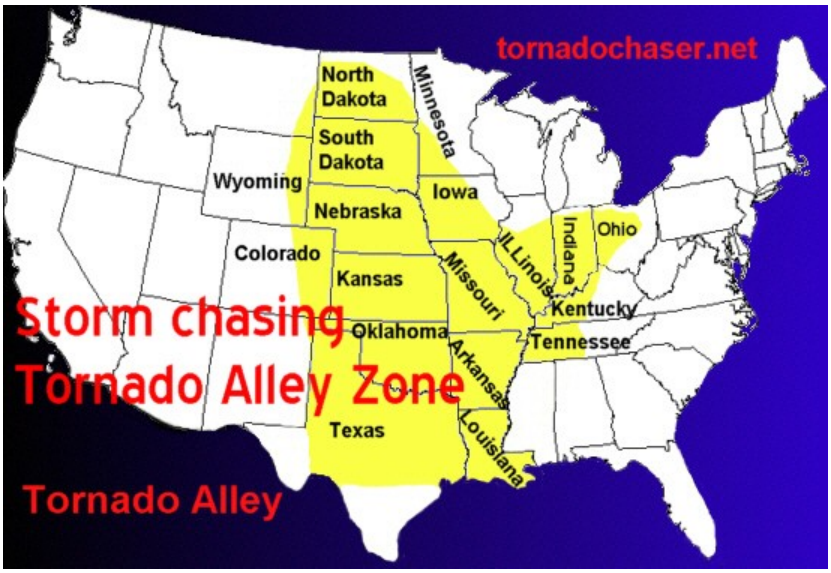
Using the NCDC data of 10 tornadoes between 2005 and 2015, the probability of a tornado striking Lincoln County in any given year is 100%.

Vulnerability

Vulnerability Overview

Lincoln County is located within a region of the U.S. with a high frequency of dangerous and destructive tornadoes referred to as "Tornado Alley". The term first appeared in 1952 as the title of a research project focusing on severe weather in parts of Texas, Oklahoma, Kansas, North and South Dakota, Iowa, Missouri, New Mexico, Colorado, and Minnesota. It is a largely media-driven term.

Figure 3.28. Tornado Alley in the U.S.



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

The state HMP vulnerability analysis measured the likelihood of future tornado impacts, average annual property loss ratio (total building exposure value divided by average annualized historic losses), population change (percent change), and housing change (percent change). Scales were created to rank these factors: likelihood (1-3), loss ratio with exposure as of 2012 (1-3), population change from 2000 - 2010 (1-3), housing change from 2000-2010 (1-3). The factor scores were added up for each county for the purposes of ranking the counties by total vulnerability. This approach attempts to identify where tornadoes could have the greatest impacts. Devastating tornadoes could still impact counties that ranked lower in this process.

For this reason, the low end of the risk is still considered Moderate and the top end Very High. Counties with a total risk score of eight to nine were considered to be at very high risk. The rating values of all factors were then combined to determine the overall vulnerability rating.

The two-part table below, taken from the 2013 Missouri State Hazard Mitigation Plan, shows Lincoln County's total vulnerability as Very High. Lincoln County is one of the 5 fastest growing counties in the state which partially accounts for its total vulnerability being scored Very High. Note that the number of tornados and the percent likelihood of occurrence differ from either of the previously cited numbers. This is likely due to the range of years the state used for their calculations.

Table 3.41. Vulnerability Calculations from 2013 Missouri HMP

County	# Tornados	Likelihood of Occurrence	Probability Rating	Total Exposure	Annualized Historical Loss	Loss Ratio
Lincoln	16	26.02%	2	$ 4,340,031,000	$ 89,265	0.002%

Loss Ratio Rating	Population Growth % Change	Population Change Rating	Housing % Change	Housing Ratio Change	Total Vulnerability
1	35.0%	3	36.50%	3	Very High

Source: 2013 Missouri State Hazard Mitigation Plan

Potential Losses to Existing Development

Lincoln County has a total exposure of over $4B and an annualized historic loss of $89,265 making the county's vulnerability to loss Very High.

