Jurisdiction	Housing Units 2010	Housing Units 2020	Change in Housing Units	Percent of Change
Foley	69	54	-15	-21.74%
Fountain N Lakes	71	64	-7	-9.86%
Hawk Point	288	293	5	1.74%
Moscow Mills	979	1316	337	34.42%
Old Monroe	113	118	5	4.42%
Silex	84	7	-77	-91.67%
Troy	4,141	4821	680	16.42%
Truxton	41	34	-7	-17.07%
Whiteside	32	24	-8	-25.00%
Winfield	568	589	21	3.70%

Source: U.S. Bureau of the Census

All sectors of Lincoln County continue to grow with the county being one of the top five fastest growing counties in the state. Most of the growth is anchored along US 61, Missouri Highway 47, and Missouri Highway 79 in and around Troy, Moscow Mills, and Winfield. Further west in the county, along Missouri Highway 47, the Hawk Point area continues to attract new residents.

3.3.2 Future Land Use and Development

The City of Troy and Winfield annexed new development areas. The City of Troy and Moscow Mills population has increased by more than 20%. The total number of housing units for Troy increased by 16% in 2020 and 34% for Moscow Mills.

City of Winfield and Elsberry are currently developing comprehensive plans to meet the development needs.

School Districts' Future Development

The Troy School District enrollment is currently 6,436 with projected growth to be 100 students per year through 2020. In addition, the district applied for funding a safe room with FEMA funds.

The Elsberry, Silex and Winfield districts reported no future development activities.

3.4 Hazard Profiles, Vulnerability, and Problem Statements

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

Hazard Profiles

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

- **Hazard Description:** This section consists of a general description of the hazard and the types of impacts it may have on a community or school/special district.
- **Geographic Location:** This section describes the geographic areas in the planning area that are affected by the hazard. Where available, use maps to indicate the specific locations of the planning area that are vulnerable to the subject hazard. For some hazards, the entire planning area is at risk.
- **Strength/Magnitude/Extent:** This includes information about the strength, magnitude, and extent of a hazard. For some hazards, this is accomplished with description of a value on an established scientific scale or measurement system, such as an EF2 tornado on the Enhanced Fujita Scale. This section should also include information on the typical or expected strength/magnitude/extent of the hazard in the planning area. Strength, magnitude, and extent can also include the speed of onset and the duration of hazard events. Describing the strength/magnitude/extent of a hazard is not the same as describing its potential impacts on a community. Strength/magnitude/extent defines the characteristics of the hazard regardless of the people and property it affects.
- **Previous Occurrences:** This section includes available information on historic incidents and their impacts. Historic event records form a solid basis for probability calculations. Tables are a good way to convey this data and when available. When data is available, tables showing random events for the past 20 years are included.
- **Probability of Future Occurrence:** The frequency of recorded past events is used to estimate the likelihood of future occurrences. Probability can be determined by dividing the number of recorded events by the number of years of available data and multiplying by 100. This gives the percent chance of the event happening in any given year. For events occurring more than once annually, the probability is reported as 100% in any given year, with a statement of the average number of events annually. For hazards such as drought that may have gradual onset and extended duration, probability is based on the number of months in drought in a given time-period and expressed as the probability for any given month to be in drought.
- **Changing Future Conditions Considerations:** In addition to the probability of future occurrence, changing future conditions were considered, including the effects of long-term changes in weather patterns and climate on the identified hazards.

Vulnerability Assessments

The vulnerability assessment will follow the hazard profile for each hazard. The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to damages from natural hazards. The vulnerability assessments are based on the best available county-level data available in the Missouri Hazard Mitigation plan (2018).

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

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

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

- **Vulnerability Overview:** The plan provides an overall summary of each jurisdiction's vulnerability to the identified hazards. The overall summary of vulnerability identifies structures, systems, populations or other community assets as defined by the community that are susceptible to damage and loss for hazard events.

- **Potential Losses to Existing Development:** For each participating jurisdiction, the plan describes the potential impacts of the hazard. Impact means the consequences of effect of the hazard on the jurisdiction and its assets. Assets are determined by the community and include, for example, people, structures, facilities, systems, capabilities, and/or activities that have value to the community. For example, impacts could be described by referencing historical disaster impacts and/or an estimate of potential future losses.

- **Previous and Future Development:** This section includes information on how changes in development have impacted the community's vulnerability to this hazard and describes how changes in development in known hazard prone areas since the previous plan have increased or decreased the community's vulnerability.

