CHAPTER 3 RISK ASSESSMENT

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

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The goal of the risk assessment is to estimate the potential losses in Kingman County, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities in Kingman County to better understand their potential risk from natural hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

The risk assessment for Kingman County and its jurisdictions followed the methodology described in the FEMA publication 386-2, *Understanding Your Risks: Identifying Hazards and Estimating Losses* (2002), which includes a four-step process:

- Identify Hazards
- Profile Hazard Events
- Inventory Assets
- Estimate Losses

This chapter is divided into three parts: hazard identification, hazard profiles, and vulnerability assessment:

- **Section 3.1, Hazard Identification,** identifies the hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.
- **Section 3.2, Hazard Profiles,** discusses the threat to the planning area and describes previous occurrences of hazard events and the probability of future occurrence.
- **Section 3.3, Vulnerability Assessment,** assesses the County's total exposure to natural hazards, considering critical facilities and other community assets at risk, and assessing growth and development trends.

3.1 Hazard Identification

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

3.1.1 Methodology

The Hazard Mitigation Planning Committee (HMPC) reviewed data and discussed the impacts of each of the hazards required for consideration by FEMA, which are listed alphabetically below:

- Avalanche
- Coastal Erosion
- Coastal Storm
- Dam/Levee Failure
- Drought
- Earthquake
- Expansive Soils
- Extreme Heat
- Flood
- Hailstorm
- Hurricane
- Land Subsidence
- Landslide
- Severe Winter Storm
- Tornado
- Tsunami
- Volcano
- Wildfire
- Windstorm

Data on the past impacts and future probability of these hazards in the Kingman County planning area was collected from the following sources:

- Federal Disaster Declarations from the Federal Emergency Management Agency (FEMA)
- USDA Farm Service Agency Disaster Declarations
- Kansas Hazard Mitigation Plan (November 2007)
- Information on past extreme weather and climate events from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center
- Information on past hazard events from the Spatial Hazard Event and Loss Database (SHELDUS), a component of the University of South Carolina Hazards Research Lab that compiles county-level hazard data for 18 different natural hazard event types
- Various articles and publications available on the Internet (sources are indicated where data is cited)

The HMPC eliminated some hazards from further profiling because they do not occur in the planning area or their impacts were not considered significant in relation to other hazards. Table 3.1 lists these hazards and provides a brief explanation for their elimination.

Table 3.1 Hazards Not Profiled in the Plan

Hazard	Explanation for Omission
Avalanche	There are no mountains in the planning area
Coastal Erosion	Planning area is not near coastal areas
Coastal Storm	Planning area is not near coastal areas
Fog	Although fog does occur in the planning area occasionally, the HMPC determined that the impacts are restricted primarily to traffic accidents and are difficult to mitigate
Hurricane	Planning area is not near coastal areas
Tsunami	Planning area is not near coastal areas
Volcano	There are no volcanic mountains in the planning area

The HMPC identified 10 natural hazards that significantly affect the planning area. These hazards are profiled in further detail in the next section. The HMPC agreed not to address manmade hazards, which are detailed in other documents such as the emergency operations plan.

- Agricultural Infestation
- Dam/Levee Failure
- Drought
  - Expansive Soils
- Earthquake
- Extreme Temperatures
- Flood
- Hailstorm
- Land Subsidence
- Landslide
- Lightning
- Soil Erosion and Dust
- Tornado
  - Windstorm
- Wildfire
- Winter Storm

3.1.2 Disaster Declaration History

One method used by the HMPC to identify hazards was to examine events that triggered federal and/or state disaster declarations. Federal and/or state declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration (SBA). FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. The quantity and types of damage are the determining factors.

A USDA disaster declaration certifies that the affected county has suffered at least a 30 percent loss in one or more crop or livestock areas and provides affected producers with access to low-interest loans and other programs to help mitigate the impact of the disaster. In accordance with the Consolidated Farm and Rural Development Act, all counties neighboring those receiving disaster declarations are named as contiguous disaster counties and, as such, are eligible for the same assistance.

Table 3.2 lists federal disaster declarations received by Kingman County. Many of the disaster events were regional or statewide; therefore, reported costs are not accurate reflections of losses to Kingman County.

Table 3.2 Disaster Declaration History in Kingman County, 1969-Present

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Constant 2006*
Major Disaster Declarations				
1699	5/6/2007 (5/4/2007)	Severe Storms, Tornadoes, and Flooding	Barton, Brown, Chase, Cherokee, Clay, Cloud, Comanche, Cowley, Dickinson, Doniphan, Douglas, Edwards, Ellsworth, Harper, Harvey, Jackson, Kingman, Kiowa, Leavenworth, Lincoln, Lyon, Marshall, McPherson, Morris, Nemaha, Osage, Osborne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Rice, Riley, Saline, Shawnee, Smith, Stafford, Sumner, Wabaunsee, Washington	$65,979,498
403	9/28/1973	Severe Storms, Tornadoes, Flooding	Atchison, Barber, Barton, Brown, Butler, Chase, Clay, Cloud, Coffey, Comanche, Cowley, Dickinson, Doniphan, Douglas, Edwards, Ellsworth, Franklin, Geary, Greenwood, Harper, Harvey, Jackson, Jefferson, Kingman, Kiowa, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Miami, Morris, Nemaha, Osage, Ottawa, Pawnee, Pottawatomie, Pratt, Reno, Republic, Rice, Riley, Saline, Sedgwick, Shawnee, Stafford, Sumner, Wabaunsee, Washington, Woodson, Wyandotte	$18,851,282
378	5/2/1973	Severe Storms, Flooding	Atchison, Barber, Barton, Bourbon, Brown, Butler, Chautauqua, Cherokee, Clark, Coffey, Crawford, Dickinson, Doniphan, Douglas, Edwards, Ellsworth, Ford, Franklin, Gray, Greenwood, Harper, Harvey, Haskell, Hodgeman, Jackson, Jefferson, Kingman, Kiowa, Labette, Leavenworth, Lincoln, Linn, Lyon, Marion, Marshall, McPherson, Meade, Miami, Montgomery , Morris, Nemaha, Ness, Osage, Osborne, Ottawa, Pawnee, Pottawatomie, Pratt, Reno, Republic, Rice, Rush, Russell, Saline, Sedgwick, Seward, Shawnee, Stafford, Stevens, Sumner, Wabaunsee, Washington, Woodson, Wyandotte	$8,829,200
Emergency Declarations				
3236	9/10/2005	Katrina Evacuation	All	$0

Sources: Federal Emergency Management Agency, www.fema.gov/; Public Entity Risk Institute, www.peripresdecusa.org/
*Incident dates are in parentheses

3.2 Hazard Profiles

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

3.2.1 Methodology

Each hazard identified in Section 3.1, Hazard Identification, is profiled individually in this section. The level of information presented in the profiles varies 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 Kingman County.

The sources used to collect information for these profiles include those mentioned in Section 3.1.1 as well as those cited individually in each hazard section.

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. It also includes a ranking to indicate typical warning times and duration of hazard events. Definitions for these rankings are included in Table 3.3.

Geographic Location

This section describes the geographic extent or location of the hazard in the planning area. Where available, maps are utilized to indicate the areas within the planning area that are vulnerable to the subject hazard.

Previous Occurrences

This section includes information on historic incidents and their impacts based upon the sources described in Section 3.1, Hazard Identification, and the information provided by the Hazard Mitigation Planning Committee.

Probability of Future Occurrence

The frequency of past events is used to gauge the likelihood of future occurrences. Where possible, the probability or chance of occurrence was calculated based on historical data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. An example would be three droughts occurring over a 30-year period, which suggests a 10 percent chance of a drought occurring in any given year. The probability was assigned a rank as defined in Table 3.3.

Magnitude/Severity

The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the location affected the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

Hazard Summary

To maintain a consistent reporting format, the Kingman HMPC used the methodology from the MitigationPlan.com planning tool to prioritize the hazards. This prioritization was based on a calculated priority risk index (CPRI) that considered four elements of risk: probability, magnitude/severity, warning time, and duration. Table 3.3 defines the rankings for each element of risk. The CPRI for each hazard is provided in this Hazard Summary section.

Table 3.3. Calculated Priority Risk Index (CPRI) Element Definitions

Element/Level	Characteristics
Probability	
4 - Highly Likely	Event is probable within the calendar year
	Event has up to 1 in 1 year chance of occurring (1/1=100%)
	History of events is greater than 33% likely per year
	Event is "Highly Likely" to occur
3 - Likely	Event is probable within the next three years
	Event has up to 1 in 3 years chance of occurring (1/3=33%)
	History of events is greater than 20% but less than or equal to 33% likely per year
	Event is "Likely" to occur
2 - Possible	Event is probable within the next five years
	Event has up to 1 in 5 years chance of occurring (1/5=20%)
	History of events is greater than 10% but less than or equal to 20% likely per year
	Event could "Possibly" occur
1 - Unlikely	Event is possible within the next 10 years
	Event has up to 1 in 10 years chance of occurring (1/10=10%)
	History of events is less than or equal to 10% likely per year
	Event is "Unlikely" but may possibly occur
Magnitude / Severity**	
4 - Catastrophic	Multiple deaths
	Complete shutdown of facilities for 30 or more days
	More than 50 percent of property is severely damaged
3 - Critical	Injuries and/or illnesses result in permanent disability
	Complete shutdown of critical facilities for at least two weeks
	25–50 percent of property is severely damaged
2 - Limited	Injuries and/or illnesses do not result in permanent disability
	Complete shutdown of critical facilities for more than one week
	10–25 percent of property is severely damaged
1 - Negligible	Injuries and/or illnesses are treatable with first aid
	Minor reduction in quality of life
	Shutdown of critical facilities and services for 24 hours or less
	Less than 10 percent of property is severely damaged
Warning Time	
4	Less Than 6 Hours
3	6-12 Hours
2	12-24 Hours
1	24+ Hours
Duration	
4	More Than 1 Week
3	Less Than 1 Week
2	Less Than 1 Day
1	Less Than 6 Hours

Source: MitigationPlan.com

* Based on history, using the definitions given, the likelihood of future events is quantified.

** According to the severity associated with past events or the probable worst case scenario possible in the state.

Using the levels described in the table above, the formula used to determine each hazard's CPRI, which includes weighting factors defined by MitigationPlan.com, was

(Probability x .45) + (Magnitude/Severity x .30) + (Warning Time x .15) + (Duration x .10) = CPRI

Based on their CPRI, the hazards were separated into three categories of planning significance: High (3.0-4.0), Moderate (2.0-2.9), and Low (1.1-1.9)

These terms relate to the level of planning analysis to be given to the particular hazard in the risk assessment process and are not meant to suggest that a hazard would have only limited impact. In order to focus on the most critical hazards, those assigned a level of significant or moderate were given more extensive attention in the remainder of this analysis (e.g., quantitative analysis or loss estimation), while those with a low planning significance were addressed in more general or qualitative ways.

Table 3.4 indicates the ranking established by the Kingman County HMPC using the method described above.

Table 3.4. Hazard Profile Summary

Hazard Type	Probability		Magnitude		Warning Time		Duration		CPRI	Planning Significance
Agricultural Infestation	Likely	3	Limited	2	24+ Hours	1	More than 1 Week	4	2.50	Moderate
Dam and Levee Failure	Unlikely	1	Limited	2	24+ Hours	1	More than 1 Week	4	1.60	Low
Drought - Expansive Soils	Likely	3	Critical	3	24+ Hours	1	More than 1 Week	4	2.80	Moderate
Earthquake	Unlikely	1	Limited	2	Less than 6 Hours	4	Less than 6 hours	1	1.75	Low
Extreme Temperatures	Highly Likely	4	Limited	2	24+ Hours	1	Less than 1 Week	3	2.85	Moderate
Flood	Likely	3	Limited	2	12-24 Hours	2	Less than 1 Week	3	2.55	Moderate
Hailstorm	Highly Likely	4	Limited	2	12-24 Hours	2	Less than 6 hours	1	2.80	Moderate
Land Subsidence	Unlikely	1	Negligible	1	24+ Hours	1	More than 1 Week	4	1.30	Low
Landslide	Unlikely	1	Negligible	1	6-12 Hours	3	Less than 6 hours	1	1.30	Low
Lightning	Highly Likely	4	Limited	2	12-24 Hours	2	Less than 6 hours	1	2.80	Moderate
Soil Erosion and Dust	Possible	2	Negligible	1	24+ Hours	1	More than 1 Week	4	1.75	Low
Tornado - Windstorm	Highly Likely	4	Critical	3	Less than 6 Hours	4	Less than 6 hours	1	3.40	High
Wildfire	Highly Likely	4	Limited	2	Less than 6 Hours	4	Less than 1 day	2	3.20	High
Winter Storm	Highly Likely	4	Critical	3	12-24 Hours	2	Less than 1 Week	3	3.30	High

The Probability and Magnitude levels were determined by the Kingman County HMPC. Warning times and duration for each hazard were obtained from the Kansas State Hazard Mitigation Plan, Appendix E.

3.2.2 Agricultural Infestation

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

Description

Agricultural infestation is the naturally occurring infection of crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption or use. Because of Kansas' substantial agricultural industry and related facilities and locations, the potential for infestation of crops or livestock pose a significant risk to the economy of the State.

Some level of agricultural infestation is normal for Kansas farmers and ranchers. It becomes a cause for concern when the level of an infestation escalates suddenly, or a new infestation appears, overwhelming normal control efforts. The levels and types of agricultural infestation appear to vary by many factors, including cycles of heavy rains and drought.

One of the key concerns regarding this hazard is the potential introduction of a rapid and economically devastating foreign animal disease, such as foot and mouth disease or bovine spongiform encephalopathy (BSE) disease, to Kansas. According to the Kansas Center for Community Economic Development, in 2005, Kingman County ranked 67th, in the State for cattle and milk production. With cattle raised locally in Kingman County, the potential for highly contagious diseases such as those, mentioned above is a continuing, significant threat to the economy of the County. The loss of milk production, abortion, decrease in production, and other lasting problems resulting from an outbreak could cause continuous and severe economic losses.

According to the Kansas Center for Community Economic Development, in 2005, Kingman County ranked 26th, in total acres harvested. These economically important crops are also subject to various types of infestation. Wheat is particularly susceptible to leaf rust, wheat streak mosaic, barley yellow dwarf virus, strawbreaker, and tan spot. Significant wheat crop losses due to these diseases are well documented in various areas of Kansas. Sorghum losses can occur when a crop is infected with sooty stripe early in the growing season. Gray leaf spot is a growing problem for corn crops.

Infestation is not only a risk to crops in the field. Insect infestation can cause major losses to stored grain. It is estimated that damage to stored grain by the lesser grain borer, rice weevil, red flour beetle, and rusty grain beetle costs the United States about $500 million annually.

Warning Time: More than 24 hours

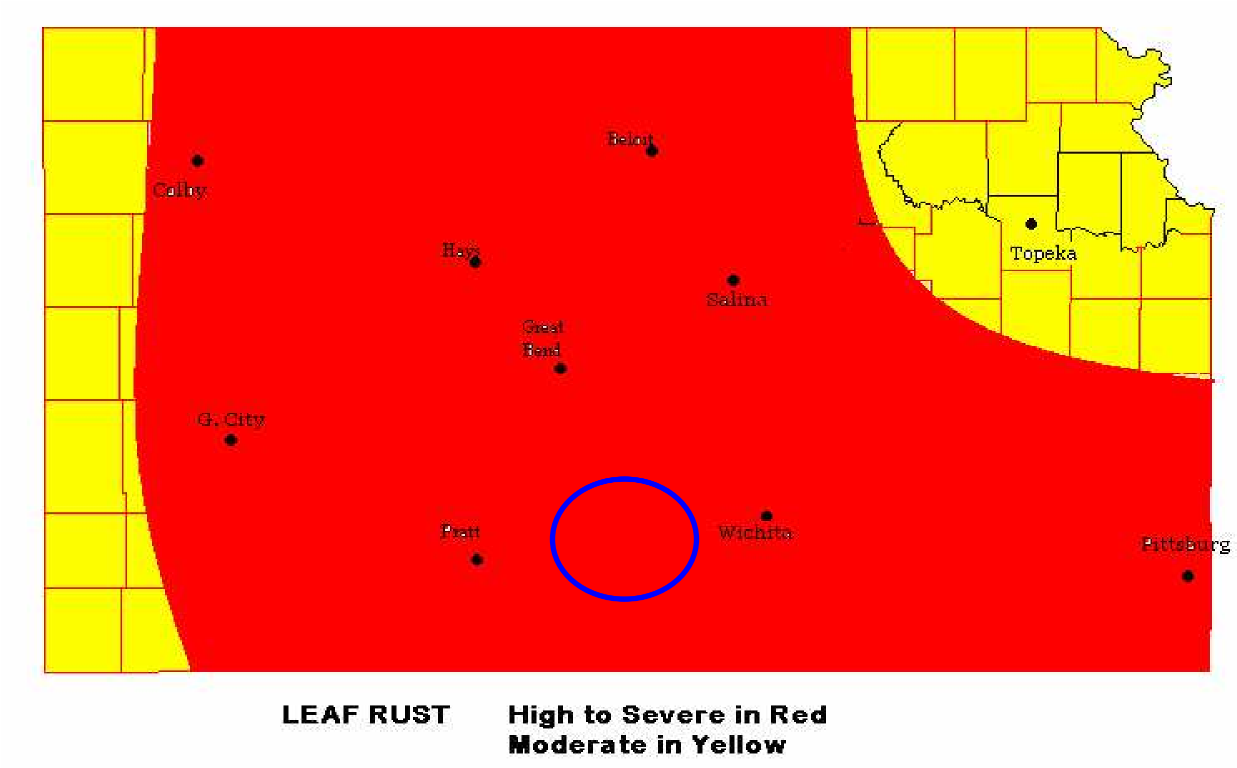
Duration: More than one week

Geographic Location

The central and western parts of the State, including Kingman County, are somewhat more susceptible to agricultural infestation. This corresponds to areas of the State with heavier utilization of the land for crops and rangeland, as well as the location of numerous feedlots.

Figure 3.1 shows the areas of the state with rust disease pressure in 2007. The approximate location of Kingman County is indicated by the blue circle.

Figure 3.1. Leaf Rust Disease Pressure, 2007



Source: Kansas State Department of Agriculture, Kansas Cooperative Plant Disease Survey Report: Preliminary 2007 Kansas Wheat Disease Loss Estimates, www.ksda.gov/plant_protection/content/183/cid/611

Other significant diseases include *Septoria* leaf disease, which, while occurring statewide, was found primarily in central and southeast Kansas, and tan spot, which hit north central and northeast Kansas the hardest. Stripe rust was primarily found in western Kansas, while barley yellow dwarf and powdery mildew were found more in the central, south central, and southeastern crop reporting districts. Scab was noted in the southern third of the State, from the Missouri border into south central Kansas.

Previous Occurrences

Cumulative disease losses for the State for the 2007 wheat crop were estimated at 17.8 percent of the crop (65.1 million bushels). This estimate exceeds the 20 year average of 11.4 percent loss and is the greatest cumulative loss since 1995 when foliar diseases and barley yellow dwarf virus were the primary contributors to a 20.4 percent loss. In 2007, leaf rust, which was epidemic statewide, caused about 80 percent of the total disease loss. The *Septoria* leaf disease complex was responsible for 1.8 percent of the loss, followed by tan spot causing 1.3 percent. Barley yellow dwarf, stripe rust, scab, and powdery mildew were estimated at 0.2 percent each and were occasionally found at significant levels.

In 2007, several diseases which had previously affected the wheat crop were not found to any extent. Dominant in 2006, wheat streak mosaic was rarely reported. Take-all and other root and crown rots were almost nonexistent. Soil borne mosaic was reported in a few locations in western Kansas, while common bunt was reported in a few locations in north central Kansas, and loose smut was reported infrequently during the survey.