Future Development

Future development is factored into the vulnerability rating above which accounts for a 35.0% population growth and a 36.50% increase in housing. These numbers are likely to be tempered due to a stagnant economy and slow housing market. In addition, three tornado sirens are to be installed during 2017 with the assistance of a FEMA HMA grant.

Hazard Summary by Jurisdiction

A tornado event could occur anywhere in the planning area, but some jurisdictions would suffer heavier damages because of the age of the housing or the high concentration of mobile homes. According to the 2010-2014 ACS Estimates, there are 3,822 mobile homes in the county which account for approximately 18.2% of housing. There are no tornado sirens in unincorporated Lincoln County; however, the chart below lists municipal siren locations.

Table 3.42. Municipal Tornado Sirens in Lincoln County

Municipality	Siren No.	Location
Troy	1	The Legends Subdivision
Troy	2	Water Plant on Boone Street
Troy	3	Behind old City Hall, 200 Main Street
Troy	4	Third and Travis

Municipality	Siren No.	Location
Troy	5	East Cherry Street
Troy	6	MO 47 at Store It and Go Lot (West)
Troy	7	Old Moscow Mills Road and Elm Tree
Troy	8	Crooked Creek on Adelhart (Middle Entrance)
Elsberry	1	Second and Griffin
Elsberry	2	900 Block of Brownsmills Road
Hawk Point	1	121 West Lincoln
Moscow Mills	1	Main Street at Lindenwood
Moscow Mills	2	Tropicana Village Drive
Winfield	1	120 Water Tower Lane
Winfield	2	304 Second Street

Problem Statement

Tornados occur in Lincoln County and they are completely random, striking at will wherever they please. The risk of a tornado is the same in any part of the county but the likelihood of death, injury, and damage is most likely in more developed parts of the county.

3.4.10 Wild Fires

Hazard Profile

Hazard Description

Fire incident types for wild fires include; 1) natural vegetation fire, 2) outside rubbish fire, 3) special outside fire, and 4) cultivated vegetation fire (crop fire).

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

Geographic Location

The risk of wild fires is higher in communities with more wildland–urban interface (WUI) areas. WUI refers to the zone of transition between unoccupied land and human development and needs to be defined in the plan. Within the WUI, there are two specific areas identified: 1) Interface and 2) Intermix. The interface areas are those areas that abut wildland vegetation and the Intermix areas are those areas that intermingle with wildland areas. The following figure shows the Wild Land / Urban interface for Lincoln County. Most of the WUI in Lincoln County is Low Density Intermix and Low Density Interface.