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

Problem Statements

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

3.4.1 Dam Failure

Hazard Profile

Hazard Description

A dam is defined by the National Dam Safety Act as an artificial barrier that impounds or diverts water and is at least 6 feet high and stores at least 50 acre-feet of water; or, is at least 25 feet high and stores at least 15 acre-feet. Missouri's DNR regulates the design, construction and maintenance of 4,100 non-federal, non-agricultural dams that are at least 35 feet high. Regardless of the size of the dam, dam owners have primary responsibility for the safe design, operation, and maintenance of their dams. They are responsible for providing early warning of problems at the dam, for developing an effective emergency action plan, and for coordinating that plan with local officials. The state has ultimate responsibility for public safety and many states regulate construction, modification, maintenance, and operation of dams. DNR's Dam Safety Division maintains a database of all dams regardless of federal, state, local or private ownership. Primary Levees are built and maintained by

the Army Corps of Engineers while Secondary Levees; i.e., those constructed on secondary rivers and streams, are regulated by the Corps who sets design and construction standards.

The failure of dams can result in injuries, loss of life, and damage to property and the environment. While levees are built solely for flood protection, dams often serve multiple purposes, one of which may be flood control. Severe flooding and other storms can increase the potential that dams and levees will be damaged and fail as a result of the physical force of the flood waters or overtopping. Dams are usually engineered to withstand a flood with a computed risk of occurrence. If a larger flood occurs, then that structure will likely be overtopped. If during the overtopping, the dam fails or is washed out, the water behind is released as a flash flood. Failed dams can create floods that are catastrophic to life and property, in part because of the tremendous energy of the released water. The problem of unsafe dams in Missouri was underscored by dam failures at Lawrenceton in 1968, Washington County in 1975, Fredericktown in 1977, and a near failure in Franklin County in 1978. On December 14, 2005, the Taum Sauk reservoir dam owned by Ameren Missouri failed. A 600-foot breech in the northwest side of the retention facility released 1.5 billion gallons of stored water into the Johnson Shut-Ins State Park in just 10 minutes. The waters destroyed the park and the park superintendent's house and swept the superintendent's family out of their house. All five family members survived. The lower reservoir was overtopped by the flow of the east fork of the Black River. As a precautionary measure, the City of Lesterville evacuated 100-150 people to higher ground. If the dam had failed during the summer months, during the park's peak use, it is likely that many lives would have been lost.

The 2011 floods in Missouri led to the Corps of Engineers having to release record levels of water through the Gavin Point Dam on the upper Missouri. This release caused downstream flooding; however, the reservoirs upstream were at 100% capacity. The difficult choice to release so much water was supported by local officials. In Wyatt, Missouri the Corps had to breach the Bird's Point Levee late at night, in order to reduce pressure on a floodwall protecting the town.

Oversight is extremely valuable to the owners as well as those people living downstream of the dam who could be flooded in the event the dam should fail. Dams can fail for many reasons. The most common are:

Piping	Internal erosion caused by embankment leakage, foundation leakage and deterioration of pertinent structures appended to the dam.
Erosion	Inadequate spillway capacity causing overtopping of the dam, flow erosion, and inadequate slope protection.
Structure Failure	Caused by an earthquake, slope instability or faulty construction.
Overtopping	Inadequate spillway design, debris blockage of spillways or settlement of the dam crest.

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

The National Inventory of Dams (NID) defines three levels of hazard potential; high, significant, and low, as accepted by the Interagency Committee on Dam Safety. The definitions are:

• **High;** Failure or incorrect operation will probably cause loss of human life.

• **Significant;** Failure or incorrect operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

• **Low;** Failure results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

Information can be obtained from:

National Resources Conservation Service: http://www.nrcs.usda.gov
DamSafetyAction.org: https://damsafety.org/missouri

Data for dams in Lincoln County has been collected from two sources; a listing by the Missouri Department of Natural Resources (MoDNR) and the National Inventory of Dams (NID). Each has its own system of classifying dams. Neither the MoDNR nor the NID hazard potential classifications references the condition of the dam. For the Risk Analysis, data was used from all MoDNR Class I and NID High Hazard dams.

Table 3.14 MoDNR Dam Hazard Classification Definitions

Hazard Class	Definition
Class I	Represents the most severe threat to public safety, life and property. Contains ten or more permanent dwellings or any public building. Inspections must occur every two years.
Class II	Represents a moderate threat to public safety, life and property. Contains 1-9 permanent buildings or 1 or more campgrounds with permanent water, sewer, and electrical services, or one or more industrial buildings. Inspections must occur every three years.
Class III	Represents the least severe threat to public safety, life and property. Inspections must occur every five years.