Probability of Future Occurrences

While some degree of agricultural infestation occurs on an annual basis, this hazard's CPRI probability is "likely" (event is probable within the next three years) as the more significant events (foreign animal disease outbreaks) do not occur annually.

Magnitude/Severity

This hazard's CPRI magnitude/severity is "limited."

3.2.3 Dam and Levee Failure

Calculated Priority Risk Index	Planning Significance
1.60	Low

Description

The Kansas Division of Water Resources defines a state-regulated “dam” as any artificial barrier, including appurtenant works, with the ability to impound water, wastewater, or other liquids that has a height of 25 feet or more; or has a height of six feet or greater and also has the capacity to impound 50 or more acre feet. The height of the dam is measured from the downstream toe to the top if a watercourse is affected or from the lowest elevation of the outside limit of the dam to the top for barriers that do not extend across a stream or watercourse. According to the State’s dam inventory, Kingman County has 29 state-regulated dams of varying size, purpose, and vulnerability to failure (as of September 2007).

The 2005 Kansas Water Plan states that some dams are exhibiting structural deficiencies due to age, while post-construction development downstream of others has raised their hazard class. Of the 29 dams, only one, Yeager Lakes Dam, is designated as high hazard (Kansas class C); 0 as significant hazard (Kansas class B), and 28 as low hazard (Kansas class A). These designations are risk-based and do not reflect the physical condition of dams. Kansas classifies its dams as follows

- Class C (high hazard)—A “hazard class C dam” shall mean a dam located in an area where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high-volume roads that meet the requirements for hazard class C dams or a high-volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described in hazard class B.
- Class B (significant hazard)—A “hazard class B dam” means a dam located in an area where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet the requirements for hazard class B dams, damage low-volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation facilities, including campground areas intermittently used for sleeping and serving a relatively small number of persons.
- Class A (low hazard)—A “hazard class A dam” means a dam located in an area where failure could damage only farm or other uninhabited buildings, agricultural or undeveloped land including hiking trails, or traffic on low-volume roads that meet the requirements for hazard class A dams.

The State requires emergency action plans for all high and significant hazard dams. However, none of the high hazard dams (1 within Kingman County) have emergency action plans.

The average age of the 29 dams with completion dates in the State's inventory database is 48 years old, and some of them are exhibiting structural deficiencies. Common problems with older dams include

- Deteriorating metal pipes and structural components,
- Inadequate hydrologic capacity,
- Increased runoff due to upstream development, and
- Increased failure hazard due to downstream development.

Cheney Lake and Dam, located within Kingman, Sedgwick, and Reno Counties, is maintained and operated by the federal government.

The Kingman County Fairgrounds are located within the South Fork Ninnescah River floodplain. The levee along the perimeter of the Fairgrounds was overtopped during the flood event of October 1973. This flood event was estimated to be a 25-year event.

Warning Time: More than 24 hours

Duration: More than one week

Geographic Location

Figure 3.2 shows the locations of the dams and levee in Kingman County.

Previous Occurrences

There have been no incidents of dam failure in Kingman County. The levee surrounding the Kingman County Fairgrounds was overtopped in October 1973.

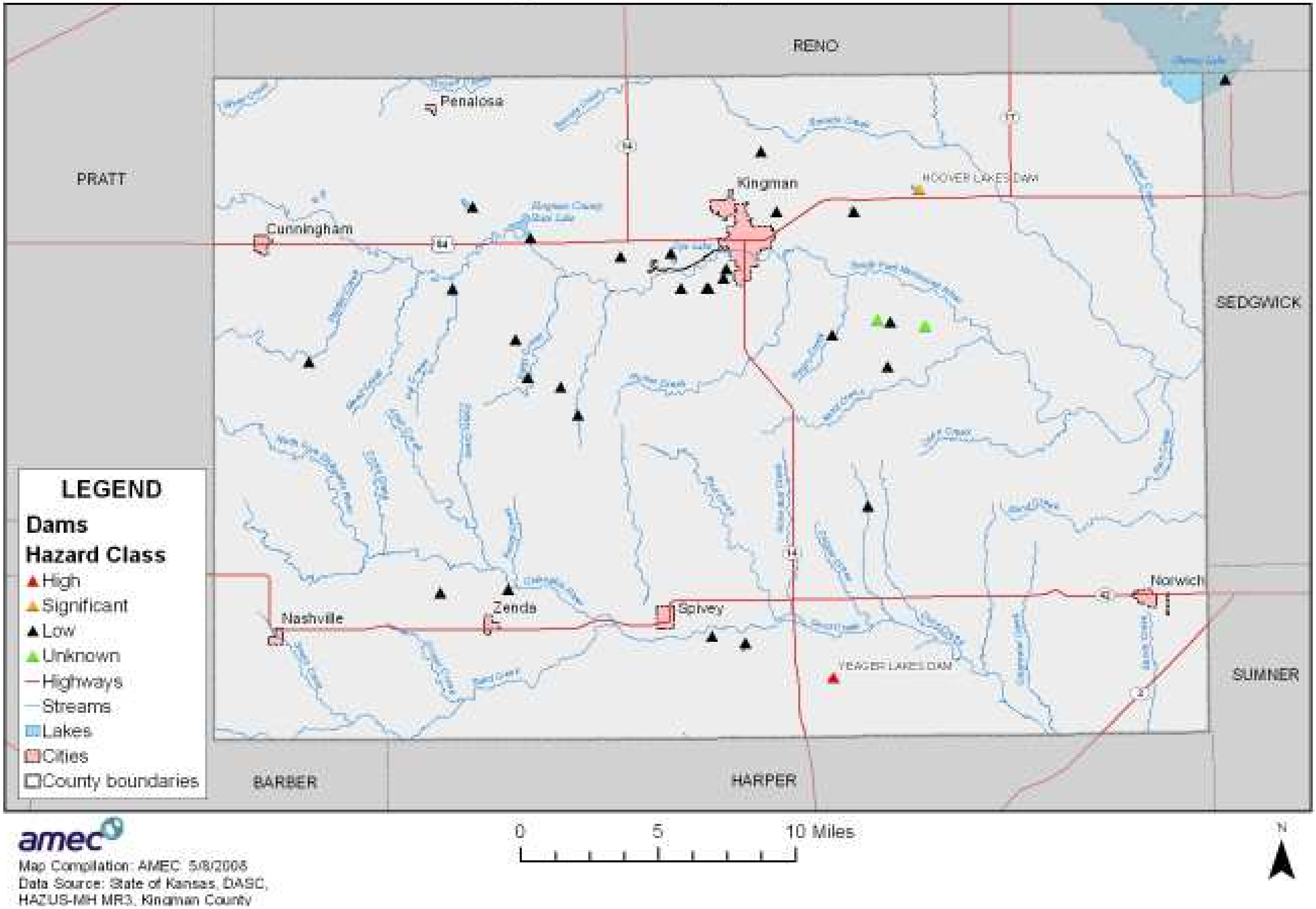
Probability of Future Occurrences

The variability of the size and construction of the dams in Kingman County makes estimating the probability of dam failure difficult on any scale less than a case-by-case basis. This hazard's CPRI probability is "unlikely" (event is possible within the next 10 years).

Magnitude/Severity

Although there is a noted high hazard dam within the County, the dam break inundation area would have limited damages. This hazard's CPRI magnitude/severity is "limited."

Figure 3.2. Map of Dam Locations



3.2.4 Drought

Calculated Priority Risk Index	Planning Significance
2.80	Moderate

Description

Drought is generally defined as a condition of moisture levels significantly below average for an extended period of time over a large area that adversely affects plants, animal life, and humans. It can also be defined in terms of meteorology, agriculture and hydrology. Although drought is not predictable, long-range outlooks may indicate an increased chance of drought, which can serve as a warning (P.L. 109-430 established a National Integrated Drought Information System within the National Oceanic and Atmospheric Administration to improve drought monitoring and forecasting capabilities). A drought period can last for months, years, or even decades. It is rarely a direct cause of death, though the associated heat, dust, and stress can all contribute to increased mortality.

Periods of drought are normal occurrences in all parts of Kansas. Drought in Kansas is caused by severely inadequate amounts of precipitation that adversely affect farming and ranching, surface and ground water supplies, and uses of surface waters for navigation and recreation. As a result of these conditions, drought can have significant economic and environmental impacts.

Expansive Soils

A relatively widespread geologic hazard for Kansas is the presence of soils that expand and shrink in relation to their water content. For Kansas, the vulnerability to this hazard most frequently is associated with soils shrinking during periods of drought. Expansive soils can cause physical damage to building foundations, roadways, and other components of the infrastructure when clay soils swell and shrink due to changes in moisture content.

Warning Time: More than 24 hours

Duration: More than one week

Geographic Location

As a regional phenomenon, drought affects all areas of the County with roughly the same frequency and severity.

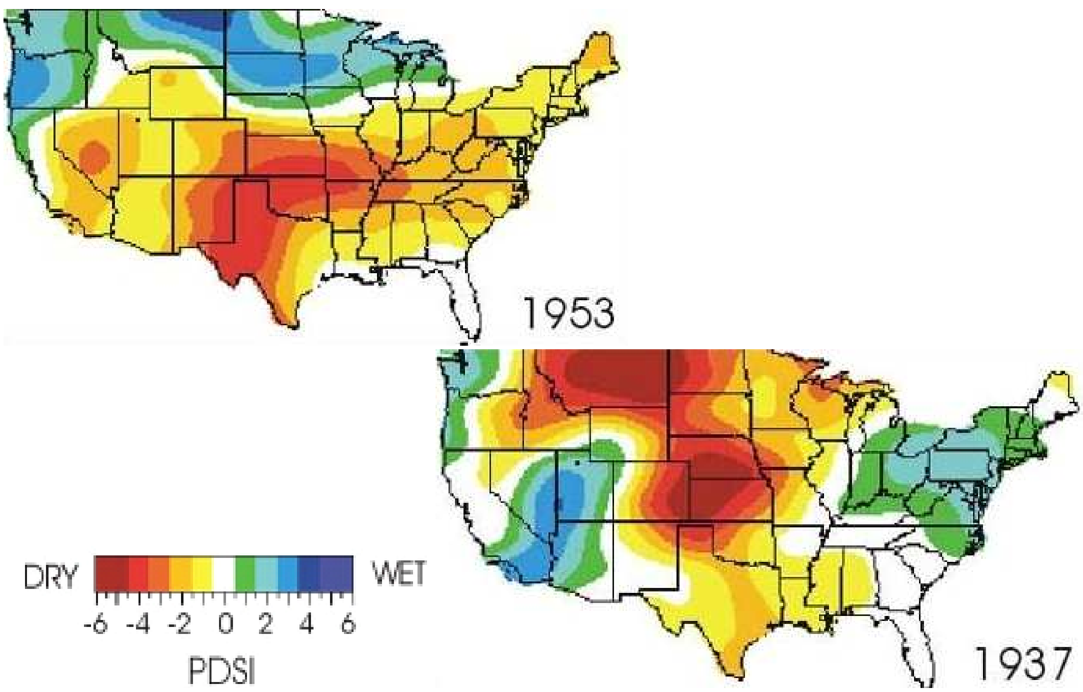
Previous Occurrences

According to the Palmer Drought Severity Index 1895-1995, Kingman County experienced severe and extreme drought 10-14.9% of the time during that 100-year period.

Historical droughts occurred in the 1930s and 1950s, as well as in 1901, 1874, 1872, and 1860 (settlers had to be fed by the Emigrant Aid Society of New England). Figure 3.3 shows the precipitation levels across the United States during the droughts in the 1950s and 1930s. In 1953, Kingman County was part of the driest area of the country (shaded dark red). In 1937, Kingman County and other southeast Kansas counties fared slightly better than the rest of the State, but were nonetheless very short on precipitation. The most recent prolonged drought period in Kansas occurred from 1988-1991. Most areas of the State were affected (Kansas Water Office).

During the period from 2003 to 2007, Kingman County was included in two drought watch declarations and 4 drought warning declarations.

Figure 3.3 Historical Droughts 1937 and 1953



<Insert maps found at link listed below>

http://www.ncdc.noaa.gov/paleo/drought/images/temporal_spatial.jpg

Probability of Future Occurrences

Lack of precipitation for a given area is the primary contributor to drought conditions. Since precipitation levels cannot be predicted long-term, it is difficult to determine the probability of future occurrences of drought. However, using available historical data, we can determine that Kingman County experienced severe and extreme drought 10-14.9% of the time during the 100 year period from 1895 to 1995. Therefore, the probability of a drought in any given year is "likely."

Magnitude/Severity

This hazard's CPRI magnitude/severity is "critical."

3.2.5 Earthquake

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description

Earthquakes can be one of nature's most damaging hazards. An earthquake is a sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of Earth's tectonic plates. The severity of these effects is dependent on the amount of energy released from the fault or epicenter.

Kansas experiences small earthquakes on a routine basis, but few are of a magnitude that causes damage to buildings or the infrastructure. According to a 2001 FEMA report, Kansas ranks 45th among the states in the amount of damage caused by earthquakes in an average year.

Warning Time: Less than 6 hours

Duration: Less than 6 hours

Geographic Location

Overall, Kansas is in an area of relatively low seismic activity. The closest series of faults, the Humboldt Fault Zone, runs through Riley and Pottawatomie Counties and extends south along the Nemaha Ridge, also known as the Nemaha Uplift (see Figure 3.4). An earthquake centered in Pottawatomie County has about a 2 percent probability (see Figure 3.5), of occurring during a 50-year interval. However, impact to Kingman County would be negligible.

Kingman County is not expected to experience damaging shaking from a large New Madrid Seismic Zone event. The New Madrid Seismic Zone roughly follows the Mississippi River valley from southeastern Missouri to northwestern Mississippi. A large earthquake in this region could displace several thousand people and potentially lead to an influx into Kansas of victims fleeing the destruction.

Previous Occurrences

At least 25 earthquakes were recorded by the Kansas Geological Survey between August 1876 and 1976 (Figure 3.4). More than 100 micro-earthquakes were measured between 1977 and 1989 (Figure 3.5). Most of these were micro-earthquakes, defined as earthquakes that are too small to feel.

Figure 3.4. Historical earthquakes in Kansas, prior to 1977

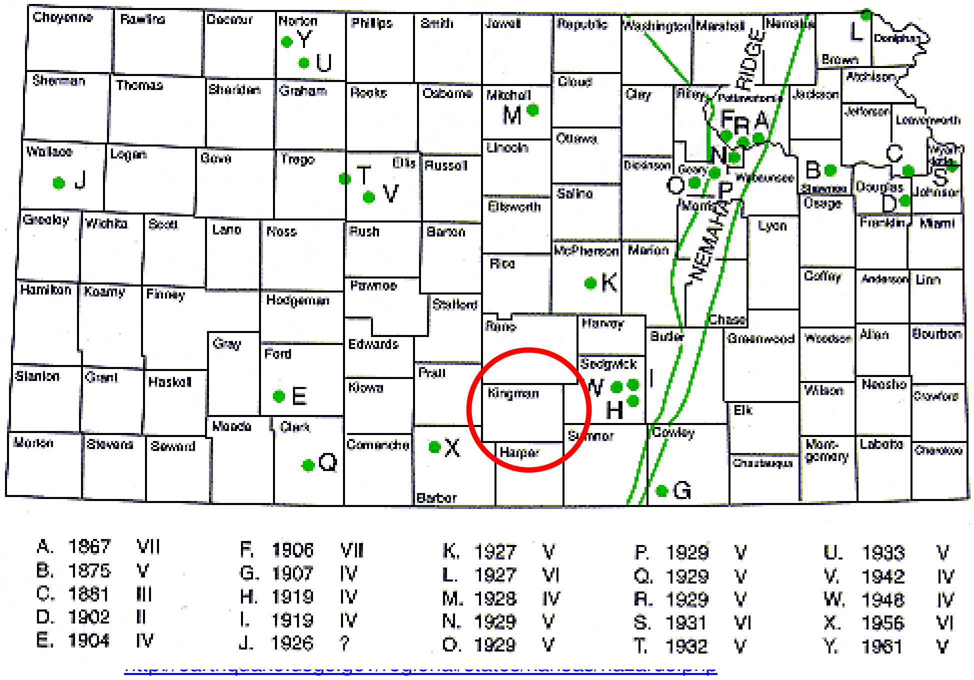
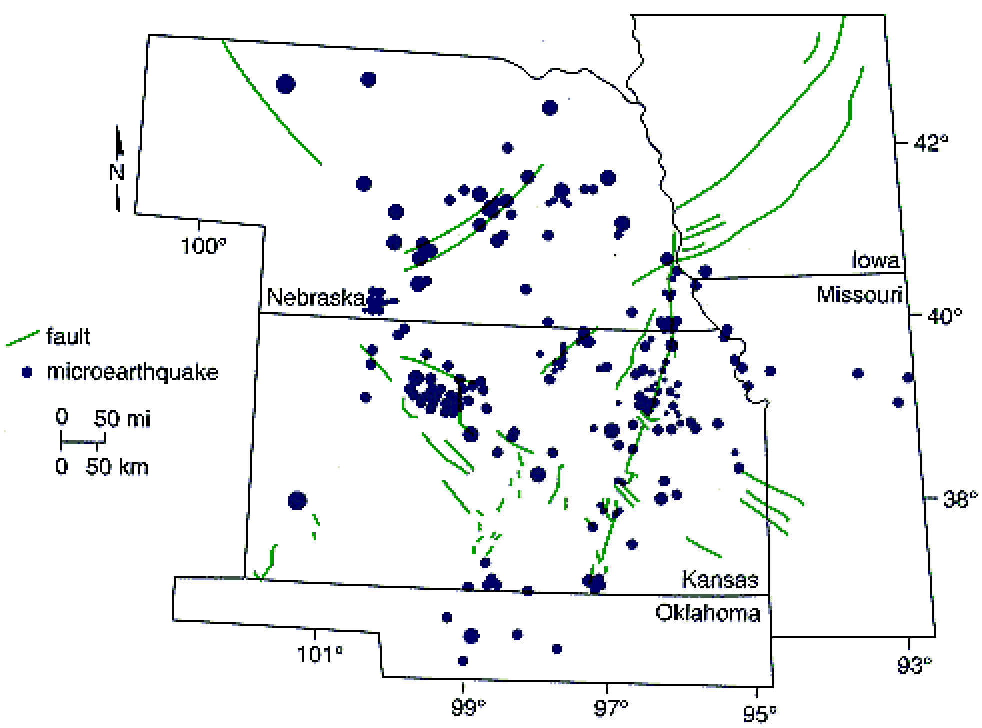


Figure 3.5. Microearthquakes recorded by the Kansas Geological Survey between August 1977 and August 1989

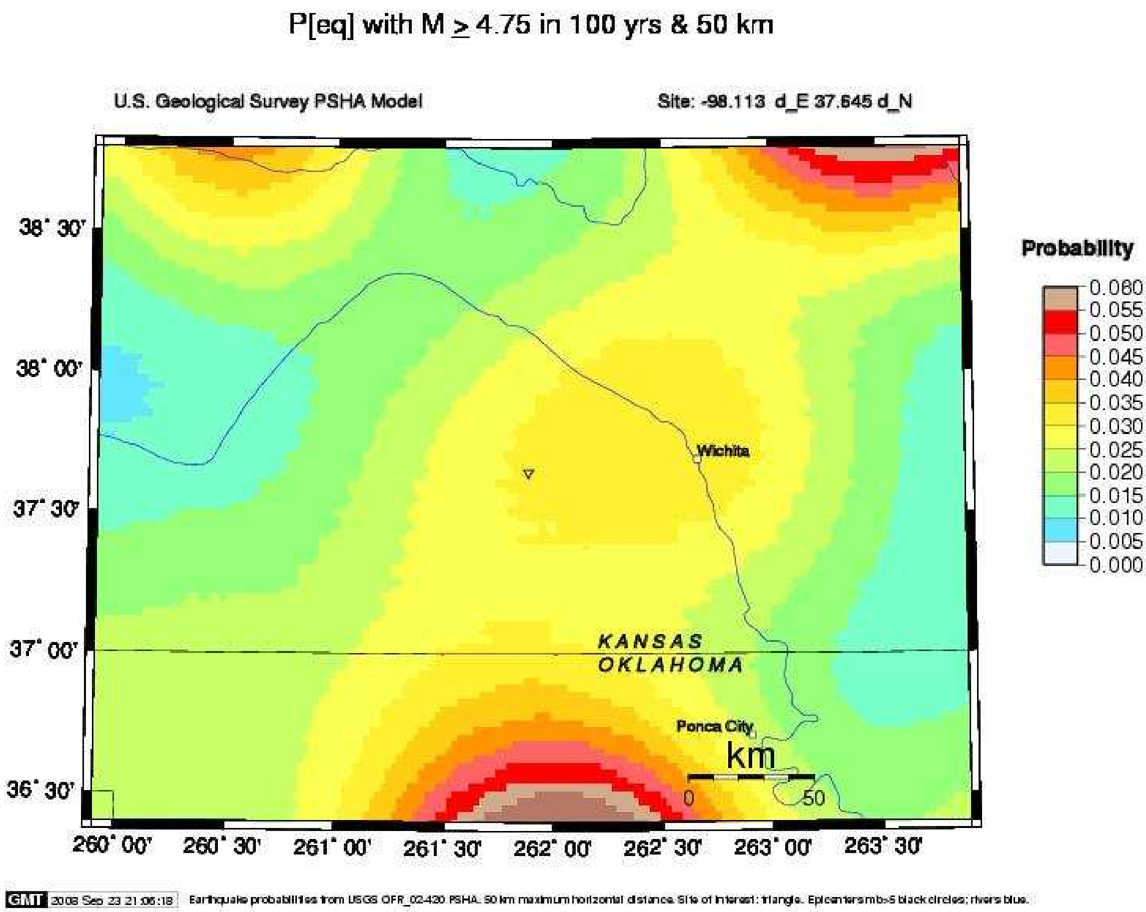


http://www.kgs.ku.edu/Publications/pic3/pic3_4.html

Probability of Future Occurrences

Figure 3.6 demonstrates that the probability of an earthquake with a magnitude greater than 4.75 in Kingman County over a 100 year time period is .040-.05. Therefore, the probability of a significant earthquake in any given year is “unlikely.”