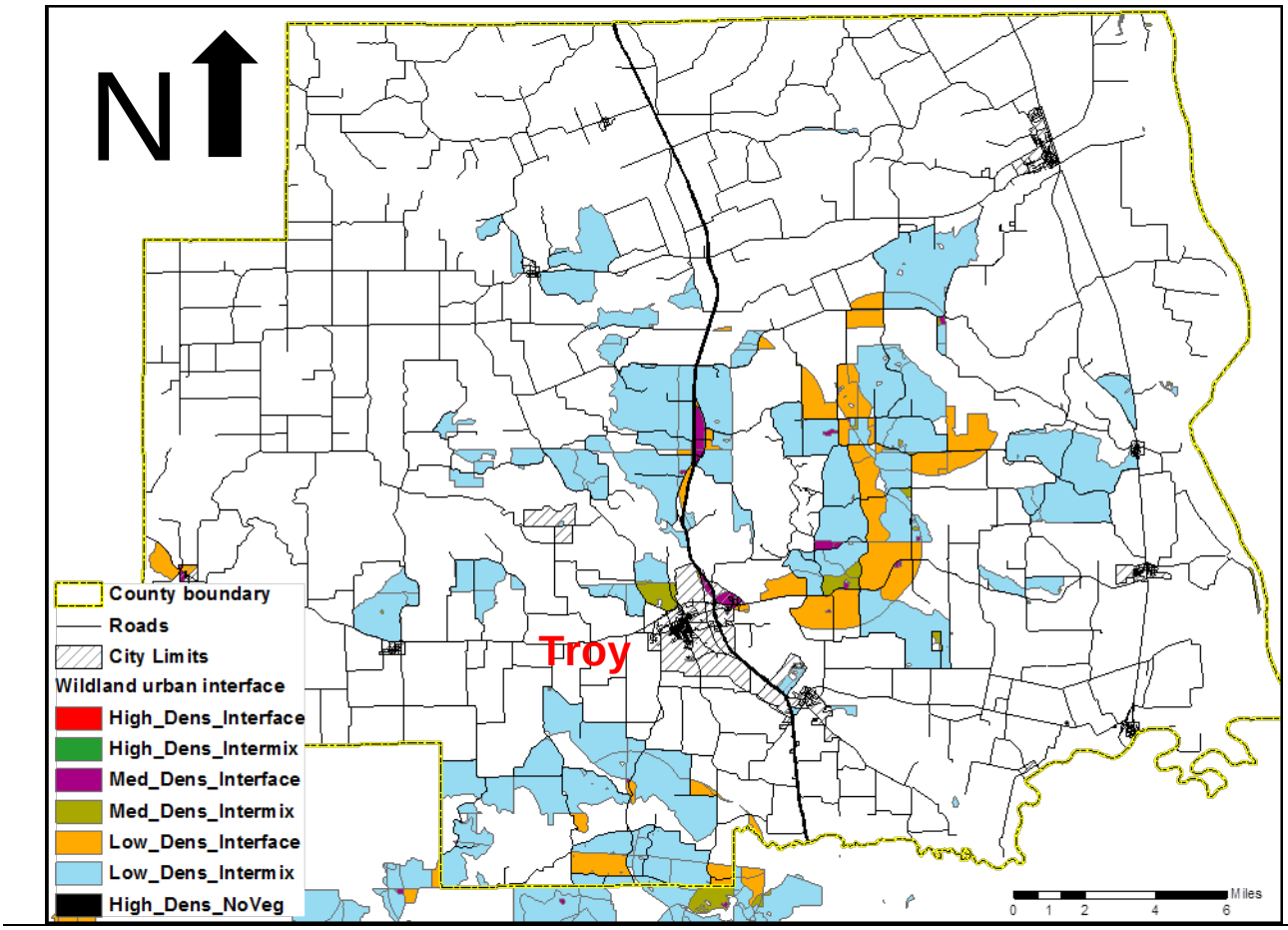


Figure 3.29. Wild Land / Urban Interface of Lincoln County

Source: USDA Forrest Service

Severity/Magnitude/Extent

Wildfires damage the environment, killing some plants and occasionally animals. Firefighters have been injured or killed, and structures can be damaged or destroyed. The loss of plants can heighten the risk of soil erosion and landslides. Although Missouri wildfires are not the size and intensity of those in the Western United States, they could impact recreation and tourism in and near the fires. Wild fires in Missouri have been mostly a result of human activity rather than lightning or some other natural event. Wildfires in Missouri are usually surface fires, burning the dead leaves on the ground or dried grasses. They do sometimes “torch” or “crown” out in certain dense

evergreen stands like eastern red cedar and shortleaf pine. However, Missouri does not have the extensive stands of evergreens found in the western US that fuel the large fire storms seen on television news stories.

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

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

Previous Occurrences

According to SEMA, wildfires are most common in the southern districts of the state. However, it is possible for wildfires to occur in Lincoln County due to drought, debris burning, and incendiary fires. Debris burning is consistently the number one cause of wildfires. Incendiary fires, willfully set on another person's property, continue to rank second in the number of wildfires each year. Fires caused by natural ignition, like lightning, are rare despite 50 to 70 thunderstorm days per year.

According to the Missouri Department of Conservation website data, during the period of January 1, 2005 through December 31, 2015; 479 wild fires burned 2,600 acres in Lincoln County. Ninety-three residences were threatened, seven residences damaged, and one residence destroyed. During the same period, 26 outbuildings were threatened, nine outbuildings were damaged, and one destroyed. Four commercial buildings were threatened and none destroyed. Almost half the fires were attributed to debris burning, 34% were of unknown origins, 5% each were classified as Miscellaneous and Equipment, 4% were caused by smoking, and the remaining fires were split between arson, children, campfires, and lightning.