Source: Missouri Department of Natural Resources, http://dnr.mo.gov/env/wrc/docs/rules_reg_94.pdf

Table 3.15 NID Dam Hazard Classification Definitions

Hazard Class	Definition
High Hazard	Loss of at least one human life if dam fails
Significant Hazard	Possible loss of human life and likely significant property or environmental destruction
Low Hazard	• Equals or exceeds 25 feet in height and exceeds 15 acre-feet in storage • Exceed 6 feet in height and equal to or exceeds 50-acre feet in storage

Source: National Inventory of Dams

Geographic Location

Dams located within the planning area

According to the Missouri Department of Natural Resources, Dam and Reservoir Safety, Lincoln County has 69 dams, of which one is Class I, or High Hazard Dams. Of these, ten are state regulated.

This contrasts to the National Inventory of Dams; NID, that lists 1278 dams in Lincoln County, of which 78 are rated High Hazard and 44 are state regulated.

Table 3.16. MoDNR Class I Dams in Lincoln County

Dam Name	Class	Height (ft)	Drainage area (square miles)	State Regulated
Lake Lincoln Dam	I	69	980	Y
Clarence Cannon #15	I	57	3430	Y
Emert Lake Dam	I	25	95	
Hillside Gardens Lake Dam	I	30	170	
Lost Creek Pilot Watershed Dam F-4	I	29	51.2	
Crystal Lake Dam	I	20	200	
Suter Lake Dam	I	25	90	
Moore Lake Dam	I	25	26	
White Lake Dam	I	40	318	Y
Merenaught Farms Lake Dam	I	25	270	
Spring Branch Farm Lake Dam	I	25	95	
Woodlake Dam	I	23	200	
Reliable Chemical Co. Lake Dam	I	25	130	
Palmer Farms Lake Dam	I	25	230	
Luecke Lake Dam	I	25	470	
Genteman Lake Dam	I	30	100	
Lost Creek #2	I	44	1056	Y
Shady Eighty Ranch Lake Dam	I	39	125	Y
Lost Creek #1	I	36	678	Y
Trojan Lake Dam	I	20	710	
White Memorial Area Sec-16 Lake Dam	I	25	85	

Sources: Mo DNR Dams, Mo DNR Geology

Table 3.17. NID High Hazard Dams in Lincoln County

Dam Name	River	Nearest City	Owner's name	Dam height (feet)	Normal acre feet storage	EAP	Inspection date	EAP last revised date
Lake Lincoln Dam	Dry Branch Sugar Creek	Troy	Mo.. DNR Parks	69	1233	Y	1/9/2017	3/30/2011
Clarence Cannon #15	Bryants Creek	Elsberry	Lincoln Co. Soil and Water Dist.	57	2380	Y	3/15/2017	1/19/2011
Mccane lake Dam	Sandy Creek	Foley	Todd Mccane	25	40			
Schlueter-Heddinger Lake Dam	Keelstone Branch	Elsberry	E Schlueter & D. Heddinger	25	80			
Glosier Lake Dam	Lost Creek	Elsberry	Glosier Bros.	30	64			
Emert Lake Dam	Little Sugar Creek	Moscow Mills	Steve & Karla Emert	25	94			
Hillside Gardens Lake Dam	Barley Branch Sandy Creek	Foley	Hillside Gardens, Inc.	30	160			
Nelsen's Lake Dam	Sandy Creek	Foley	Alfred C Nelsen Sr.	30	80			
Christoffers on Lake Dam	Bobs Creek	Peruque	Hank Christofferson	20	86			
Boehm Lake Dam	Sandy Creek	Foley	Lawrence Boehm Sr.	25	54			
Clarence Cannon Mem Watershed Dam 34	Bryants Creek	Elsberry	Clar Cannon Memeorial Wrsd Subdistrict	25	66			
Schupman n Lake Dam	Coon Creek	Chain of Rocks	Irvan Schupmann	32	109			
Charles Geno Farm Pond Drive	West Fork Cuivre River	Troy	Charles Geno	33	224			
Terbrock Lake Dam	West Fork Cuivre River	Moscow Mills	Alvin Terbrock	20	86			
Touchette Lake Dam	Cuivre River	Chain Of Rocks	Francis Touchette	15	144			
Crystal Lake Dam	Big Creek	Chain of Rocks	Crystal Lakes Estates	20	107			
Suter Lake Dam	Bobs Creek	Peruque	Ronald Suter	25	107			
Lost Creek Pilot Watershed Dam F-4	Lost Creek	Elsberry	Robert Pirtle	29	255	Y	6/14/1979	
Moore Lake Dam	Cuivre River	Chain of Rocks	Louella Moore	25	54			