Figure 3.6. Earthquake Probability Map



http://eqint.cr.usgs.gov/eqprob/2002/index.php

Magnitude/Severity

Considering the location of Kingman County in relation to existing fault lines, this hazard’s CPRI magnitude/severity is “limited.”

3.2.6 Extreme Temperatures

Calculated Priority Risk Index	Planning Significance
2.85	Moderate

Description

According to the Centers for Disease Control and Prevention, 8,015 people died in the United States from excessive heat exposure between 1979 and 2003. During this period, more people in the United States died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined. Those at greatest risk for heat-related illness include infants and children up to four 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. Also, during extreme heat events, infrastructure, energy sources in particular, can be stressed, and long-term extreme heat can stress water sources, particularly if occurring during a period of drought.

Extreme cold can cause hypothermia (an extreme lowering of the body's temperature), frostbite and death. Infants and the elderly are particularly at risk, but anyone can be affected. While there are no firm data on hypothermia (cold) death rates, it is estimated that 25,000 older adults die from hypothermia each year. The National Institute on Aging estimates that more than 2.5 million Americans are especially vulnerable to hypothermia, with the isolated elderly being most at risk. About 10 percent of people over the age of 65 have some kind of temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic. The heightened vulnerability of the elderly to hypothermia is of interest to Kansas, in light of the fact that the percentage of the State's elderly population is slightly higher than the national average.

Also at risk are those without shelter or 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.

Warning Time: More than 24 hours

Duration: Less than one week

Geographic Location

All of Kingman County is susceptible to extreme temperatures.

Previous Occurrences

The High Plains Regional Climate Center (HPRCC) archives National Weather Service (NWS) surface observations including daily measurements of high temperature, low temperature, precipitation, snowfall, and evaporation for first order (NWS forecast offices) and second order (cooperative observer network) sites. There are two NWS cooperative sites located in Kingman County: Kingman (144313); and Norwich (145870).

Recorded extreme temperatures in Kingman County from 1948 through 2007 were averaged for the two sites of Kingman and Norwich and have ranged from –14 degrees °F to 114 degrees °F. Averaged temperature extremes for each month are shown in Table 3.5.

Table 3.5 Record Temperatures by Month

Month	Maximum Temperature	Minimum Temperature	Month	Maximum Temperature	Minimum Temperature
January	78	-13	July	114	50
February	88	-14	August	113	47
March	91	-4	September	109	29
April	98	17	October	100	17
May	105	31	November	88	1
June	110	42	December	84	-16

Source: High Plains Regional Climate Center, www.hprcc.unl.edu/data

Probability of Future Occurrences

This hazard's CPRI probability is "highly likely." An extreme heat event is more likely to occur in the summer months of May, June, July, August, and September, and an extreme cold event is more likely to occur in the winter months of November, December, January, February, and March.

Magnitude/Severity

The most recent extreme temperature event recorded by the NCDC on July 16, 2006, noted that the prolonged heat claimed five lives across south-central and southeast Kansas, most of them elderly men. This hazard's CPRI magnitude/severity is "limited."

3.2.7 Flood

Calculated Priority Risk Index	Planning Significance
2.55	Moderate

Description

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. There are several different types of likely flood events in Kansas including flash, riverine, and urban stormwater. Regardless of the type of flood, the cause can almost always be attributed to excessive rainfall, either in the flood area or upstream reach.

The term "flash flood" describes localized floods of great volume and short duration. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall on a relatively small drainage area. Precipitation of this sort usually occurs in the spring and summer.

Riverine floods result from precipitation over large areas. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include many independent river basins. The duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface areas due to urbanization.

Urban flood events result when land loses its ability to absorb rainfall as it is converted from fields or woodlands to roads, buildings, and parking lots. Urbanization increases runoff two to six times over what would occur on undeveloped terrain. During periods of urban flooding, streets can become swift moving rivers.

All flood events may result in upstream flooding due to downstream conditions such as channel restriction and/or high flow in a downstream confluence stream. This type of flooding is known as backwater flooding.

Kingman County is located within the Lower Arkansas River Basin. As part of the National Flood Insurance Program (NFIP), floodplains and floodways on many local streams have been established and are regulated by the local floodplain management ordinance. The most recent Flood Insurance Study (FIS) for the City of Kingman was published by FEMA in 1979. The FIS includes Flood Insurance Rate Maps (FIRM) that presents the adopted floodplains, floodways, and flood profiles for streams in Kingman County. During the preparation of the FIRMs, a total of three streams with combined lengths of approximately 2.7 miles were studied by detailed methods.

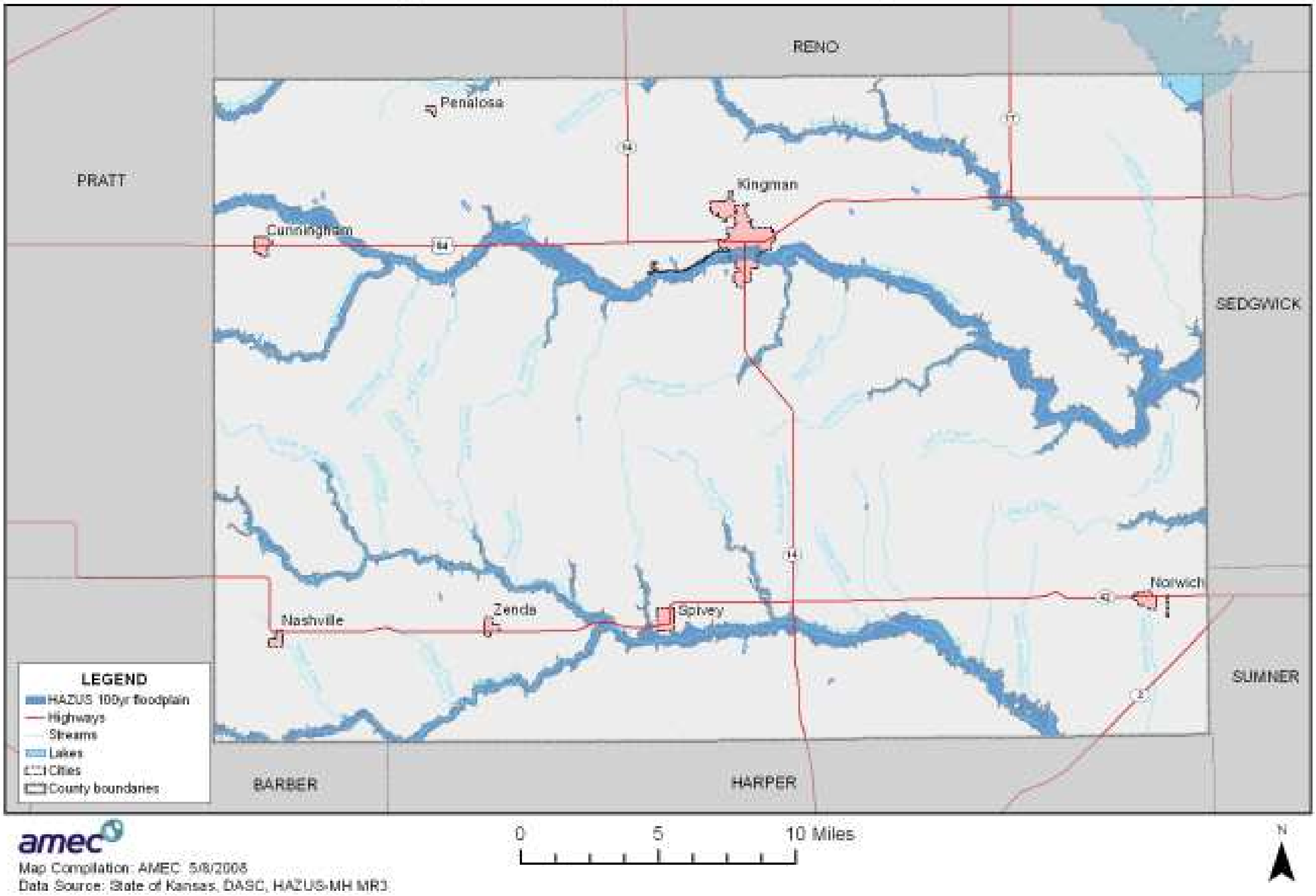
Warning Time: 12 to 24 hours

Duration: Less than one week

Geographic Location

Figure 3.8 shows the locations of the approximate floodplains (modeled by HAZUS-MH) in Kingman County.

Figure 3.8 Kingman County 100-Year Floodplain



Previous Occurrences

According to the FIS Report for the City of Kingman, low-lying areas adjacent to creeks are subject to flooding caused by the runoff from intense rainfall. Street surface drainage was also noted as a problem in some areas as the stormwater is unable to discharge into the receiving streams.

According to the NCDC and SHELDUS, there were 14 flood events in Kingman County between 1974 and 2006. Details about some of these events can be found below.

- September 18, 1996 – In Cunningham, two individuals driving north on SW 170 Avenue drove into water that was covering the roadway. This caused the vehicle to hydroplane and land in 3 to 4 feet of water in a ditch. Property damage was $5,000.
- July 20-July 21, 1997 – Near Norwich, Sandy Creek flooded parts of K42. The Chikaskia River flooded two miles south of Rago closing a small section of K14.
- October 31, 1998 – Widespread heavy rains of 6-10 inches caused the Arkansas, Little Arkansas, Chikaskia, and Ninnescah Rivers, as well as their respective tributaries, to flood. The flooding resulted in the closure of numerous roads and highways across Kingman, Harper, Reno, Sedgwick and Sumner Counties.
- May 17, 1999 – Several roads were under water in Murdock.
- March 23, 2000 – Widespread thunderstorms producing heavy rains caused flooding of Highway 14 at 100th St. near Kingman. By 2:45 PM, the flooding had spread to five miles northeast of Kingman where a bridge was also flooded. By 3:35 PM, numerous roads were underwater in downtown Kingman including Highway 14, as were most County roads. At 5:37 PM, Smoots Creek in Northeast Kingman County overflowed in Midway where Northeast 10th St. was barricaded.
- May 7, 2002 – Several streets in the town of Kingman were covered by water.
- June 4, 2002 – Many secondary roads near Nashville flooded.
- May 12, 2004 – Highway 42 flooded one mile east of Norwich.
- June 13, 2004 – Several County roads were impassable due to water covering them.
- May 9, 2006 – Water was reported over roads in the City of Kingman.

Probability of Future Occurrences

Floods have a 1-percent chance of occurrence in any given year in identified special flood hazard areas.

Based on 14 recorded events over a 33 year time period (1974–2006), a flood event occurs every 2.4 years on average. This hazard's CPRI probability for a significant event is "likely" (event is probable within the next three years).

Magnitude/Severity

Total property and crop damage for these events is estimated at $66,000 and $289,000, respectively, in 2005 dollars. There were no deaths or injuries reported during this time period. This hazard's CPRI magnitude/severity is "limited."

As of March 2008, the City of Kingman had 46 flood insurance policies in-force totaling $5,488,600.00 of insurance in force. Kingman County had 17 policies totaling $1,223,100 of insurance in force.

3.2.8 Hailstorm

Calculated Priority Risk Index	Planning Significance
2.80	Moderate

Description

Hailstorms in Kansas cause damage to property, crops, and the environment and kill and injure livestock. Because of the large agricultural industry in Kansas, crop damage and livestock losses due to hail are of great concern to the State. In the United States, hail causes more than $1 billion in damage to property and crops each year. In 2005, hail and wind damage made up 45% of homeowners insurance losses. Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans, and has occasionally been fatal.

Hail is associated with thunderstorms that can also bring high winds and tornadoes. It forms when updrafts carry raindrops into extremely cold areas of the atmosphere where they freeze into ice. Hail falls when it becomes heavy enough to overcome the strength of the updraft and is pulled by gravity towards the earth.

Warning Time: 12 to 24 hours

Duration: Less than 6 hours

Geographic Location

All of Kingman County is susceptible to hailstorm events.

Previous Occurrences

According to the National Climatic Data Center Storm Events database and SHELDUS, there were 266 recorded hailstorm events in Kingman County between 1958 and 2007. Those events causing property and crop damage include the following:

- June 15, 1993 – Penalosa, $50,000 property damage, $50,000 crop damage resulting from 2.75 inch hail
- June 17, 1993 – Several hail events occurred throughout the county totaling $20,000 in property damage and $20,000 in crop damage. Hail size ranged from 1.5 inches to 1.75 inches.
- October 16, 1993 – 3 miles east of Rago, $1,000 property damage

- April 21, 1994 – Norwich, $1,000 property damage
- June 25, 1997 – Murdock, one home was badly damaged resulting in $30,000 in property damage
- May 24, 1998 – Norwich, $1,800,000 in crop damage

Probability of Future Occurrences

Based on the 266 notable events within a 49 year time period (1958–2007), a hail event occurs every 0.2 years on average. This hazard's CPRI probability is "highly likely" (event is probable within the calendar year).

Magnitude/Severity

There have been 266 notable extreme hail events reported in Kingman County since 1958, according to the National Climatic Data Center. Of the 266 notable events, no deaths or injuries have been recorded. Total property and crop damage for events between 1993 and 2007 is estimated at $102,000 and $1,870,000, respectively. This hazard's CPRI magnitude/severity is "limited."

3.2.9 Land Subsidence

Calculated Priority Risk Index	Planning Significance
1.30	Low

Description

Subsidence is caused when the ground above manmade or natural voids collapses. Subsidence can be related to mine collapse, water and oil withdrawal, or natural causes such as shrinking of expansive soils, salt dissolution (which may also be related to mining activities), and cave collapses. The surface depression is known as a sinkhole. If sinkholes appear beneath developed areas, damage or destruction of buildings, roads and rails, or other infrastructure can result. The rate of subsidence, which ranges from gradual to catastrophic, correlates to its risk to public safety and property damage.

Areas of karst, a terrain or type of topography generally underlain by soluble rocks, such as limestone, gypsum, and dolomite, in which the topography is chiefly formed by dissolving the rock, are particularly prone to sinkholes.

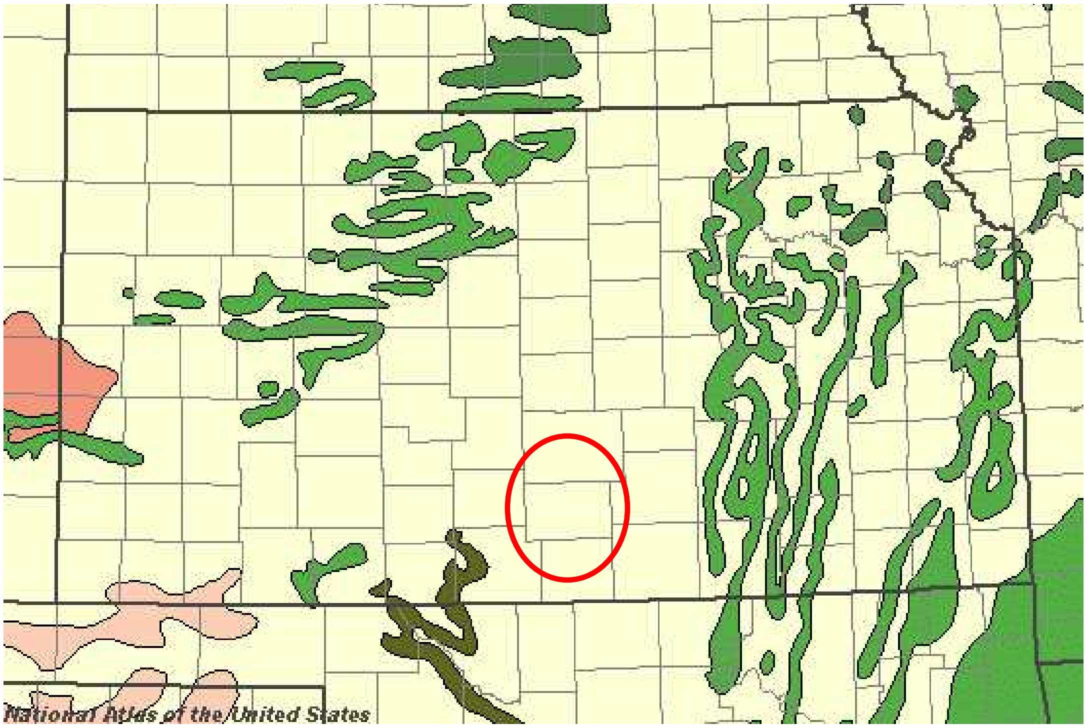
Warning Time: More than 24 hours

Duration: More than one week

Geographic Location

Figure 3.9 illustrates the location of karst features in Kansas. The green areas shown in the map in Figure 3.9 show fissures, tubes, and caves generally less than 1,000 feet (ft.) long with 50 ft. or less vertical extent in gently dipping to flat-lying carbonate rock. Brown areas have similar features in gently dipping to flat lying gypsum beds. Light pink colored areas are features analogous to karst with fissures and voids present to a depth of 250 ft. or more in areas of subsidence from piping in thick unconsolidated material. Darker pink areas contain fissures and voids to a depth of 50 ft. There are limited documented problems associated with limestone subsidence and sinkholes in Kansas.

Figure 3.9 Karst Features in Kansas



Source: U.S. Geological Survey, mapped by the National Atlas of the United States, www.nationalatlas.gov

Previous Occurrences

There are no previous occurrences of land subsidence in Kingman County.