There are no records of schools being damaged or threatened by wild fires in Lincoln County.

Probability of Future Occurrence

Lincoln County experienced 479 wildfires over the period of 15 years for an average of 32 wildfires each year. The average acreage burned per fire is 5.4 acres while the number of acres that appears most frequently, the mode, is one acre.

Vulnerability

Vulnerability Overview

Most of Lincoln County is vulnerable to wildfire; however, damage to property has been minor and no human deaths or injuries can be attributed to them.

Potential Losses to Existing Development

There is no reason to believe that significant changes to wildfire vulnerability will take place.

Impact of Future Development

There is significant growth in unincorporated areas of the county increasing the exposure to wildfire damage. However, as stated earlier, the risk is low and does not promise to increase significantly in the near term.

Problem Statement

Lincoln County will continue to experience wildfire events on a regular basis. However, the acreage burned is relatively small, just two buildings have been destroyed, and there has been no loss of life. It is reasonably certain that wildfire will not be a significant contributor to hazards in the county.

3.4.11 Winter Weather / Snow / Ice / Severe Cold

Hazard Profile

Hazard Description

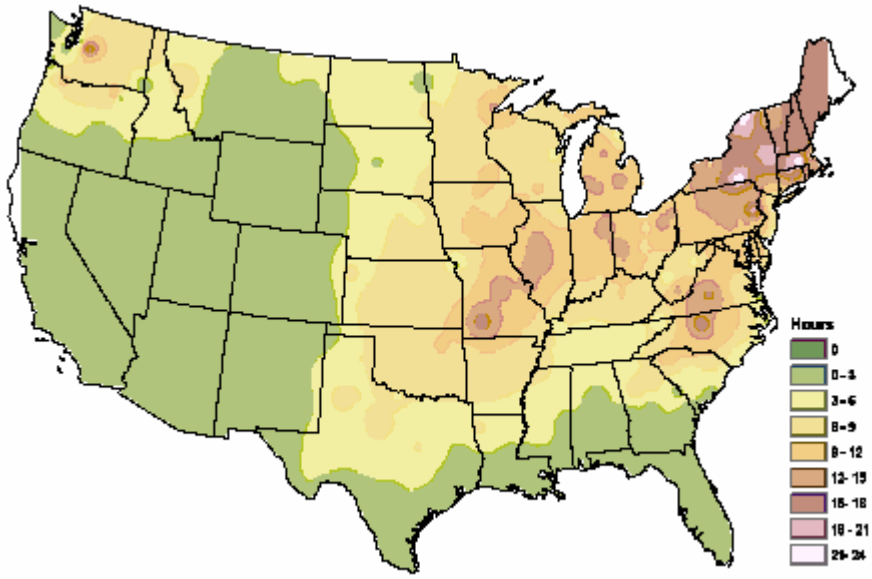
A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. The National Weather Service describes different types of winter storm events as follows.

- Blizzard—Winds of 35 miles per hour or more with snow and blowing snow reducing visibility to less than 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 county is vulnerable to heavy snow, ice, extreme cold temperatures and freezing rain. The figure below shows the average number of hours per year the county receives freezing rain. In the case of Lincoln County the average number of hours per year is 16-18.

Figure 3.30. NWS Statewide Average Number of Hours per Year with Freezing Rain



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

Severity/Magnitude/Extent

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

Extreme cold often accompanies severe winter storms and can lead to hypothermia and frost bite in people without adequate clothing protection. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators. Cold temperatures can also overpower a building’s heating system and cause water and sewer pipes to freeze and rupture. Extreme cold also

increases the likelihood for ice jams on flat rivers or streams. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is hazardous to health and safety.