Dam Name	River	Nearest City	Owner's name	Dam height (feet)	Normal acre feet storage	EAP	Inspection date	EAP last revised date
Wollgast Lake Dam	Sandy Creek	Foley	Carl Wollgast	25	40			
Henebry Lake Dam	West Fork Cuivre River Offstream	Davis	James B Henebry	25	67			
White Lake Dam	Mill Creek Tributary	Whiteside	Mo. Dept. of Conservation	40	458	Y	4/27/2016	4/12/2011
Merenaught Farms Lake Dam	Sandy Creek	Foley	Naughton Lane	25	67			
Gooch Lake Dam	Cuivre River	Moscow Mills	Leon Gooch	25	80			
Peek Lake Dam – Sec 13	Upper Sandy Creek	Foley	Chas M Peek	30	80			
Girl Scout Lake Dam	Sugar Creek	Moscow Mills	Girl Scout Council	30	128			
Spring Branch Farm Lake	Little Sugar Creek	Moscow Mills	Spring Branch Farm	25	107			
Woodlake Dam	Coon Creek	Chain of Rocks	Hulon D McDaniel	23	209			
Burkemper Lake	Spring Creek	Moscow Mills	Tom Burkemper	25	94			
Wm Logan State Wildlife Area Lk #4 Dam	Dry Branch Mill Creek	Silex	Mo. Dept. of Conservation	25	94			
Reliable Chemical Co. Lake Dam	North Fork Cuivre River	Silex	Reliable Chemical Co.	25	80			
Palmer Farms Lake Dam	Campbell Branch Cuivre River	Ethlyn	Palmer Farms	25	120			
Skyway Lake Dam	Bobs Creek	Old Monroe	Elmer Marx	31	166			
Westhoff Lake Dam	Bobs Creek	None	Leonard Westhoff, Jr.	19	73			
Luecke Lake Dam	Little Sandy Creek	Briscoe	Ralph Luecke	25	201			
Birkhead Lake Dam	Birkhead Br Bobs Creek	Peruque	Hubert Birkhead	30	80			
Girl Scouts Dam	Sugar Creek Offstream	Ashburn	Unknown	20	64			
Genteman Lake Dam	Coon Creek	Chain of Rocks	M G Genteman	30	96			

Dam Name	River	Nearest City	Owner's name	Dam height (feet)	Normal acre feet storage	EAP	Inspection date	EAP last revised date
Wendt Lake Dam	Brushy Fork	Peruque	Peter J Wendt	30	48			
Peek Lake Dam – Sec 18	Upper Sandy Creek	Foley	Chas M Peek	25	27			
Terrell Lake Dam	Sandy Creek	Foley	Rodney Terrell	25	54			
Campbell Lake Dam	Sandy Creek	Foley	Charles Campbell	25	40			
Ross-Mulvehill Lake Dam	Birkhead Branch Bobs Creek	Peruque	N & J Mulvehill	25	94			
Clarence Cannon Mem Watershed Dam 12	Old Kings Lake Creek	Elsberry	Cannon Mem Wrsd Subdistrict	25	295			
Lost Creek Pilot Watershed Dam E-1	Lost Creek	Elsberry	Daniel Horgan	30	127	Y	4/22/1990	
Stone Lake Dam	Camp Creek	Foley	Barry J Smith	37	165			
Lost Creek Pilot Watershed Dam F-2	Lost Creek	Elsberry	Gary Hagemeier	29	38			
Lost Creek Pilot Watershed Dam E-7	Lost Creek	Elsberry	Holland, Kempfer, Conrad, Lowry	31	269			
Lost Creek Pilot Watershed Dam E-2	Lost Creek	Elsberry	Ralph Hoelting	30	178			
Lost Creek Pilot Watershed Dam G-1	Union Creek	Elsberry	Hugh Steavenson Trust	31	313			
Lost Creek #2	Lost Creek	New Hope	Lost Creek Wtrsd Subdistrict	4	675	Y	12/7/2016	8/28/2014
Lost Creek Pilot Watershed Dam B-4	Lost Creek	Elsberry	George Segress	28	54			
Clarence Cannon Mem Watershed Dam 11	Bryants Creek	Elsberry	Cannon Mem Wrsd Subdistrict	33	128			