Probability of Future Occurrences

According to the Kansas Geological Survey, karst features are not noted in Kingman County. This hazard's CPRI probability is "unlikely" (event is possible within the next 10 years).

Magnitude/Severity

Magnitude and severity is based upon past events. With no previous occurrences, no reported injuries or damages, this hazard's CPRI magnitude/severity is "negligible."

3.2.10 Landslide

Calculated Priority Risk Index	Planning Significance
1.30	Low

Description

Landslides are natural phenomena that are not new to Kansas. A landslide is the downhill movement of masses of soil and rock by gravity. The basic ingredients for landslides are gravity, susceptible soil or rock, sloping ground, and water. Types of landslides that occur in Kansas are rockfalls, block slides, slumps, earth flows, and creep. Creep is widespread on hillsides throughout Kansas.

Landslides require hilly terrain. Typically, as the slope angle increases, so does the potential for landslides. Anything that increases the slope angle can trigger a landslide (e.g., a stream actively eroding a hill, construction practices). While slope steepness is the primary factor determining slope stability, soil and rock types are also important. The most common rocks found in Kansas are shales, limestones, and sandstones. Shales—rocks composed of clay- and silt-sized grains—are most often associated with landslides. When shale is near the ground surface where the water content fluctuates, it weathers into a clayey soil that could be landslide prone. Limestones and sandstones exposed in cliffs or roadcuts can pose a risk for rock fall, especially when they overlie shales.

Landslides may occur when soil on hillsides is saturated following extended periods of rainfall or snow melt. Landslides can damage or destroy structures, roadways, and utilities as well as block roadways with debris. They cause more than 25 fatalities and $1.5 billion in damage each year in the United States and are often associated with other hazard events (e.g., earthquakes, flooding, heavy rainfall).

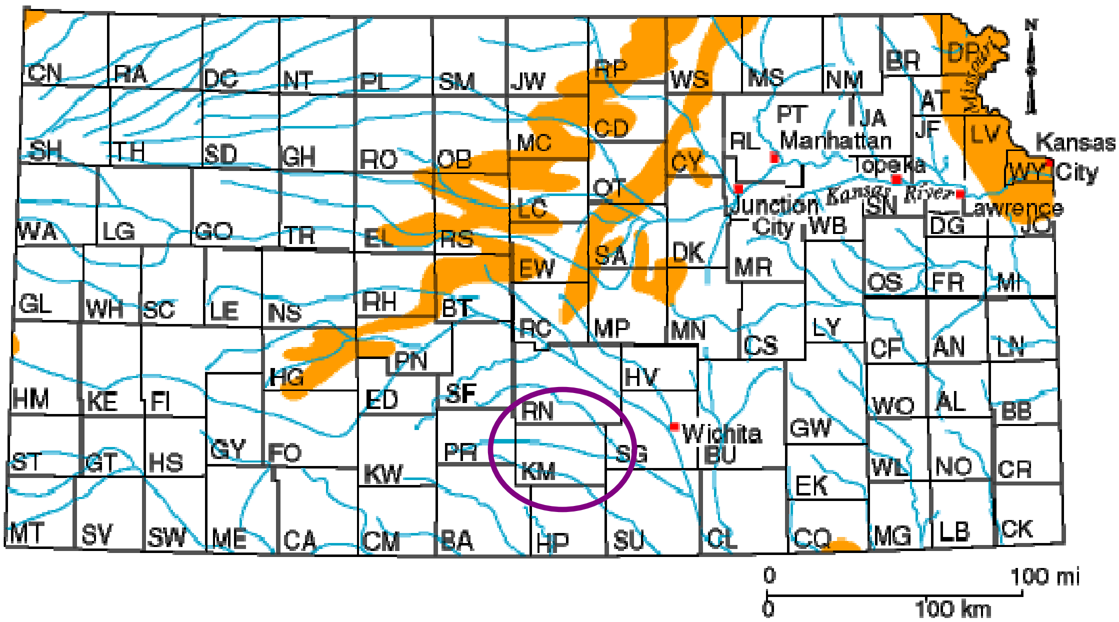
Warning Time: 6 to 12 hours

Duration: Less than 6 hours

Geographic Location

According to the U.S. Geological Survey, the areas of Kansas that are most prone to landslides are the Missouri River Corridor in northeastern Kansas; the Smoky Hills in northern and central Kansas (see Figure 3.10). Kingman County is not noted to contain areas prone to landslides.

Figure 3.10. Landslide-Prone Areas of Kansas



Source: Kansas Geological Survey, www.kgs.ku.edu/Publications/pic13/pic13_1.html
Note: Landslide risk is moderate in the shaded areas (1.5 percent to 15 percent of the area is landslide prone). Other areas in Kansas have a low landslide risk (less than 1.5 percent of area).

Previous Occurrences

There are no previous occurrences of landslides within Kingman County.

Probability of Future Occurrences

According to the Kansas Geological Survey, Kingman County has a low landslide risk. This hazard's CPRI probability is "unlikely" (event is possible within the next 10 years).

Magnitude/Severity

Magnitude and severity is based upon past events. With no previous occurrences, no reported injuries or damages, this hazard's CPRI magnitude/severity is "negligible."

3.2.11 Lightning

Calculated Priority Risk Index	Planning Significance
2.80	Moderate

Description

According to the National Weather Service, lightning is one of the most underrated severe weather hazards. The second deadliest weather killer in the United States, it ranks above hurricanes or tornadoes causing an average of 73 deaths and 300 injuries each year.

Severe thunderstorms strike Kansas on a regular basis. In addition to the heavy rains that cause floods, high winds, tornadoes, and thunderstorms, lightning often accompanies thunderstorms and can cause injury, death property damage, and wildland fires. The widespread and frequent nature of thunderstorms makes lightning a relatively common occurrence. Of particular concern in Kansas is protection of facilities and communications systems that are critical to emergency response operations, protection of public health, and maintenance of the Sate's economy. The threat to communications systems includes tornado sirens, which could get knocked out just when they are needed most.

Warning Time: 12 to 24 hours

Duration: Less than 6 hours

Geographic Location

Kingman County has an average of 30 to 50 thunderstorm days each year (see Figure 3.11). In addition, Kingman County has approximately two to four lightning strikes per square kilometer per year (See Figure 3.12).

Previous Occurrences

The NCDC and SHELDUS databases have record of 13 damaging lightning events in Kingman County from 1960 to 2007. Those events reporting significant property damage (greater than $25,000) include the following:

- May 3, 1994 – Spivey, lightning struck a tank battery installation one mile north of the Harper-Kingman County line. The resulting fire destroyed the entire installation ($50,000).

Figure 3.11. Distribution and Frequency of Thunderstorms

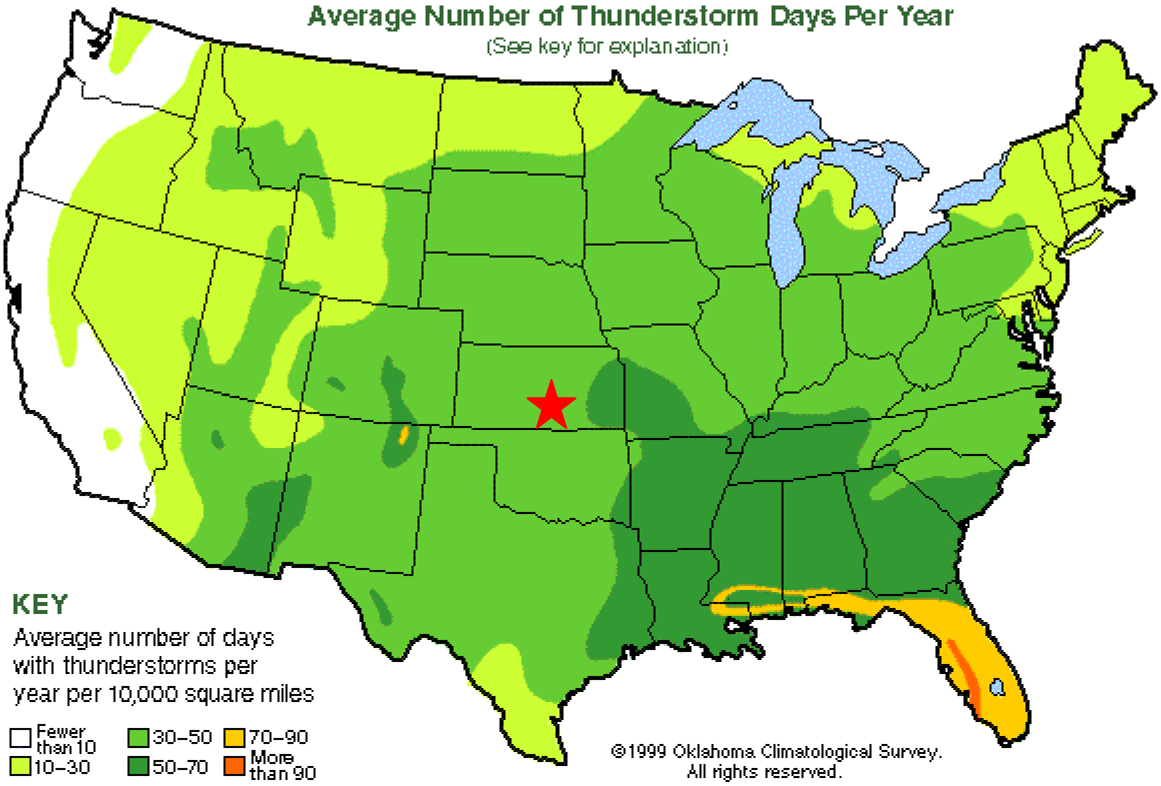
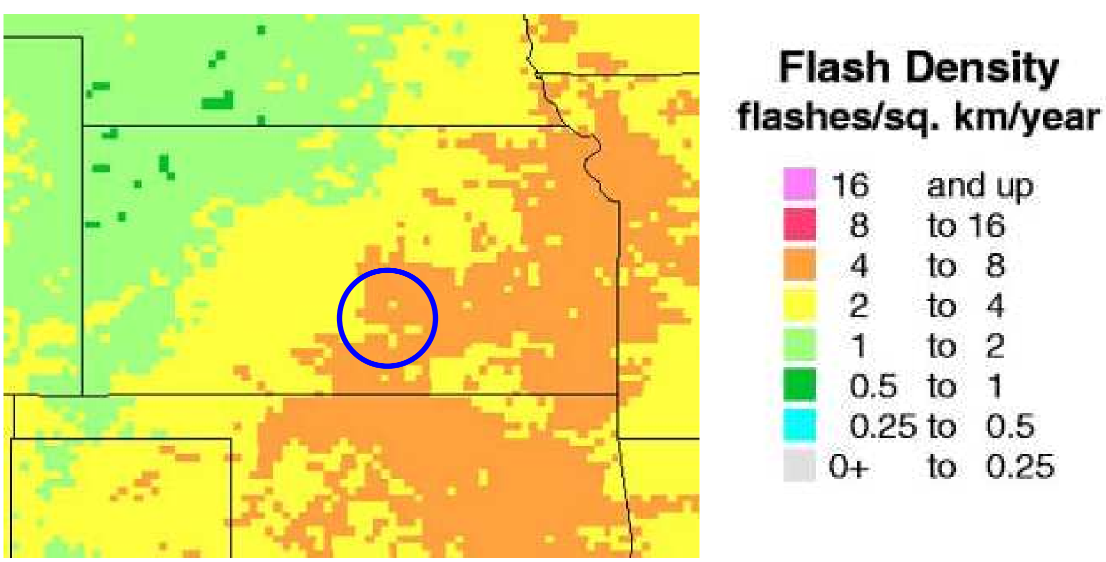


Figure 3.12. Location and Frequency of Lightning in Kansas



Source: National Weather Service, www.lightningsafety.noaa.gov/lightning_map.htm

Probability of Future Occurrences

Based on the 14 noted events within a 34 year time period (1960–1994), a lightning event occurs every 2.4 years on average. Additionally, the National Weather Service reports four to eight lightning flashes per square kilometer per year. This hazard's CPRI probability is "highly likely" (event is probable within the calendar year).

Magnitude/Severity

There have been 14 noted lightning events reported in Kingman County since 1960 according to the National Climatic Data Center and SHELDUS. Of the 14 noted events, there have been no reported injuries or deaths. The total property damage for these 14 events is approximately $50,000. This hazard's CPRI magnitude/severity is "limited."

3.2.12 Soil Erosion and Dust

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description

Soil erosion and dust are ongoing problems for Kansas. Both can cause significant loss of valuable agricultural soils, damage crops, harm environmental resources, and have adverse economic impacts. Soil erosion in Kansas is largely associated with periods of drought, when winds are able to move tremendous quantities of exposed dry soil (wind erosion), and flooding (streambank erosion). Improper agricultural and grazing practices can also contribute to soil erosion.

The United States is losing soil 10 times faster than the natural replenishment rate, and related production losses cost the country about $37.6 billion each year. On average, wind erosion is responsible for about 40 percent of this loss and can increase markedly in drought years. Wind erosion physically removes the lighter, less dense soil constituents such as organic matter, clays and silts. These are the most fertile parts of the soil; their removal lowers soil productivity, resulting in lower crop yields or poorer grade pastures and increase economic costs.

Streambank erosion, which can remove agricultural land and damage or destroy transportation systems and utility lines, occurs each year, particularly in the spring, and can occur along any streambank. A large proportion of all eroded soil ends up in rivers, streams, and lakes, which makes waterways more prone to flooding and contamination. One type of streambank erosion occurs after heavy rains when water is released from reservoirs causing water levels to rise in rivers and streams. The dry soil at the top of embankments becomes saturated. When reservoir gates are closed and flows return to normal, water levels suddenly drop and the heavy wet soil at the top of the embankments falls into the rivers and streams below.

Erosion increases the amount of dust carried by wind. Dust can also cause economic impacts by reducing seedling survival and growth, increasing the susceptibility of plants to certain stressors, and damaging property and equipment (e.g., clogging machinery parts). It is also a threat to health and safety. Dust acts as an abrasive and air pollutant and carries about 20 human infectious disease organisms (including anthrax and tuberculosis). There is evidence that there is an association between dust and asthma.. Some studies indicate that as much as 20 percent of the incidence of asthma is related to dust. Blowing dust can be severe enough to necessitate highway closures because of low visibility, which can cause vehicle accidents.

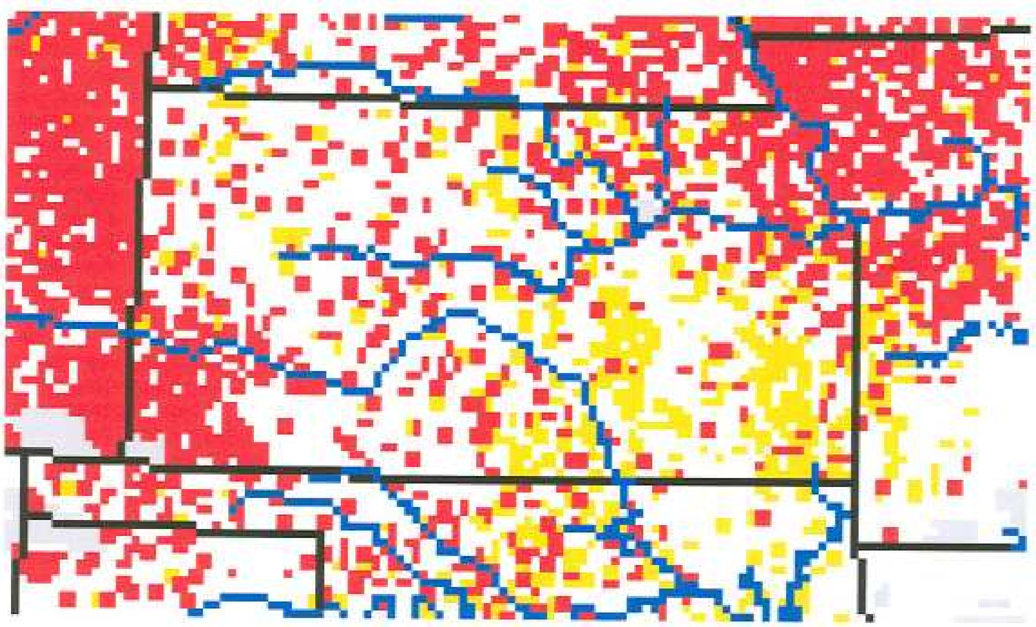
Warning Time: More than 24 hours

Duration: More than one week

Geographic Location

Figure 3.13 shows areas of excessive erosion of farmland in Kansas based on a 1997 analysis. Each red dot represents 5,000 acres of highly erodible land, and each yellow dot represents 5,000 acres of non-highly erodible land with excessive erosion above the tolerable soil erosion rate. Kingman County and the southeast portion of Kansas generally have less highly erodible land. However, it appears that Kingman County does have some sections of land that are considered highly erodible as well as non-highly erodible.

Figure 3.13. Locations of Excessive Erosion of Farmland, 1997



Previous Occurrences

In the spring of 1996, wind erosion severely damaged agricultural land throughout the Great Plains. The figure below is an example of saltation drift on the edge of a wheat field; note the dunes beginning to form.

Figure 3.14. Locations of Excessive Erosion of Farmland, 1997

Photograph taken March 1996, (Skidmore, Wind Erosion Research, USDA).

Probability of Future Occurrences

While soil erosion and dust occur annually as part of natural processes, the adverse effects of erosion are only fully realized as a cumulative function. Therefore, the probability of notable effects from soil erosion and dust events is considered “possible,” meaning the cumulative effect of annual events reaches a notable level on the average of every five years.

Magnitude/Severity

This hazard’s CPRI magnitude/severity is “negligible.”

3.2.13 Tornado

Calculated Priority Risk Index	Planning Significance
3.40	High

Description

The National Weather Service defines a tornado as a "violently rotating column of air extending from a thunderstorm to the ground." Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 mph and damage paths can be more than one mile wide and 50 miles long. In an average year, more than 900 tornadoes are reported in the United States, resulting in approximately 80 deaths and more than 1500 injuries. High winds not associated with tornadoes are profiled separately in this document in Section 3.2.15, Windstorm.

Although tornadoes have been documented on every continent, they occur most frequently in the United States east of the Rocky Mountains. Kansas is situated in an area that is generally known as "Tornado Alley." Climatological conditions are such that warm and cold air masses meet in the center of the country to create conditions of great instability and fast moving air at high pressure that can ultimately result in the formation of tornado funnels.

In Kansas, most tornadoes and tornado-related deaths and injuries occur during the months of April, May, and June. However, tornadoes have struck in every month. Similarly, while most tornadoes occur between 3:00 and 9:00 p.m., a tornado can strike at any time.

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis and better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado. Table 3.6 shows the wind speeds associated with the original and enhanced Fujita scale ratings and the damage that could result at different levels of intensity. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3.6. Comparison of Fujita and Enhanced Fujita Scales

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	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	Over 200

Source: http://www.spc.noaa.gov/faq/tornado/ef-scale.html

Windstorm

High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss.

Straight-line winds are generally any thunderstorm wind that is not associated with rotation (i.e., is not a tornado). It is these winds, which can exceed 100 mph that represent the most common type of severe weather and 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. In 2005, hail and wind damage made up 45 percent of homeowners insurance losses. One type of straight-line wind is the downburst, which can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

Thunderstorms over Kansas typically happen between late April and early September, but, given the right conditions, they can develop as early as March. They are usually produced by supercell thunderstorms or a line of thunderstorms that typically develop on hot and humid days.

Warning Time: Less than 6 hours

Duration: Less than 6 hours

Geographic Location

While tornadoes can occur in all areas of the State of Kansas, historically, some areas of the state have been more susceptible to this type of damaging storm. Figure 3.15 illustrates the number of

F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 1998. Kingman County is shown to have 6-15 tornadoes of this magnitude during this 48-year period. Additionally, according to Figure 3.16, Kingman County is in Wind Zone IV, the zone in the US that has experienced the most and the strongest tornado activity.