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

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

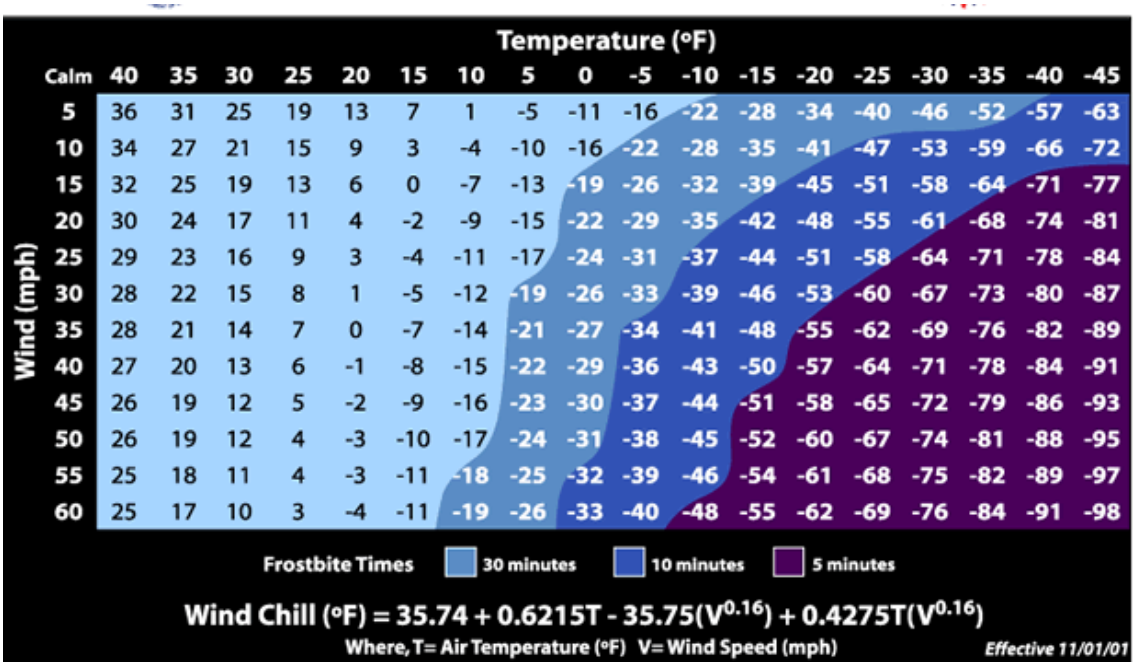
Buildings with overhanging tree limbs are more vulnerable to damage during winter storms when limbs fall. Businesses experience loss of income as a result of closure during power outages. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to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

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

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

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

Figure 3.31. Wind Chill Chart



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

Winter storms, cold, frost and freeze take a toll on crop production in the planning area. The table below shows the USDA's Risk Management Agency payments for insured crop losses in Lincoln County as a result of cold conditions and snow for the past 10 years resulting in $408,000 in claims.

Table 3.43. Crop Insurance Claims Paid in Lincoln County as a Result of Cold Conditions and Snow, 2005 - 2015

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Wheat	Cold Wet Weather	$88
2005	Corn	Freeze	$139
2005	Corn	Cold Weather	$1,173
2005	Soybeans	Cold Wet Weather	$1,692
2006	Corn	Cold Wet Weather	$816
2006	Soybeans	Cold Wet Weather	$8,929
2007	Wheat	Freeze	$19,694
2007	Corn	Cold Wet Weather	$810
2007	Soybeans	Cold Wet Weather	$1,748
2008	Wheat	Cold Wet Weather	$3,806
2008	Corn	Cold Wet Weather	$900
2009	Wheat	Freeze	$1,128
2009	Wheat	Cold Weather	$9,150