Dam Name	River	Nearest City	Owner's name	Dam height (feet)	Normal acre feet storage	EAP	Inspection date	EAP last revised date
Clarence Cannon Mem Watershed Dam 8	Bryants Creek	Elsberry	Cannon Mem Wrsd Subdistrict	27	190			
Clarence Cannon Mem Watershed Dam 9	Dry Fork Creek	Elsberry	Cannon Mem Wrsd Subdistrict	34	300			
Shady Eighty Ranch Lake Dam	Sugar Creek	Moscow Mills	Mo. DNR Parks	39	70	Y	7/13/2016	6/2/2014
Clarence Cannon Mem Watershed Dam 4	Bryants Creek	Elsberry	C Cannon Mem Watershed Subdistrict	34	828			
Lost Creek Pilot Watershed Dam D-6	Lost Creek	Elsberry	Richard Landgraf Trust	29	166			
Lost Creek #1	Lost Creek	Elsberry	Lammert Farms LP	36	699	Y	10/6/2015	9/2/2014
Clarence Cannon #1 Dam	Bryants Creek	Elsberry	Clar Cannon Meml Watershed	48	2064	Y	11/14/2017	1/19/2011
Indian Camp Lake Dam	Big Creek	Chain of Rocks	Robert Hotfelder	39	306		9/19/2017	
White Memorial Area Sec 16 Lake Dam	Little Sandy Creek	Whiteside	Mo. Dept of Conservation	25	94			
Mississippi River Lock and Dam 25	Mississippi River		USACE St. Louis District	25	176000	Y	7/6/2020	7/6/2015

Source: National Inventory of Dams, http://nid.usace.army.mil/cm_apex/f?p=838:12

Strength/Magnitude/Extent

None of the dams are located in close proximity to any city limits.

It should be noted that the severity/magnitude of dam failure would be similar in some cases to the impacts associated with flood events (see the flood hazard vulnerability analysis and discussion). Based on the hazard class definitions, failure of any of the High Hazard/Class I dams could result in a serious threat of loss of human life, serious damage to residential, industrial or commercial areas, public utilities, public buildings, or major transportation facilities. Catastrophic failure of any high

hazard dams has the potential to result in greater destruction due to the potential speed of onset and greater depth, extent, and velocity of flooding. Note that for this reason, dam failures could flood areas outside of mapped flood hazards.

It can be stated that the strength/magnitude of dam failure would be similar in some cases to flood events (see the flood hazard vulnerability analysis and discussion). The strength/magnitude/extent of dam failure is related to the volume of water behind the dam as well as the potential speed of onset, depth, and velocity. Note that for this reason, dam failures could flood areas outside of mapped flood hazards.

Previous Occurrences

There are no documented prior occurrences of dam failure in Lincoln County.

Probability of Future Occurrence

No failures of a high hazard dam have been reported during the past 21-year period thereby making a calculation of the probability of future occurrence meaningless. there are two factors that can impact dam failure; regulation and inspection. Regulation requires regular inspections which can determine issues that contribute to failure.

Changing Future Conditions Considerations

If we accept the climate change scenario that forecasts more dramatic periods of precipitation, we can then infer that more stress will be placed upon dams which will be more prone to failure. Couple that with an infrastructure of aging, uninspected, perhaps poorly maintained dams, and we have the makings of a serious problem for those living downstream. Most of Lincoln County's growth surrounding Highway 61 and Missouri Route 47 & 79 corridors where little additional potential for loss is likely.

Vulnerability

Vulnerability Overview

Vulnerability to dam failure is a factor due to the number of dams in the planning area. As there are no recorded dam failures and most of them are located in unincorporated areas, the planning committee chose only to address high hazard dams when funding becomes available.

Potential Losses to Existing Development

If any of the state-regulated dams with available inundation areas breach, it could account for loss of 13 agricultural, 5 commercial and 31 residential structures valued at $1.8 M and potential loss of life for up to 86 people.

Impact of Previous and Future Development

Most of Lincoln County's growth surrounds US Highway 61 and Missouri Highways 47 and 79 corridors where little additional potential for loss is likely.

Hazard Summary by Jurisdiction

While a dam break could flood many rural, unpopulated areas of the county, there are no specific areas with dam failures within the county.

Problem Statement

Areas at risk to inundation due to dam failure in Lincoln County are very minimal.