Figure 3.15. Tornado Activity in the United States

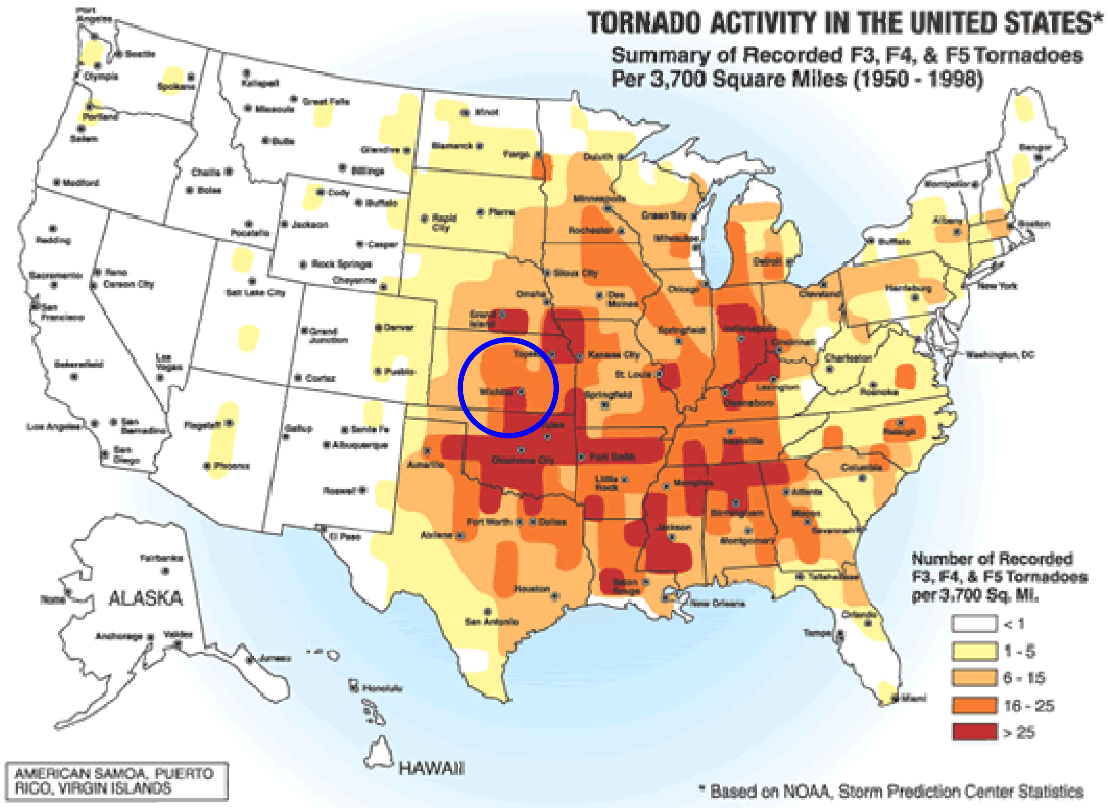
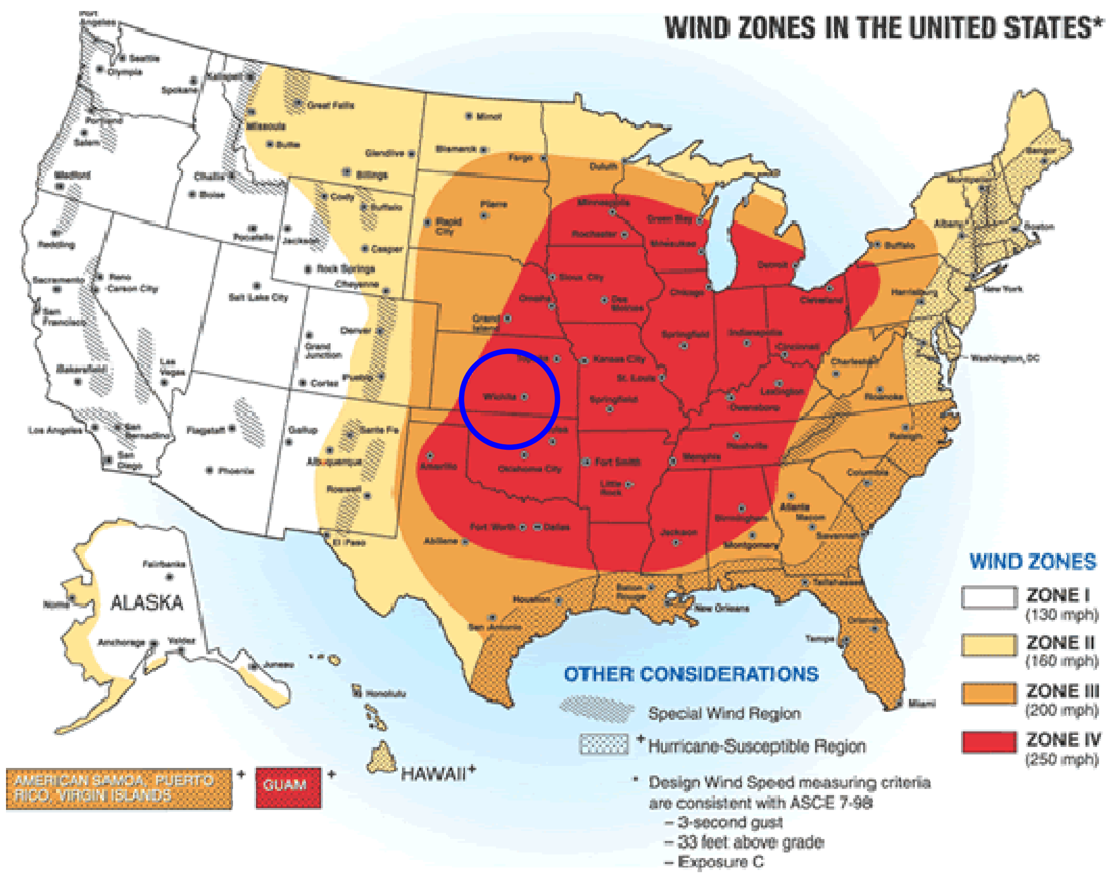


Figure 3.16. Wind Zones in the United States



Previous Occurrences

According to the National Climatic Data Center Storm Events Database, there were 43 tornadoes in Kingman County between 1950 and 2007. Of these, 31 were rated F0, 8 were rated F1, 2 were rated F2 and 2 were not rated. Kingman County has been included in Presidential Disaster Declarations for tornado damage in 1973 and 2007. The tornado event of 2007 is further defined below:

FEMA-1699-DR: Severe Storms, Tornadoes, and Flooding—May 6, 2007 (May 4)

On May 4, 2007, deadly tornadoes tracked through six counties in Kansas, including a 1.7 mile-wide EF5 tornado with wind estimated at 205 mph which struck Greensburg in Kiowa County, destroying approximately 90 percent of the town and severely damaging the remaining 10 percent. On May 6, a major disaster declaration was issued for the State by President Bush. On May 24, FEMA expanded assistance to nine Kansas counties, including Kingman County, to help pay for emergency services and to repair or replace public facilities damaged by the May storms, tornadoes and flooding. Governmental entities, municipal authorities, school districts and certain private nonprofit organizations in Kingman County became eligible for all categories of public assistance.

According to the National Climatic Data Center Storm Events database, there were 145 wind events in Kingman County between 1959 and 2007. Those events reporting significant property damage (greater than $100,000) include the following:

- April 9, 1994 – City of Kingman, large trees were uprooted, a fence was blown through a garage, shingles were blown off a roof, and a chimney sustained damage from strong thunderstorm winds ($500,000).

- July 1, 1994 – Norwich, winds of 70 to 100 mph blew across the southeast part of the County. There was extensive tree damage. A large well-digging truck was blown over three miles west of Cheny with damage at $50 thousand ($500,000).

- April 27, 1996 – City of Kingman, roof blown off business, building at lumber company demolished ($800,000).

- September 22, 2000 – Cunningham, a garage was blown down, the roof peeled from an office building resulting in the damaging of computers and other equipment inside, and tree damage was widespread ($100,000).

Probability of Future Occurrences

Based on the 43 notable events within a 57 year time period (1950–2007), a tornado event occurs every 1.3 years on average. Based on the 145 wind events occurring within Kingman County between 1959 and 2007 (48 years), a wind event occurs every 0.33 years on average. This hazard's CPRI probability is "highly likely" (event is probable within the calendar year).

Magnitude/Severity

During the 1950 to 2007 time period, there were no reported deaths and one reported injury. Total property damage for events between 1950 and 2007 is estimated at $396,000 million. This hazard's CPRI magnitude/severity is "critical."

3.2.14 Wildfire

Calculated Priority Risk Index	Planning Significance
3.20	High

Description

Wild fires in Kansas typically originate in pasture or prairie areas following the ignition of dry grasses (by natural or human sources). About 75 percent of Kansas wildfires start during spring due to dry weather conditions. Since protecting people and structures takes priority, a wildfire's cost to natural resources, crops, and pastured livestock can be ecologically and economically devastating. In addition to the health and safety impacts to those directly affected by fires, the State is also concerned about the health affects of smoke emissions to surrounding areas.

Wildfires in Kansas are frequently associated with lightning and drought conditions, as dry conditions make vegetation more flammable. As new development encroaches into the wildland-urban interface (areas where development occurs within or immediately adjacent to wildlands, near fire-prone trees, brush, and/or other vegetation), more and more structures and people are at risk. On occasion, ranchers and farmers intentionally ignite vegetation to restore soil nutrients or alter the existing vegetation growth. These fires have the potential to erupt into wildfires.

Warning Time: Less than 6 hours

Duration: Less than 1 day

Geographic Location

There is not a wildfire hazard mapping available for Kingman County. There is a greater risk in agricultural areas, where Conservation Reserve Program land is burned, and in rural areas, where individuals burn trash or debris. During high wind conditions, these small fires can get out of control and spread to dry vegetation such as native grasses, shrubs, and invasive eastern red cedar trees.

Previous Occurrences

According to data from the Kansas State Fire Marshal's Office, between 2003 and 2006, Kingman County experienced 261 wildland/crop fires across 2,956 acres. Dollar losses totaled over $264,000 (2006 dollars). There was civilian death.

Probability of Future Occurrences

Kingman County experiences, on average, 65 wildland/crop fires across 739 acres each year, based on the data from the Kansas State Fire Marshal's Office. This hazard's CPRI probability is "highly likely" (event is probable within the calendar year).

Magnitude/Severity

Kingman County experiences, on average, $66,000 in losses each year, based on the data from the Kansas State Fire Marshal's Office. This hazard's CPRI magnitude/severity is "limited."

3.2.15 Winter Storm

Calculated Priority Risk Index	Planning Significance
3.30	High

Description

Winter storms in Kansas usually come in the form of heavy snow or freezing rain (ice storms). Regardless of the form they take, they can have significant impacts to the state and its residents for days, weeks, or months. They can immobilize a region, blocking roads and railways and closing airports, which can disrupt emergency and medical services, hamper the flow of supplies, and isolate homes and farms, possibly for days. Heavy snow can collapse roofs and knock down trees and power lines. Unprotected livestock may be lost. Economic impacts include cost of snow removal, damage repair, business and crop losses, and power failures. It is these impacts which are of greatest concern to Kansas.

A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures (see Section 3.3.6 Extreme Temperatures). The National Weather Service describes different types of winter storm events as follows:

- **Blizzard—**Winds of 35 mph or more with snow and blowing snow reducing visibility to less than 1/4 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 whose temperature is 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

Heavy accumulations of ice, often the result of freezing rain, can bring down trees, utility poles, and communications towers, and disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians.

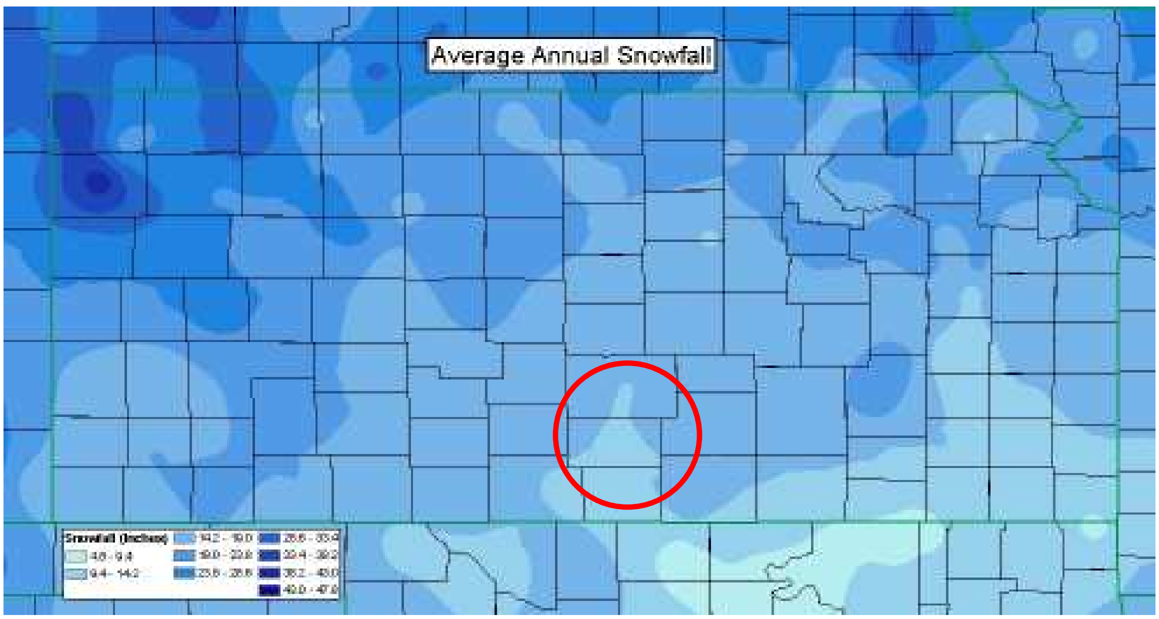
Warning Time: 12 to 24 hours

Duration: Less than one week

Geographic Location

The entire State of Kansas is vulnerable to heavy snow and freezing rain. Northwestern Kansas receives the greatest average annual snowfall and the southeast receives the least (see Figure 3.17). In this figure, Kingman County is shown to receive an average of 14.2 to 19.0 inches of snowfall annually.

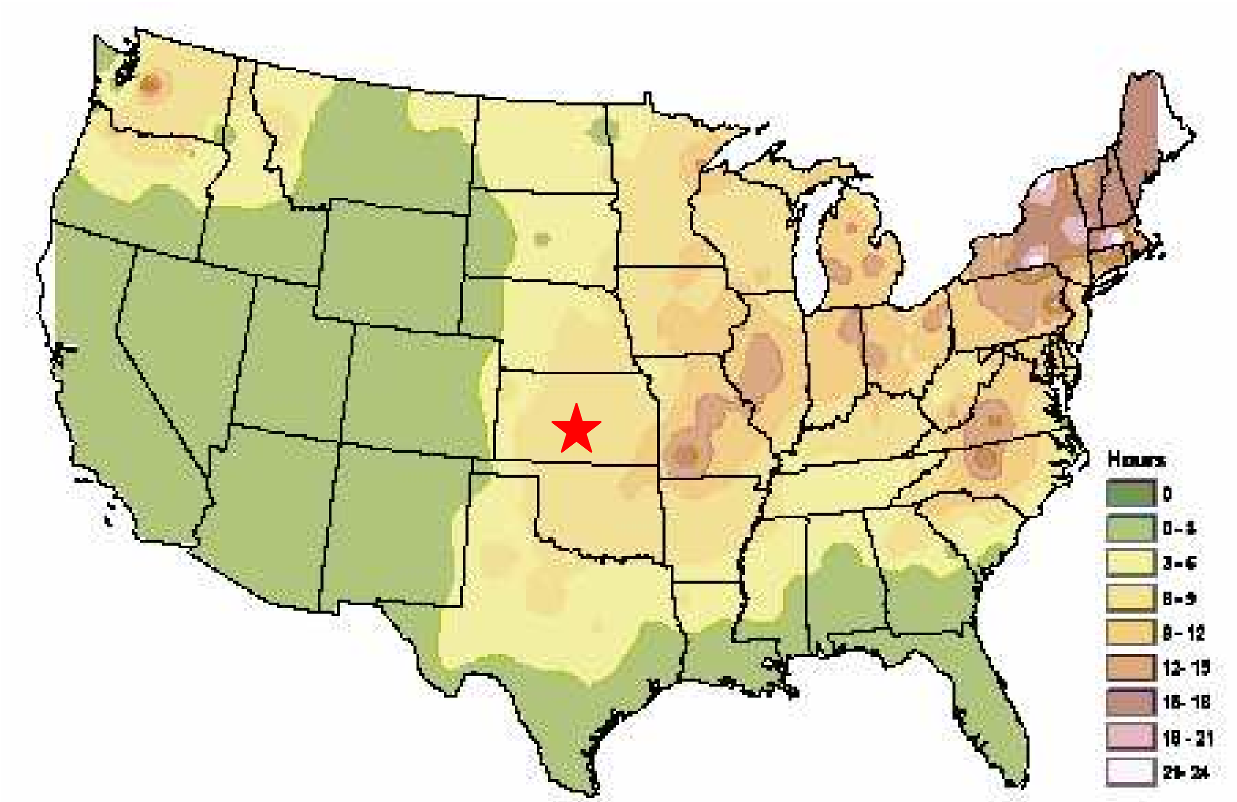
Figure 3.17. Average Annual Snowfall



Source: Kansas State University, Research and Extension, Weather Data Library, www.oznet.ksu.edu/wdl/Maps/Climatic/AnnualFreezeMap.asp

Conversely, freezing rains occurs most frequently in southeastern Kansas and least frequently in western Kansas (see Figure 3.18). In this figure, Kingman County is shown to receive between 8-12 hours per year of freezing rain.

Figure 3.18. Average Number of Hours per Year with Freezing Rain in the United States



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

Previous Occurrences

According to the National Climatic Data Center Storm Events database, there were 47 recorded winter storms in Kingman County between 1965 and 2007. Those events reporting significant property damage (greater than $50,000) include the following:

- January 29, 2002 - Widespread freezing rain and sleet developed late in the afternoon of the 29th across south-central Kansas and continued through the night of the 30th, eventually changing to snow early on the morning of the 31st. The result was a major ice accumulation of 1-2 inches on trees and power lines across south-central Kansas that severed power to much of the area.

- January 4, 2005 - Considered by many to be the worst ice storm since 1982 to ravage all of central & most of south-central Kansas, this storm lasted from the afternoon of the 4th through morning of the 5th, coating almost the entire warning area with 1/2 to 1 inch of ice. Although freezing rain was the primary culprit, the winter storm was magnified considerably by periods of sleet that accumulated to depths of 1 to 2 inches. $1,199,000 reported in damage in Kingman County

- December 10, 2007 - Roughly one inch of ice encrusted Kingman County during the ice storm which resulted in approximately 1000 downed power poles and power lines down throughout the County. Damage to the electrical infrastructure is estimated at around $15 million. There was also widespread damage to trees but the cost of the damage is unknown.

In addition to the National Climatic Data Center, the High Plains Regional Climate Center (HPRCC) archives National Weather Service (NWS) surface observations including daily measurements of snowfall for first order (NWS forecast offices) and second order (cooperative observer network) sites. There are two NWS cooperative sites located in Kingman County: Kingman (144313) and Norwich (145870).

Recorded total snowfall in Kingman County from 1948 through 2007, was averaged for the two sites. Averaged snowfall, in inches, for each month is shown in Table 3.7.