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2009	Wheat	Snow	$1,249
2009	Corn	Cold Wet Weather	$14,381
2009	Sorghum	Freeze	$3,880
2009	Soybeans	Cold Weather	$386
2010	Wheat	Cold Weather	$10,937
2010	Wheat	Cold Wet Weather	$52,646
2011	Wheat	Cold Wet Weather	$4,609
2011	Soybeans	Cold Wet Weather	$2,173
2012	Corn	Cold Wet Weather	$12
2012	Corn	Snow	$107,126
2013	Wheat	Cold Wet Weather	$9,825
2013	Wheat	Snow	$9,745
2013	Corn	Cold Wet Weather	$3,645
2013	Corn	Snow	$4,465
2014	Wheat	Freeze	$72,318
2014	Wheat	Cold Weather	$16,528
2014	Wheat	Cold Wet Weather	$35,481
2014	Corn	Cold Wet Weather	$4,935
2014	Soybeans	Cold Wet Weather	$4,431
2015	NA	NA	$0
TOTAL			**$408,845**

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

Previous Occurrences

Since 2006, Lincoln County received four presidential major disaster declarations, and four USDA declarations for this hazard, listed in the table below.

Table 3.44. Disaster Declarations in Lincoln County Involving Winter Storms

Declaration Date	Description	Declaration Type	Disaster Number
January 30, 2009	Severe Winter Storms	Presidential- Major Disaster Declaration	FEMA 3303-DR
March 19, 2008	Severe Winter Storms	Presidential- Major Disaster Declaration	FEMA 1749-DR
December 27, 2007	Severe Winter Storms	Presidential- Major Disaster Declaration	FEMA 1736-DR
December 12, 2007	Severe Winter Storms	Presidential- Major Disaster Declaration	FEMA 3281-DR
January 14, 2007	Severe Winter Storms	Presidential- Major Disaster	FEMA 1676-DR

Declaration Date	Description	Declaration Type	Disaster Number
		Declaration	
December 1, 2007	Winter Storms	USDA	M1676
December 6, 2007	Winter Storms	USDA	N1736
January 12, 2007	Winter Storms	USDA	N873
March 30, 2007	Winter Storms	USDA	S2532

Source: NCDC

The table below shows NCDC reported events and damages for the past 10 years.

Table 3.45. NCDC Lincoln County Winter Weather Events Summary, 2005 - 2015

Date	Event	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
11/30/2006	Winter Storm	NA	0	0	$ -	$ -
12/1/2006	Winter Storm	NA	0	0	$ -	$ -
1/12/2007	Ice Storm	NA	0	0	$ -	$ -
12/6/2007	Winter Weather	NA	0	0	$ -	$ -
12/8/2007	Ice Storm	NA	0	0	$ -	$ -
12/15/2007	Heavy Snow	NA	0	0	$ -	$ -
1/31/2008	Heavy Snow	NA	0	0	$ -	$ -
2/1/2008	Heavy Snow	NA	0	0	$ -	$ -
2/21/2008	Sleet	NA	0	0	$ -	$ -
1/1/2010	Cold/Wind Chill	NA	0	0	$ -	$ -
1/6/2010	Winter Weather	NA	0	0	$ -	$ -
1/19/2011	Heavy Snow	NA	0	0	$ -	$ -
1/31/2011	Winter Storm	NA	0	0	$ -	$ -
2/1/2011	Winter Storm	NA	0	0	$ -	$ -
2/1/2011	Blizzard	NA	0	0	$ -	$ -
2/21/2013	Winter Storm	NA	0	0	$ -	$ -
3/24/2013	Heavy Snow	NA	0	0	$ -	$ -
1/5/2014	Winter Storm	NA	0	0	$ -	$ -
1/5/2014	Winter Storm	NA	0	0	$ -	$ -
1/6/2014	Cold/Wind Chill	NA	0	0	$ -	$ -
2/4/2014	Winter Storm	NA	0	0	$ -	$ -
2/15/2015	Heavy Snow	NA	0	0	$ -	$ -

Source: NCDC, data accessed August 16, 2016

Probability of Future Occurrence

According to NCDC data above, Lincoln County has suffered 22 winter events during the past 10 years. This gives the county a 100% chance of receiving severe winter weather of some type during any given year. The average number of events per year is 2.2

Vulnerability

Vulnerability Overview

Severe Winter Weather including snow, ice, and severe cold has caused more damage for Missourians in recent years with five Presidential Declarations since 2007. The method used by the State of Missouri to determine vulnerability to severe winter weather across Missouri was statistical analysis of data from several sources: National Climatic Data Center (NCDC) storm events data (1993 to December 2012), FEMA's Public Assistance (PA) funds from DR-1672, DR-1736, DR-1748, DR-1822, and DR-1961, Crop Insurance Claims data from USDA's Risk Management Agency (1998-2012), total building exposure from HAZUS-MR4, U.S. Census Data (2000), and the USDA's Census of Agriculture (2007).