3.4.2 Drought

Hazard Profile

Hazard Description

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

- Meteorological drought is defined in terms of the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. A meteorological drought must be considered as region-specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

- Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (e.g., stream-flow, reservoir and lake levels, ground water).The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, stream-flow, and ground water and reservoir levels. As a result, these impacts also are out of phase with impacts in other economic sectors.

- Agricultural drought focus is on soil moisture deficiencies, differences between actual and potential evaporation, reduced groundwater or reservoir levels, etc. Plant demand for water depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

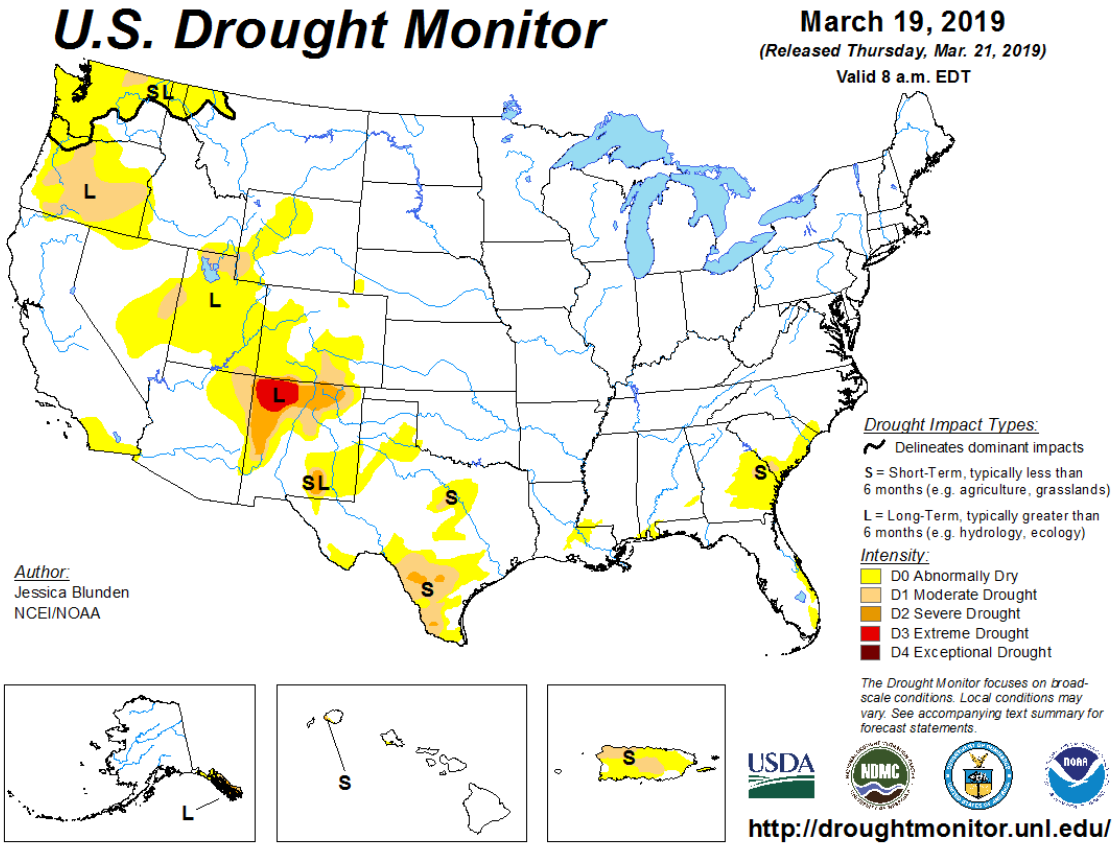
- Socioeconomic drought refers to when physical water shortage begins to affect people.

Geographic Location

The entire planning area is at risk to drought. Drought most directly impacts the agricultural sector which spreads evenly across the county, comprising 80% of surface land. There is no likelihood of this farmland being significantly reduced in the near term.

A recent map from the U.S. Drought Monitor shows a snapshot of the drought forecast for the planning area on March 21, 2019. Remember that it is only a snapshot of conditions at a given moment in time. A red circle shows the approximate location of the planning area.

Figure 3.1. U.S. Drought Monitor Map of Missouri on March 21, 2019



Strength/Magnitude/Extent

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

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

numbers.

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

Previous Occurrences

The table below shows crop losses attributable to drought from year 2000 to 2020. For the nearly 20-year period, crop losses due to drought totaled $17.8 million.