Table 3.7 Record Snowfall (inches) by Month

Month	Snowfall (inches)	Month	Snowfall (inches)
January	3.2	July	0.0
February	3.6	August	0.0
March	2.0	September	0.0
April	0.3	October	0.1
May	0.0	November	0.9
June	0.0	December	2.5

Source: High Plains Regional Climate Center, www.hprcc.unl.edu/data

Probability of Future Occurrences

Based on the 47 noted events within a 43 year time period (1965–2008), a winter storm event occurs every 0.9 years on average. This hazard's CPRI probability is "highly likely" (event is probable within the calendar year).

Magnitude/Severity

There have been 47 noted extreme temperature events reported in Kingman County since 1965, according to the National Climatic Data Center and SHELDUS. Of the 47 notable events, one death was reported in February 2003 and three deaths in January 2005. This hazard's CPRI magnitude/severity is "critical."

3.3 Vulnerability Assessment

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

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

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

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

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

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

3.3.1 Methodology

The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk from natural hazards. The vulnerability assessment for this plan followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (2002).

The vulnerability assessment was conducted based on the best available data and the overall planning significance of the hazard. Data to support the vulnerability assessment was collected from the same sources identified in Section 3.1, Hazard Identification, and Section 3.2, Hazard Profiles, and from FEMA's HAZUS-MH MR3 loss estimation software.

The Vulnerability Assessment is divided into three parts:

- **Section 3.3.2, Community Asset Inventory,** describes the assets at risk in Kingman County, including the total exposure of people and property; critical facilities and infrastructure; natural, cultural, and historic resources; and economic assets.
- **Section 3.3.3, Vulnerability by Hazard,** describes the County's overall vulnerability to each hazard identified and profiled in Sections 3.1 and 3.2. For hazards of high and moderate significance, the assessment identifies existing and future structures, critical facilities and infrastructure in identified hazard areas, and estimates potential losses to vulnerable structures, where data is available.

- **Section 3.3.4, Development and Land Use Trends,** discusses development trends, including population growth, housing demand, land use patterns, and provides an analysis in relation to hazard-prone areas.

3.3.2 Community Asset Inventory

This section assesses the population, structures, critical facilities, infrastructure, and other important assets in Kingman County that may be at risk from natural hazards.

Total Exposure of Population and Structures

Table 3.8 shows the total population, number of structures, and value of improvements by jurisdiction. Land values have been purposely excluded because land remains following disasters and subsequent market devaluations are frequently short term and difficult to quantify. Additionally, state and federal disaster assistance programs generally do not address loss of land or its associated value. The greatest exposure of people and property is concentrated in the cities of Cunningham and Kingman.

Table 3.8. Maximum Population and Building Exposure by Jurisdiction

Community	Population 2006	Number of Structures	Total Structure Value ($)
Cunningham	514	380	$103,857,000
Kingman	3384	2144	$439,887,000
Nashville	111	86	$11,745,000
Norwich	551	367	$89,435,000
Penalosa	27	28	$3,364,000
Spivey	80	69	$14,569,000
Zenda	123	85	$12,085,000
Unincorporated Kingman County	3883	2865	$352,127,000
Total	**8673**	**6024**	**$1,027,069,000**

Sources: Kansas Division of the Budget (population); HAZUS-MH (MR 3) (structures)

Critical Facilities and Infrastructure

A critical facility may be defined as one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Table 3.9 is an inventory of critical facilities in Kingman County based on available data from the State of Kansas and from HAZUS-MH MR3, FEMA's GIS-based loss estimation software. Figure 3.19 displays the locations of these facilities; Figure 3.20 shows the pipelines and power infrastructure that traverse the County; and Figure 3.21 shows the location of bridges in Kingman County.

Figure 3.19. Kingman County Critical Facilities

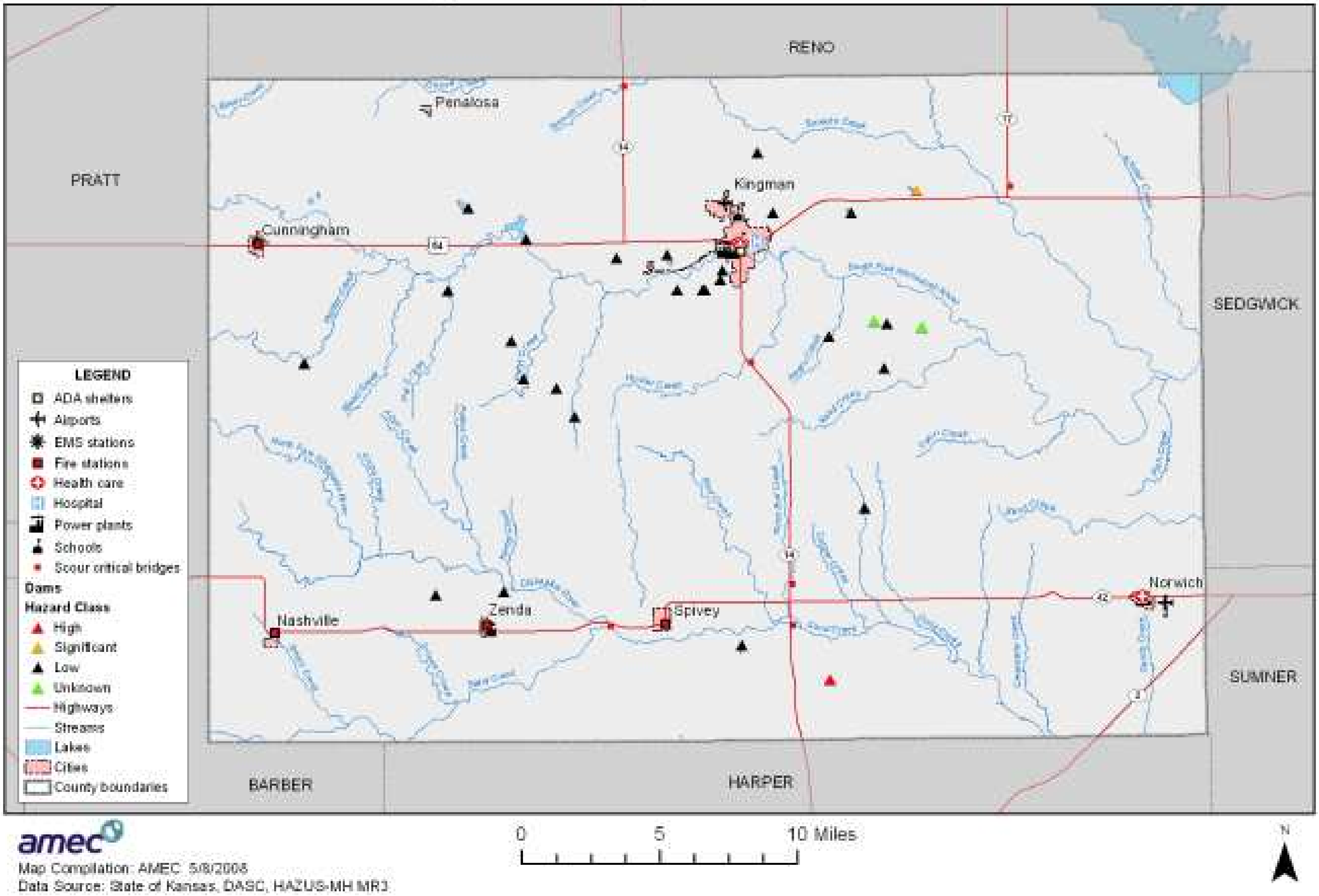


Figure 3.20. Kingman County Pipelines and Power Infrastructure

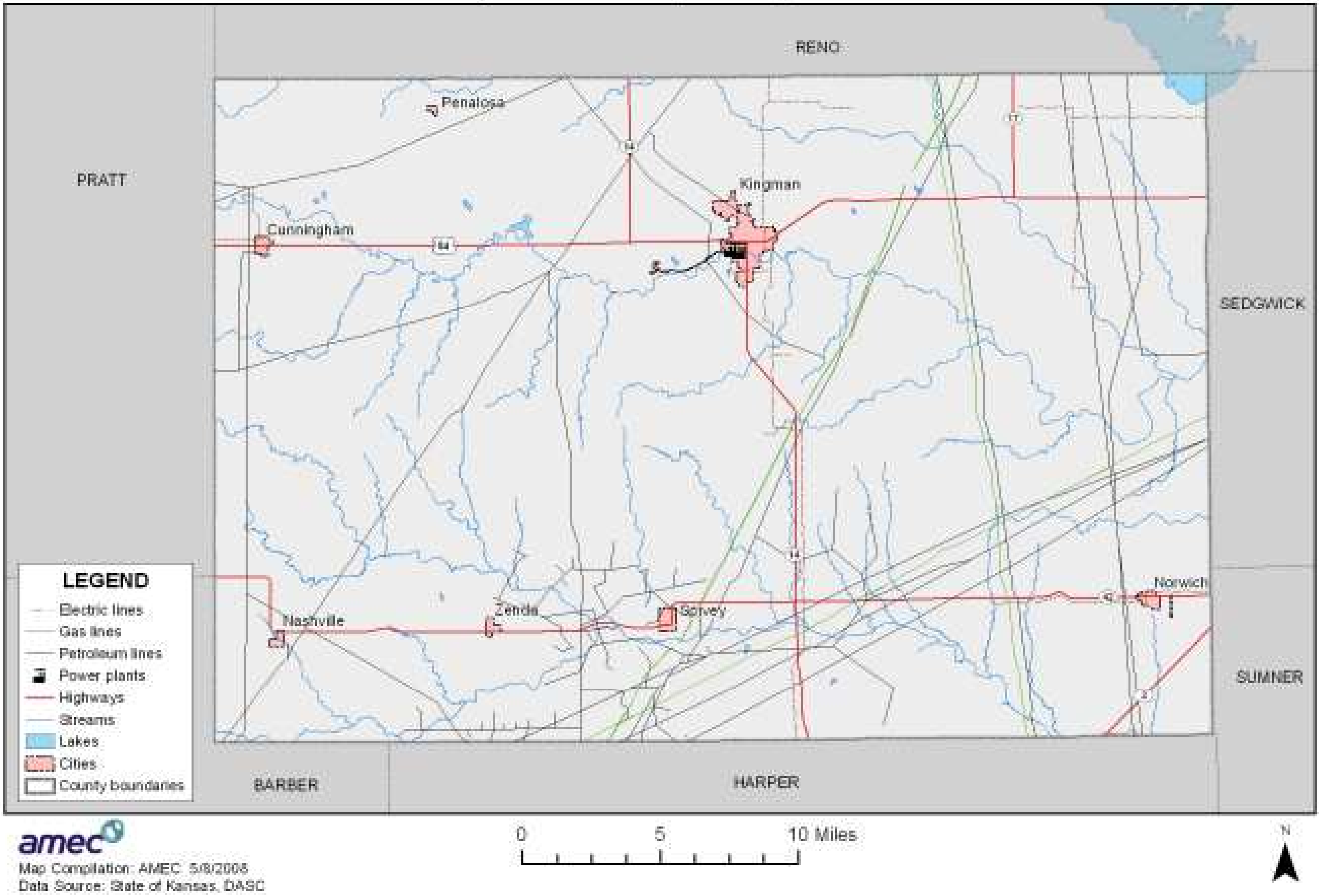


Figure 3.21. Kingman County Bridges

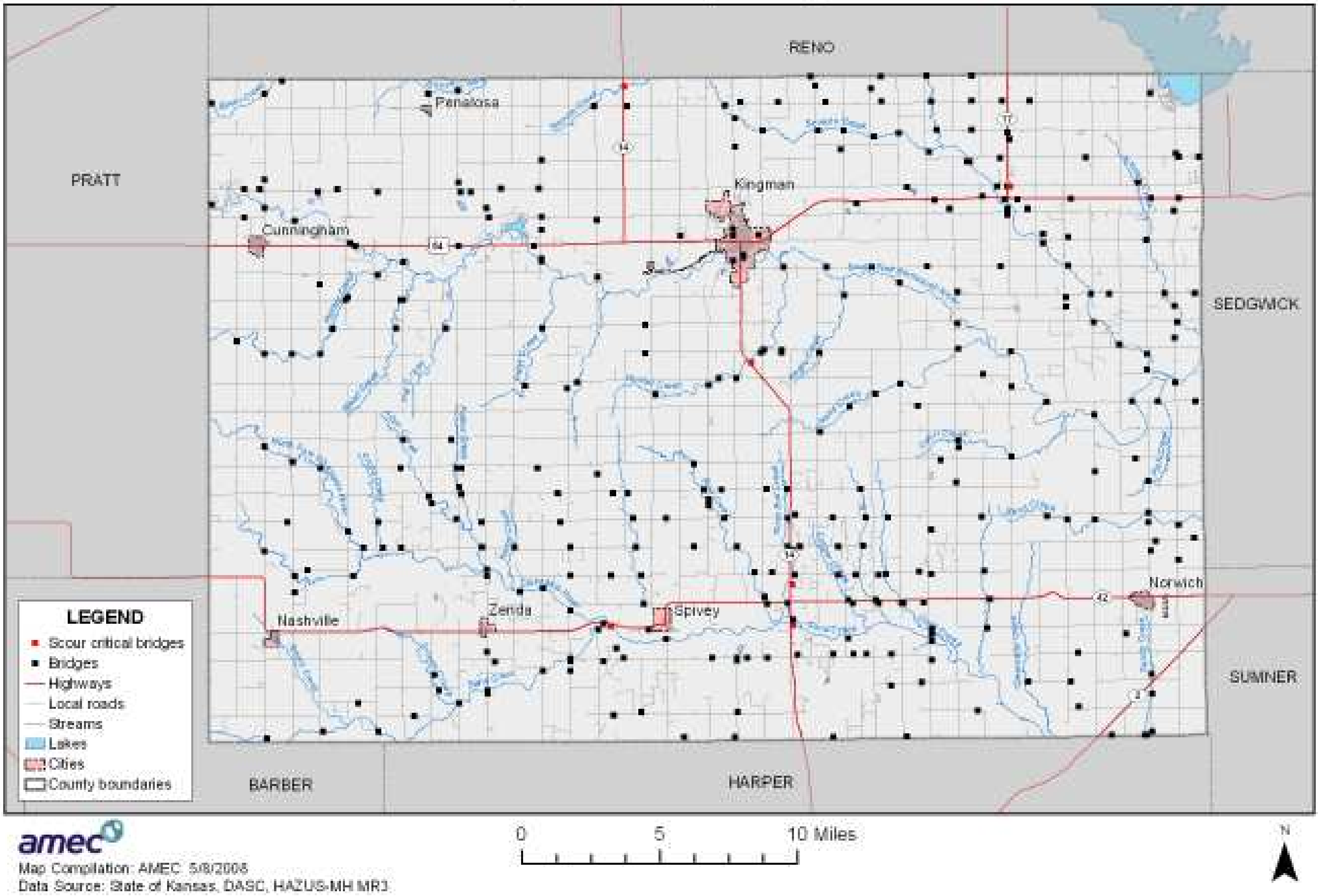


Table 3.9. Inventory of Critical Facilities by Community

Facility	Unincorporated Area	Cunningham	Kingman	Nashville	Norwich	Penalosa	Spivey	Zenda
Airports	---	---	1	---	1	---	---	---
Electric Plants	---	---	1	---	---	---	---	---
EMS Stations	---	---	1	---	1	---	---	---
Fire stations	---	1	1	1	1	---	1	1
Health care	---	---	5	---	1	---	---	---
Nursing Homes	---	1	1	---	---	---	---	---
Power Plants	---	---	1	---	---	---	---	---
Schools	---	2	3	---	2	---	---	1
Totals	**0**	**4**	**15**	**1**	**6**	**0**	**1**	**2**

Source: HAZUS-MH (MR 3)

Other Community Assets

Assessing the vulnerability of Kingman County to disaster also involves inventorying the natural, historic, cultural, and economic assets of the area. This is important for the following reasons:

- The County may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, identifying them ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources, such as wetlands and riparian habitat, absorb and attenuate floodwaters—beneficial functions which can help reduce the impacts of these hazards.
- Losses to economic assets (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

In Kingman County, specific assets include the following:

- Natural resources: There are six threatened species within Kingman County: bald eagle, eastern spotted skunk, flathead chub, longnose snake, piping plover, and snowy plover. There are three endangered species within Kingman County: black-footed ferret, least tern and peregrine falcon.
- Cultural resources: The Cunningham Museum, Zenda Community Museum, Kingman County Historical Museum, and Santa Fe Depot in the City of Kingman are important cultural, as well as historic, resources for the County.
- Historic resources: There are eight Kingman County properties on the National Register of Historic Places. These properties are identified in Table 3.10.

Economic assets: According to the 2000 Census, the industries that employed the highest percentages of Kingman County's labor force were educational, health, and social services

(22.8%); manufacturing (18.4%); agriculture, forestry, fishing and hunting, and mining (11.6%) and retail trade (10.3%).

Table 3.10. Kingman County Properties on the National Register of Historic Places

Property Name	Address	Location	Date Listed
Doney--Clark House	817 W. Sherman St.	Kingman	5/6/1994
Kingman Carnegie Library	455 N. Main	Kingman	6/25/1987
Kingman City Building	Main St. and C Ave.	Kingman	4/13/1972
Kingman County Courthouse	120 Spruce St.	Kingman	9/11/1985
Kingman National Guard Armory	111 S. Main St.	Kingman	7/7/2004
Kingman Santa Fe Depot	201 East Sherman	Kingman	10/11/2001
Prather, Charles M., Barn	NW 30th St. and NW 60th Ave.	Kingman	10/31/2002
US Post Office--Kingman	425 N. Main St.	Kingman	10/17/1989

Source: Kansas State Historical Society, www.kshs.org/resource/national_register/index.php

3.3.3 Vulnerability by Hazard

In order to focus on the most critical hazards, those assigned a level of high or moderate planning significance were given more extensive attention in the remainder of this analysis (e.g., quantitative analysis or loss estimation), while those with a low planning significance were addressed in more general or qualitative ways.

This section describes overall vulnerability, identifies structures, and estimates potential losses to buildings, infrastructure, and critical facilities located in identified hazard areas. This assessment was limited to the hazards that were considered moderate or high in planning significance, based on HMPC input and the hazard profiles. Hazards ranked of low significance due to a lack of notable past damage or very low probabilities are not included in the vulnerability assessment. These include the following:

- Dam and Levee Failure
- Earthquake
- Land Subsidence
- Landslide
- Soil Erosion and Dust

Vulnerability for these hazards is discussed in qualitative terms in Section 3.2, Hazard Profiles. This assessment is also limited by the data available for the high or moderate ranked hazards. The methods of analysis vary by hazard type and available data. Many of the identified hazards, particularly weather related hazards, affect the entire planning area, and specific hazards areas cannot be mapped geographically. For these hazards, which include agricultural infestation, drought, extreme temperature, hailstorm, lightning, tornado, wildfire and winter storm, vulnerability is mainly discussed in qualitative terms because data on potential losses to structures is not available.

Of the high and moderate significance hazards, flood is the primary hazard that varies between jurisdictions and has identified hazard areas. It is discussed first and the remaining hazards are presented in alphabetical order.

Flood

Vulnerability Overview

Vulnerability to flooding is highest in developed areas of the floodplains of the South Fork Ninnescah River, Salt Creek, and Pocomo Creek within the City of Kingman. Cunningham, Spivey, Zenda, and unincorporated areas of Kingman County also have structures at risk.

Identifying Structures and Estimating Potential Losses

Estimated Potential Losses to Existing Development

The best available data for flooding in Kingman County was generated by HAZUS-MH MR3, FEMA's software program for estimating potential losses from disasters. The current flood insurance rate map for the County was completed in 1979, and a complete digital version of this map is not available. The County has not yet begun the process to update flood insurance rate maps through FEMA's map modernization program.