The following table provides the housing density, building exposure, crop exposure, total incidents, total property loss, and the total crop insurance paid. These are the common data elements for the analysis of severe winter weather. The total property loss column represents a combination of NCDC and FEMA PA funds. For declared events, the PA damage figures were used in lieu of NCDC data. NCDC damages

Table 3.46. Vulnerability of Lincoln County to Winter Weather

County	Housing Units/sq. mi.	Total Building Exposure	Crop Exposure (2007)	Total Incidents	Total $ Property Loss	Total Crop Insurance Paid
Lincoln	33.5	$4,340,031,000	$39,235,000	44	$3,367,547	$132,678

Source: 2013 Missouri State Hazard Mitigation Plan

Potential Losses to Existing Development

NCDC reflects property damage totaling $3.4M over 10 years. Under-reporting and other data limitations may have caused this figure to be lower than it should, but the fact remains that most damages associated with winter weather involve automobile accidents and injuries incurred as people attempt to travel through the winter environment or compensate for low temperatures, rather than as a direct result of winter weather.

Future Development

Using the same vulnerability figures from the section on Tornados, where future development is factored into the vulnerability rating, a 35.0% population growth and a 36.5% increase in housing

will likely drive increased exposure for the county. These numbers are likely to be tempered due to a stagnant economy and slow housing market.

Problem Statement

Lincoln County has some vulnerability to severe winter weather, particularly in regard to transportation. Excessive snowfall, sleet, freezing rain, and icing conditions can overwhelm road crews, hamper emergency response, and bring commerce to a temporary halt.

3.4.12 Hazardous Materials

Hazard Profile

Hazard Description

A hazardous material is any substance or material in a quantity or form that may pose a reasonable risk to health, the environment, or property. Per the updated 2013 State Hazard Mitigation Plan, the hazardous materials included are substances such as toxic chemicals, fuels, nuclear wastes and /or products, and other radiological and biological or chemical agents. In this section, hazardous materials incidents from fixed facilities and transportation accidents are addressed.

Geographic Location

Three major highways cross the county: US 61 (North-South), Missouri Highway 47 (North/South) and Missouri Highway 79 (North-South along the Missouri River). One active railroad runs North-South paralleling the Mississippi River (Burlington Northern & Santa Fe). There are 253 Tier II facilities in Lincoln County that manufacture, store and use hazardous substances. Six pipelines run through the county. There are a number of fixed facilities in Lincoln County that use or store hazardous substances. The eastern edge of the county, including Missouri Highway 79, are located within flood plains. Flooding in the past has resulted in run-off of agricultural chemicals and petroleum products into the Mississippi River. A Hazardous Materials Flow Study was completed at the end of August, 2016.

In addition, the Callaway Nuclear Plant, operated by Ameren Electric of St. Louis, is located near Fulton, in Callaway County. Emergency Management agencies from the At Risk counties of Callaway, Gasconade, Montgomery, and Osage coordinate their Emergency Operations Plans with those of the Callaway plant. Lincoln County is not included in the planning as it is considered to be outside the anticipated risk zone. However, if unforeseen circumstances require portions of Lincoln County to be evacuated due to a release of radioactive material, Lincoln County is prepared to respond using its planned evacuation scenarios.

In the event of a serious hazardous materials incident in Lincoln County, most likely it will be a transportation-related accident. Hazardous materials are also transported daily over highways, rail, rivers, and through the skies. A hazardous material incident would mostly likely occur on US 61 or along the Burlington Northern & Santa Fe Railroad. Missouri Highways 47 and 79 could also be the