Table 3.18. Drought losses 2000-2020

Year	Acres	Dollars
2000	180.54	3,808.50
2001	949.52	30,364.00
2002	15,315.92	795,573.70
2003	5,775.24	276,607.10
2004	39.20	3,303.00
2005	19,010.58	916,981.06
2006	2,950.75	95,023.00
2007	12,776.21	931,356.65
2008	26.00	1,123.00
2009	0.00	0.00
2010	9.50	268.00
2011	0.00	0.00
2012	48,373.63	12,923,501.95
2013	5,082.89	333,473.24
2014	0.00	0.00
2015	634.64	98,213.20
2016	255.23	9,404.42
2017	2,940.53	233,943.37
2018	14,374.83	1,091,684.11
2019	16.56	56.43
2020	859.76	73,593.00
TOTAL	129,571.50	17,818,277.73

The NOAA Storm Events database lists two long-term drought events between January 2000 and December 31, 2020. According to SEMA's Declared Disasters in Missouri website, there were no drought disasters declared between 2000-2020.

Probability of Future Occurrence

There is not enough consistent data to accurately calculate probability of occurrence. However, if we use the twenty-one-year data from USDA in the chart above, we then have a range of 252 months of data. There are 18 years during which crop losses were reported. Assuming one month of drought for each of the 18 years, we then have 18 months. Hence, 18 months of 252 months were in drought, from which we can conclude an 7.14% change of drought in any given month. The 2018 State Plan forecasts Lincoln County to be in a severe drought or greater 9% -10.7% of the year.

Changing Future Conditions Considerations

Severe drought, a natural part of Missouri's climate, is a risk to the agriculture-dependent state. Although some predict climate change to increase precipitation, they also believe temperatures to rise thereby causing evaporation rates to burn off moisture thus increasing the potential for drought.

Vulnerability

Vulnerability Overview

The 2018 Missouri State Plan shows Lincoln County in Region B. Region B has moderate drought susceptibility. Groundwater resources are adequate to meet domestic and municipal needs, but crop irrigation well depths are prohibitively expensive. The State Plan ranks Lincoln County Drought Vulnerability as Medium-High.

Potential Losses to Existing Development

The National Drought Monitor Center at the University of Nebraska at Lincoln summarized the potential impacts of drought as follows: Drought can create economic impacts on agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn place both human and wildlife populations at higher levels of risk. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Finally, while drought is rarely a direct cause of death, the associated heat, dust and stress can all contribute to increased mortality. The 2018 State Plan annualizes crop losses to Lincoln County at $1.27M to $2.15M per year.

Impact of Previous and Future Development

Lincoln County continues to experience a reduction in agricultural acreage with the land use shifting toward residential and recreational areas as well as some light industrial facilities. This will mitigate crop and livestock impacts but may increase impacts to people and industries. As of this date, this are no known large-scale development plans that could impact the water supply.

Changing Future Conditions Considerations

A new analysis, performed for the Natural Resources Defense Council, examined the effects of climate change on water supply and demand in the contiguous United States. The study found that more than 1,100 counties will face higher risks of water shortages by mid-century as a result of climate change. Two of the principal reasons for the projected water constraints are shifts in

precipitation and potential evapotranspiration (PET). Climate models project decreases in precipitation in many regions of the U.S., including areas that may currently be described as experiencing water shortages of some degree. Lincoln County continues to experience a reduction in agricultural acreage with the land use shifting toward residential and recreational areas as well as some light industrial facilities. This will mitigate crop and livestock impacts but may increase impacts to people and industries. As of this date, this are no known large-scale development plans that could impact the water supply.

Hazard Summary by Jurisdiction

No area of Lincoln County is at more risk than others, although, agriculture will face the most financial risk.

Problem Statement

Agriculture-related businesses in Lincoln County will continue to face the risk of drought due to the county's geographic location. It will be helpful for communities to promote about water conservation measures and notify the residents when drought conditions might occur.

3.4.3 Earthquakes

Hazard Profile

Hazard Description

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

Eight earthquake seismic zones are located in the central United States, two of which are located in Missouri. The most active zone is the New Madrid Seismic Zone, which is also the most active seismic area in the United States east of the Rocky Mountains according to the U.S. Geological Survey. The New Madrid Zone is by some measures as high a risk for tremors as seismic zones in California. It runs from northern Arkansas through southeast Missouri and western Tennessee and Kentucky to the Illinois side of the Ohio River Valley. 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 the Bootheel region of southeast Missouri. Thousands of aftershocks continued for years.