HAZUS was used to generate a one percent annual flood, or base flood, event for major rivers and creeks in the County (those with a minimum drainage area of 10 square miles). The software produces a flood polygon and flood-depth grid that represents the base flood. While not as accurate as official flood maps, such as digital flood insurance rate maps, these floodplain boundaries are used in GIS-based loss estimation.

HAZUS provides reports on the number of buildings impacted, building repair costs, and the associated loss of building contents and business inventory. Building damage can cause additional losses to a community as a whole by restricting the building's ability to function properly. Income loss data accounts for business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by HAZUS using a methodology based on the building damage estimates. Flood damage is directly related to the depth of flooding. For example, a two-foot flood generally results in about 20 percent damage to the structure (which translates to 20 percent of the structure's replacement value). HAZUS uses depth-damage curves to estimate building losses as the flood depth varies across the inundation area.

After running the HAZUS analysis for the 100-year flood event, the building inventory loss estimates (which are linked to census block geography) were sorted by incorporated communities in Kingman County and the unincorporated County to illustrate how the potential for loss varies across the planning area. Table 3.11 and Figure 3.22 show estimated potential building losses by jurisdiction.

The City of Kingman is most at risk to flood losses according to this analysis. The unincorporated County accounts for about 23 percent of the loss.

Table 3.11. Estimated Building Losses by Community

Jurisdiction	Building Damage ($)	Contents Damage ($)	Inventory Loss ($)	Relocation Loss ($)
Cunningham	$46,000	$28,000	-	-
Kingman	$7,205,000	$16,117,000	$2,826,000	$28,000
Nashville	-	-	-	-
Norwich	-	-	-	-
Penalosa	-	-	-	-
Spivey	$6,000	$3,000	-	-
Zenda	$7,000	$4,000	-	-
Unincorporated Kingman County	$4,024,000	$4,142,000	$164,000	$1,000
Total	$11,288,000	$20,294,000	$2,990,000	$29,000

Source: HAZUS-MH MR3

Jurisdiction	Capital-Related Loss ($)	Lost Wages ($)	Total Loss ($)	Percent of Total
Cunningham	-	-	$74,000	<1%
Kingman	$449,000	$10,000	$26,653,000	76%
Nashville	-	-	-	0%
Norwich	-	-	-	0%
Penalosa	-	-	-	0%
Spivey	-	-	$9,000	<1%
Zenda	-	-	$11,000	<1%
Unincorporated Kingman County	$39,000	$5,000	$8,393,000	23%
Total	$488,000	$15,000	**$35,140,000**	**100%**

Source: HAZUS-MH MR3

Default HAZUS-MH data was used to develop the loss estimates. Thus, the potential losses derived from HAZUS-MH, the best available data, may contain some inaccuracies. The building valuations used in HAZUS-MH MR3 are updated to R.S. Means 2006 and commercial data is updated to Dun & Bradstreet 2006. There could be errors and inadequacies associated with the hydrologic and hydraulic modeling of the HAZUS-MH model. The damaged building counts generated by HAZUS-MH are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis.

HAZUS also estimates the population displaced during a 100-year flood event using U.S. Census data and flood depths. This analysis is shown in Table 3.12. The software estimates that the highest number of people displaced and needing shelter will be in the unincorporated areas of the County followed by the City of Kingman.

Table 3.12. Estimated Displaced Persons in Floodplain

Jurisdiction	Estimated Displaced Persons
Cunningham	514
Kingman	3,384
Nashville	111
Norwich	551
Penalosa	27
Spivey	80
Zenda	123
Unincorporated	3,883
Total	**8,673**

Source: HAZUS MH MR3

Critical Facilities and Infrastructure in 100-Year Floodplain

Table 3.13 shows critical facilities located in the HAZUS generated 100-year floodplain. Critical facility data was obtained from the State of Kansas. These facilities are mapped on Figures 3.24 to 3.27.

Table 3.13. Critical Facilities Located in 100-Year Floodplain

Facility Name	Facility Type	Location
Sheriffs Office	Police	Kingman
ADA Shelter	ADA Shelter	Kingman
KS018187	Bridge	Kansas State Highway 14 (K42 & K14)
KS018192	Bridge	Kansas State Highway 14 S of Kingman
KS019648	Bridge	Kansas State Highway 42 W of Spivey
KSNONAME 4878	Dam	Chikaskia River N of Spivey
Kansas F F and Game Commission	Dam	South Fork Ninnescah River W of Kingman
Kingman Light and Power Plant	Electric Plant	Kingman
Kingman Power Plant	Power Plant	Kingman

Source: State of Kansas GIS Data; HAZUS MH MR3

*Note: Analysis does not include water or wastewater treatment plants, for which GIS data was not available.

Figure 3.22. Estimated Building Losses from 100-Year Flood in Kingman County

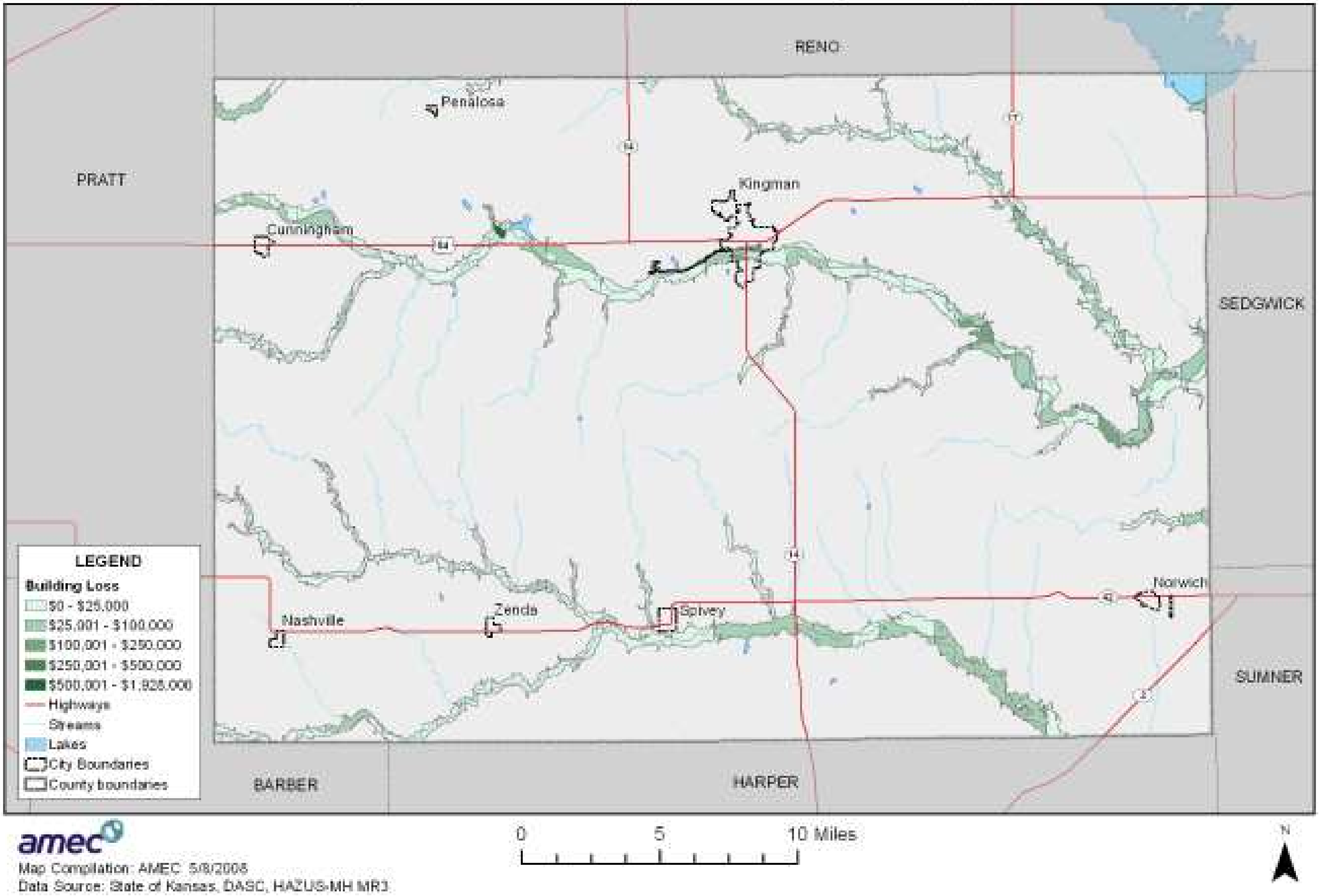


Figure 3.23. Estimated Population Displaced by 100-Year Flood in Kingman County

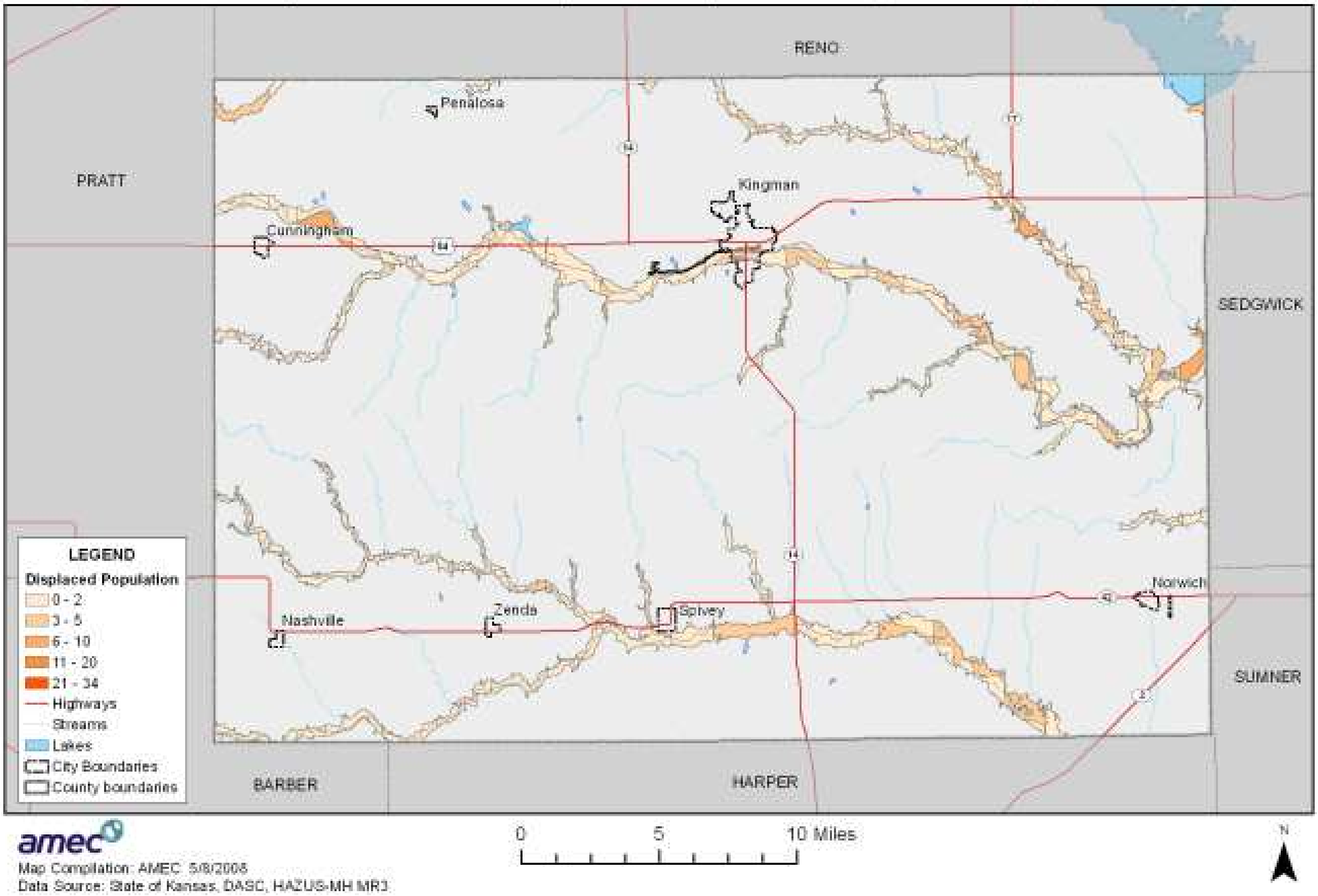


Figure 3.24. Critical Facilities in the 100-Year Floodplain in Kingman County

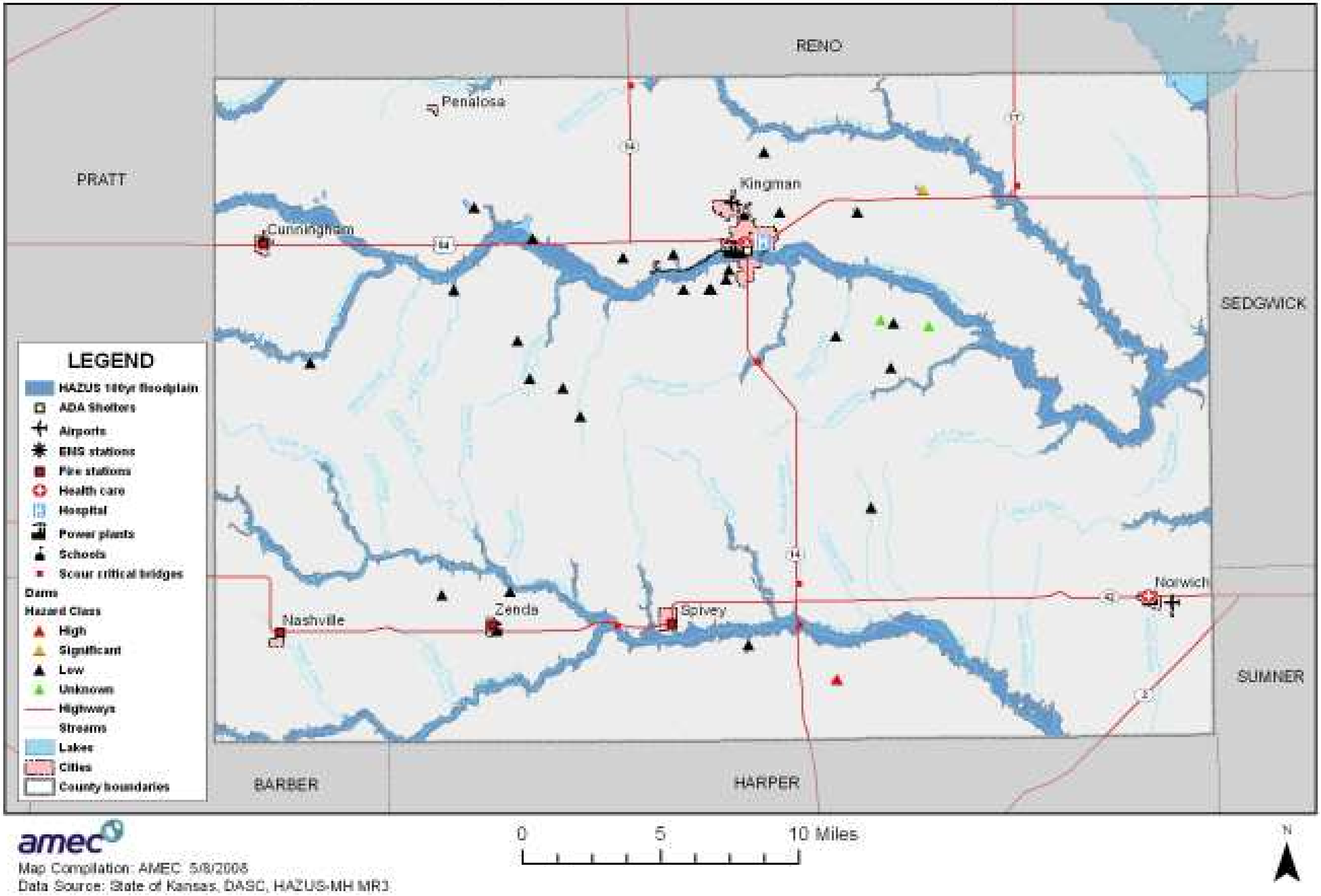


Figure 3.25. Pipelines and Electric Lines in the 100-Year Floodplain in Kingman County

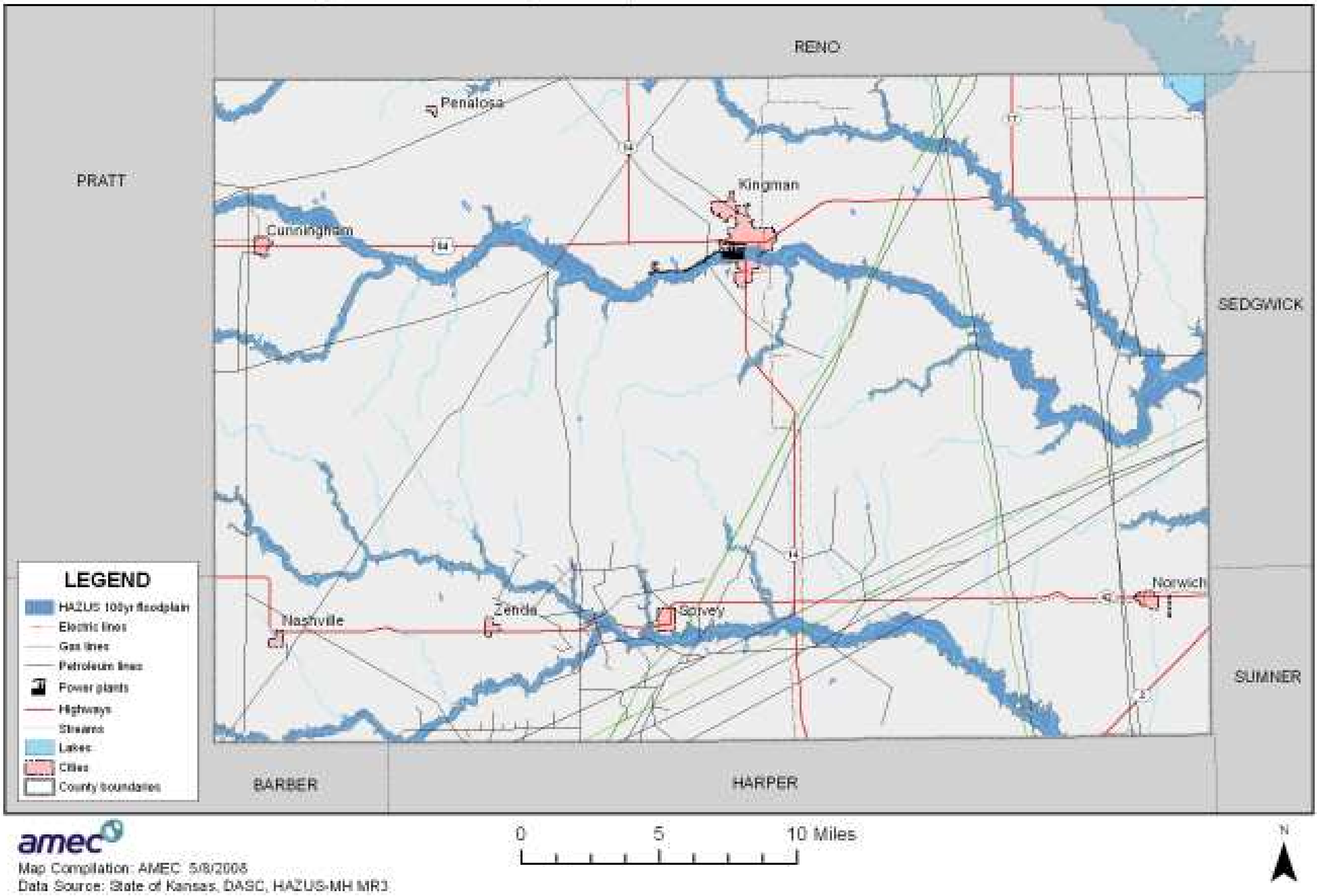


Figure 3.26. Critical Facilities in the 100-Year Floodplain in the City of Kingman