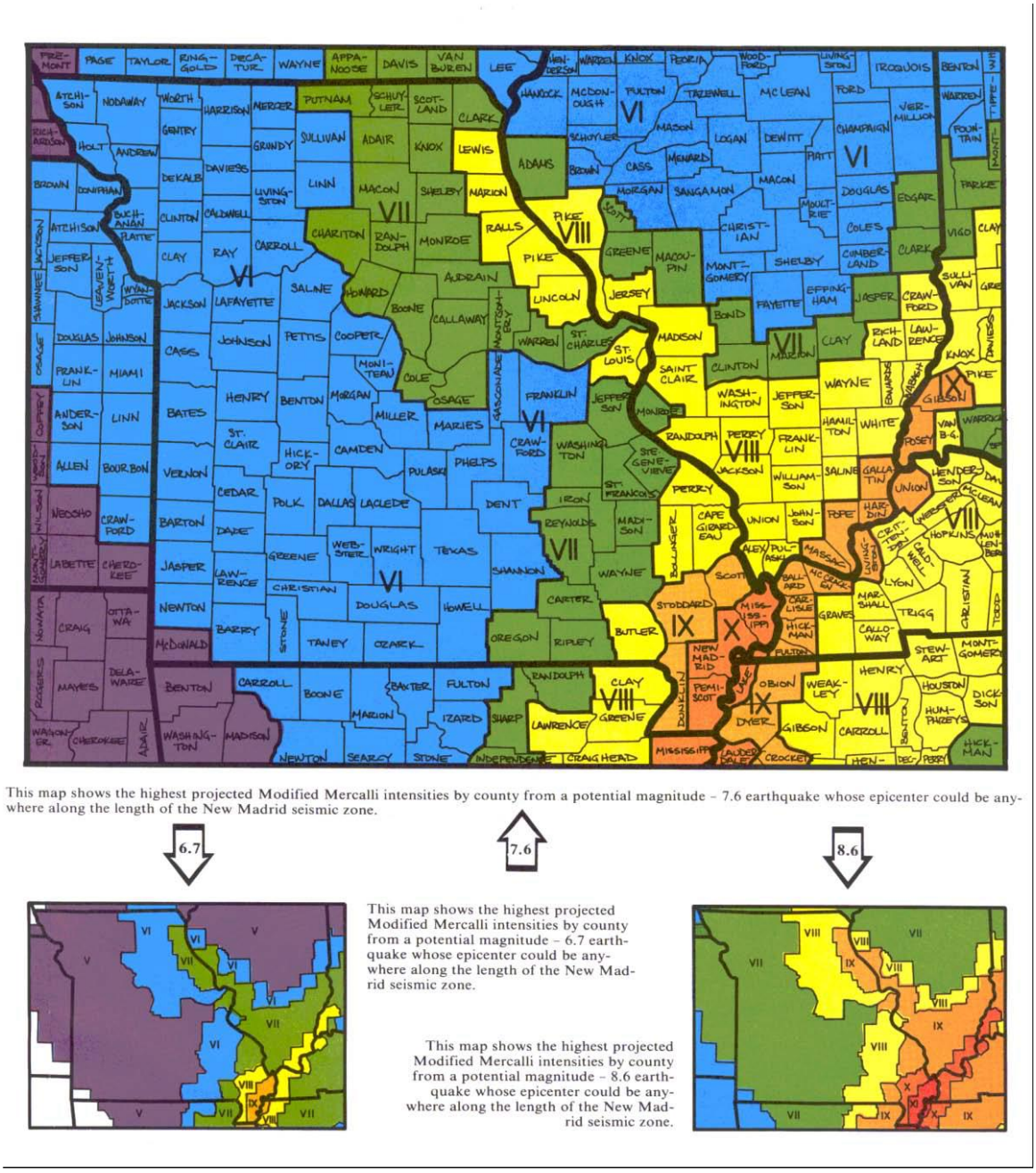
Significant earthquakes, each about magnitude 6, occurred in 1843 near Marked Tree, Arkansas, and on October 31, 1895 near Charleston, Missouri. In November 1968 a magnitude 5.5 earthquake centered in southeastern Illinois caused moderate damage to chimneys and walls at Hermann, St. Charles, St. Louis, and Sikeston, Missouri. The quake was felt in areas that 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.

Geographic Location

Of the potential earthquake risk zones, the New Madrid Fault Zone is the most likely to impact Lincoln County. The following figure illustrates the highest projected Modified Mercalli intensities by county from a potential magnitude 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid Seismic Zone.

Figure 3.2. Impact Zones for Earthquake Along the New Madrid Fault



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