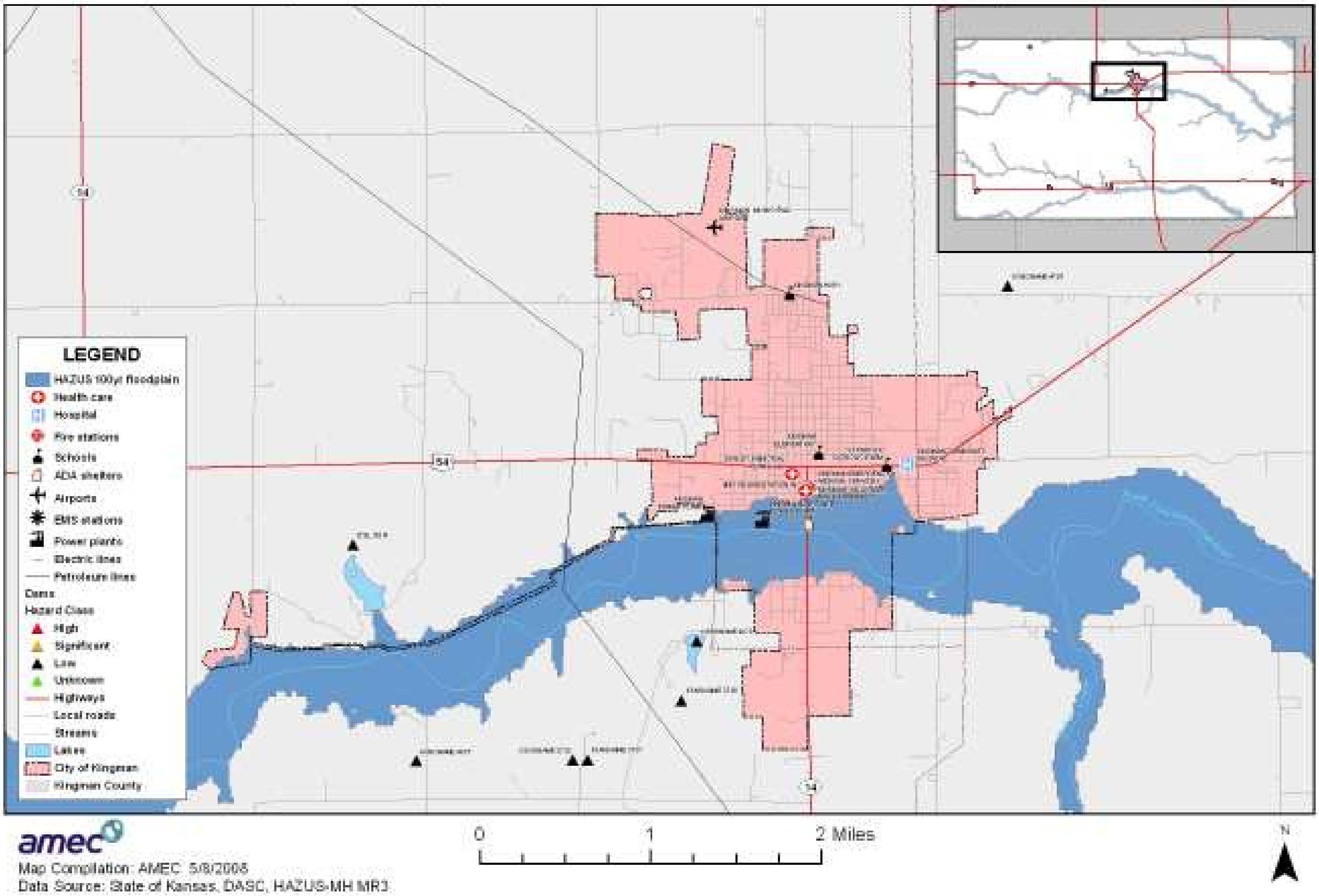
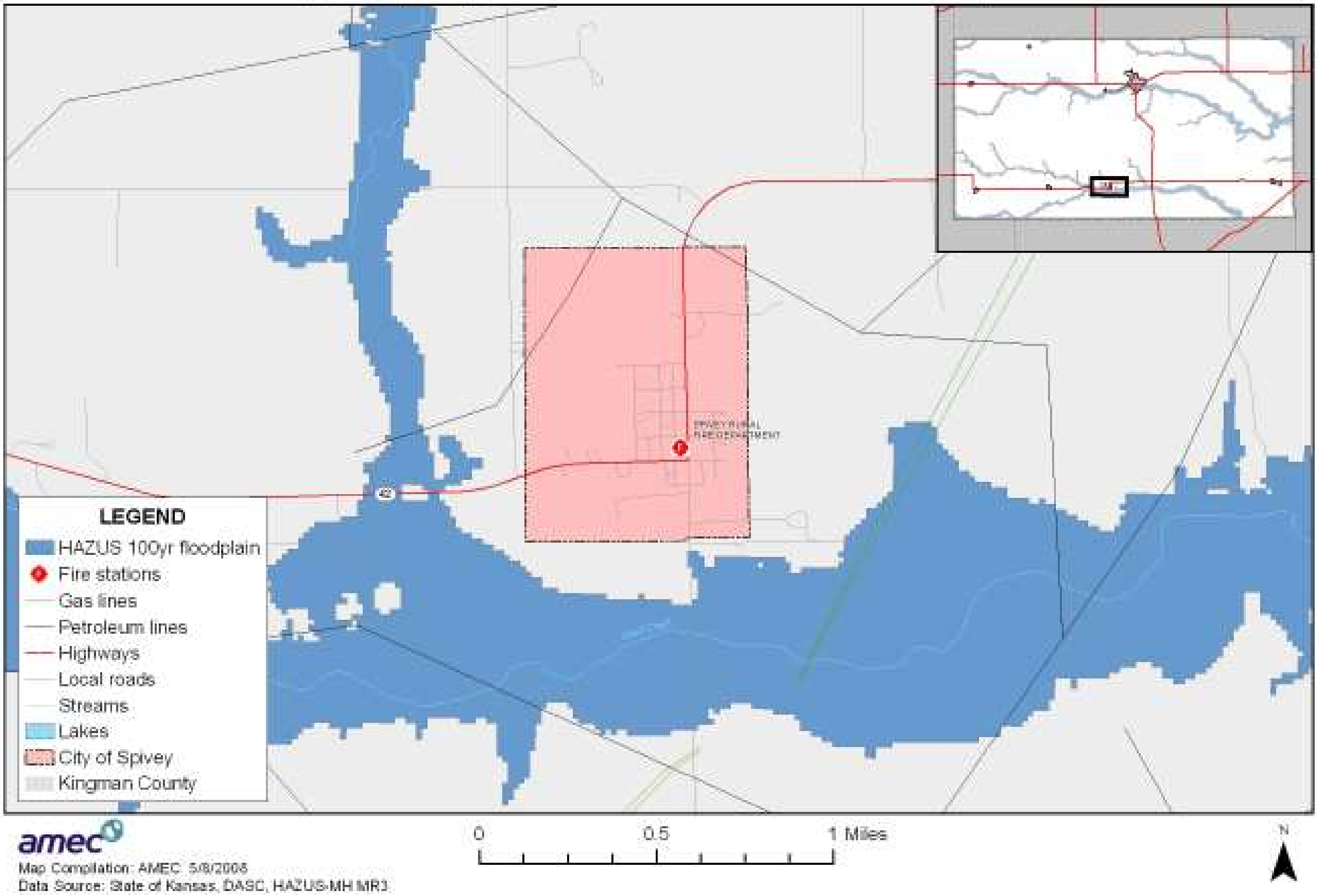


Figure 3.27. Critical Facilities in the 100-Year Floodplain near Spivey



Included with HAZUS-MH is a database of bridges called the National Bridge Inventory developed by the Federal Highway Administration. It includes a scour index used to quantify the vulnerability of a bridge to scour during a flood. Bridges with a scour index between one and three are considered “scour critical,” or a bridge with a foundation element determined to be unstable for the observed or evaluated scour condition. There are six scour critical bridges in Kingman County. Four are located along Kansas Highway 14, one is located between the City of Zenda and the City of Spivey on Kansas Hwy 42, and one is located east of the City of Kingman on Kansas Hwy 17, as shown in Figure 3.21.

National Flood Insurance Program

Table 3.14 provides detailed information on National Flood Insurance Program (NFIP) policies in NFIP participating jurisdictions in Kingman County. The communities of Cunningham, Nashville, Norwich, Penalosa, Spivey, and Zenda do not participate in the NFIP and have not been mapped.

Table 3.14. Community Participation in the National Flood Insurance Program

Jurisdiction	Date Joined	Effective FIRM Date	Policies in Force	Insurance in Force ($)	Number of Claims	Claims Totals ($)
Kingman	06/18/1980	06/18/1980	46	$5,488,600.00	0	0
Unincorporated Kingman County	02/01/1990	02/01/1990	17	$1,223,100.00	1	$5,956.18
Total	**---**	**---**	**63**	**$6,711,700.00**	**1**	**$5,956.18**

Source: National Flood Insurance Program, February 29, 2008

Kingman County—Of the 17 policies in force in the unincorporated County, 15 are residential and 2 are nonresidential. Fourteen of the policies are in special flood hazard areas (A Zone) and 3 are in B, C, and X Zones. There has been one historical claim for flood losses within the B, C, and X Zone.

City of Kingman—Of the 46 policies in force, 31 are residential and 15 are nonresidential. Thirty-five of the policies are in special flood hazard areas (A and AE Zones) and 11 are in B, C, or X Zones. There have been no historical claims for flood losses.

Future Development

The risk of flooding to future development in Kingman County should be minimized by the floodplain management programs of the County and the City of Kingman, if properly enforced. Risk to new development could be further reduced by strengthening floodplain ordinances beyond minimum NFIP requirements.

Agricultural Infestation and Drought

Vulnerability Overview

Over ninety percent of the 552,544 acres in Kingman County are used for agricultural purposes, such as pasture for livestock grazing or fields planted with crops. The agricultural economy of Kingman County is vulnerable to periods of drought. Drought can also affect the water supply and water quality of communities and water districts in the County. Drought increases the impacts of soil erosion and dust and the risk of wildfire hazards.

Identifying Structures and Estimating Potential Losses

Drought normally does not impact structures and it can be difficult to identify specific hazard areas. Data is not available to estimate potential losses to structures in identified hazard areas.

According to the three-year period for which data is available from USDA Risk Management Agency, the average amount of annual claims paid for crop damage as a result of drought in Kingman County from 2005 to 2007 was $351,425. The HMPC realizes that USDA claims only represent a small portion of the actual damages. However, this is the only data specific to Kingman County available at this time from which to compute loss estimates. Agricultural damages are estimated to be at least $350,000 annually. Other losses as a result of drought are not quantifiable at this time.

Future Development

As population grows, so do the water needs for household, commercial, industrial, recreational, and agricultural uses. However, population is declining in Kingman County and there is limited new development; vulnerability to drought is unlikely to increase.

Extreme Temperatures

Vulnerability Overview

The elderly population in the planning area is most vulnerable to extreme heat. Table 3.15 shows that the percentage of elderly people in the planning area is well above the national average. In addition, individuals below the poverty level may be at increased risk to extreme heat if air conditioning is not affordable. The percentage of the population below the poverty level is similar to the national average.

Table 3.15. Population Over Age 65 and Below the Poverty Level

Community	Total Population	Age 65 and Over (%)	Individuals Below Poverty Level (%)
United States	281,421,906	12.4	12.4
Kingman County	8673	19.6	10.6
Cunningham	514	30	9.9
Kingman	3,384	22.7	12.2
Nashville	111	18.9	17.9
Norwich	551	22.1	6.8
Penalosa	27	37	11.4
Spivey	80	15	6.6
Zenda	123	19.5	13.4

Source: 2000 Census, U.S. Census Bureau

Note: The Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty.

The HMPC identified the power distribution and infrastructure as vulnerable to brownouts during periods of extreme heat when the use of air conditioning puts a strain on power generation and transmission.

Identifying Structures and Estimating Potential Losses

Extreme heat normally does not impact structures and it is difficult to identify specific hazard areas. Data is not available to estimate potential losses to structures in identified hazard areas.

Nursing homes and elder care facilities are especially vulnerable to extreme heat events. There is one such facility in Cunningham and two in the City of Kingman. The power infrastructure is known to be at risk, but at this time, there is no data available to estimate potential dollar losses as a result of power failure during extreme heat events. Although agriculture is also vulnerable, there are no financial losses recorded by the USDA attributed specifically to heat in available data for Kingman County from 2005 to 2007.

Future Development

A growing population increases the number of people vulnerable to extreme heat events; new development increases the strain on the power grid during extreme heat periods. Current growth and development trends in Kingman County are declining and unlikely to increase vulnerability to extreme heat.

Tornado and Windstorm

Vulnerability Overview

Although historically there has not been a tornado event in Kingman County that caused widespread damage, the potential for a strong, damaging event is likely. All above-ground buildings, infrastructure, and critical facilities are at risk of damage.

Identifying Structures and Estimating Potential Losses

To assess vulnerability to this damaging hazard, the HMPC considered the impacts of the recent tornado in Greensburg, Kansas (2007). Greensburg is approximately 65 miles due east of the City of Kingman. On May 4, 2007, Greensburg was hit by an EF5 tornado. The tornado was estimated to be 1.7 miles in width and traveled for nearly 22 miles. Ninety-five percent of the city was confirmed to be destroyed, with the other 5 percent severely damaged. Greensburg has a population of approximately 1,500 with 1.5 square miles in city limits.

If a tornado event similar to that of Greensburg occurred in the populated sections of the planning area, it is conceivable that a similar level of destruction could occur. Table 3.16 estimates potential losses for an EF5 event by calculating a 95 percent loss of structure value in each jurisdiction. It indicates that a similar scenario in Cunningham or Kingman could result in over $100,000,000 in structural losses. This level of loss is not conceivable for the unincorporated area as a whole and is not included.

Table 3.16. Estimated Potential Property Loss from EF5 Tornado by Jurisdiction

Community	Number of Structures	Total Structure Value ($)	Estimated 95% Structure Loss ($)
Cunningham	380	$103,857,000	$98,664,150
Kingman	2144	$439,887,000	$417,892,650
Nashville	86	$11,745,000	$11,157,750
Norwich	367	$89,435,000	$84,963,250
Penalosa	28	$3,364,000	$3,195,800
Spivey	69	$14,569,000	$13,840,550
Zenda	85	$12,085,000	$11,480,750
Total	5683	$1,218,686,000	$1,157,751,700

The Kansas Hazard Mitigation Plan lists data from the NCDC on total property losses and annualized losses due to tornadoes from 1950-2006, analyzed by county. In Kingman County, the estimate for past damage is $1,967,584 and for annualized property damage is $34,519.

Future Development

Future residential or commercial buildings built to code should be less vulnerable to high winds associated with tornadoes. Building standards can offer only limited protection. Unincorporated areas of the County do not have building codes, but new development there is limited.

Wildfire

Vulnerability Overview

The Kansas Forest Service Community Wildfire Hazard Assessment Report for Kingman County describes most of the County at low vulnerability to wildfire. Areas of moderate vulnerability include the City of Nashville and the community of Rago due to the heavier fuel loads of hardwood timber, grass and eastern red cedar mix with little or no break in the fuel continuity between the communities and the surrounding vegetation fuels.

Identifying Structures and Estimating Potential Losses

The Kansas Forest Service Community Wildfire Hazard Assessment Report for Kingman County utilized countywide boundaries of the wildland/urban interface (WUI) from the USGS website GeoMac (www.geomac.gov), and other sources. This data was then confirmed with a field survey conducted by the Kansas Forest Service. During the survey areas both within and outside of the GeoMac WUI boundaries were inspected for any occurrence of threatening fuel types and/or fuel loads in close proximity to structures.

Homes built in rural areas near uncontrolled vegetation are most at risk. The vulnerability of structures in rural areas is greater due to the lack of hydrants in these areas and the travel distance required for firefighting vehicles and personnel to respond. For the most part the GeoMac WUI boundaries were fairly close to identifying those areas in the county that are the concentrations of population and therefore the most at risk for a wildfire causing structural or personal damage.

Future Development

As new development encroaches into the wildland-urban interface (areas where development occurs within or immediately adjacent to wildlands, near fire-prone trees, brush, and/or other vegetation), more structures and people are at risk. Neither the County nor participating jurisdictions have any policies in place to address new development in the wildland-urban interface. However, growth and development trends are very low.

Winter Storm

Vulnerability Overview

Overall vulnerability to winter storms relative to other hazards is considered moderate, with moderate potential impact to the general population and/or built environment and moderate exposure of assets. Winter storms typically involve snow and ice, occasionally accompanied by high winds, which can cause downed trees and power lines, power outages, accidents, and road closures. Transportation networks, communications, and utilities infrastructure are the most vulnerable physical assets in the planning area. The most significant damage during winter storm events occurs when freezing rain and drizzle accumulate on utility poles and power lines causing widespread power outages.

During heavy snow and ice events, the threat to public safety is typically the greatest concern. Lower income and elderly populations may be more at risk in cases of power outages during winter storms. These storms also impact the local economy by disrupting transportation and commercial activities. Travelers on highways in Kingman County, particularly along remote stretches of road, can become stranded, requiring search and rescue assistance and shelter provisions. Agriculture and livestock are also vulnerable to extreme cold temperatures and heavy snow.

Identifying Structures and Estimating Potential Losses

Buildings that have tree limbs hanging over them are more vulnerable to damage by falling tree limbs. The power poles lines are the critical facilities that are most vulnerable. Roads and bridges covered with snow and ice make travel treacherous and slow emergency vehicles. Businesses experience losses as a result of closure during power outages. Schools also must often close.

According to the three-year period for which data is available from USDA Risk Management Agency, the average amount of annual claims paid for crop damage as a result of freeze in Kingman County from 2005 to 2007 was $564,396. The HMPC realizes that USDA claims only represent a small portion of the actual damages. However, this is the only data available specific to Kingman County at this time from which to compute loss estimates. Agricultural damages are estimated to be approximately $500,000 annually. Other losses as a result of winter storm are not quantifiable at this time.

Future Development

Future residential or commercial buildings built to code should be able to withstand snow and ice loads from severe winter storms. However, unincorporated areas of the County do not have building codes, but new development there is limited.

3.3.4 Development and Land Use Trends

According to the Kansas Department of the Budget, the 2007 population of Kingman County was 7,826. This is a decrease of 10.8 percent from the 2000 census population of 8,673. All areas of the County experienced decreases in population ranging from 8 percent in Penalosa to 12 percent in Cunningham.

Despite the decrease in population, the number of housing units in the County increased between 2000 and 2006 by 5.7 percent (207 units). Tables 3.17-3.19 illustrate past growth in Kingman County in terms of population, housing units, and population density (1990/2000 data is used for housing units because subcounty data is not available for more recent years).

Table 3.17. Kingman County Population Growth, 2000-2007

Jurisdiction	2000	2007	Percent Change (%)	# Change
Cunningham	514	459	(12.0)	(55)
Kingman	3,387	3,056	(10.8)	(331)
Nashville	111	101	(9.9)	(10)
Norwich	551	501	(10.0)	(50)
Penalosa	27	25	(8.0)	(2)
Spivey	80	74	(8.1)	(6)
Zenda	123	113	(8.8)	(10)
Unincorporated	3880	3,497	(11.0)	(383)
Total	8,673	7,826	(10.8)	(847)

Source: Kansas Division of the Budget, http://budget.ks.gov/ecodemo.htm

Table 3.18. Kingman County Growth in Housing Units, 1990-2000

Jurisdiction	1990	2000	Percent Change (%)	# Change
Cunningham	223	218	(2.2)	(5)
Kingman	1,500	1,563	4.2	63
Nashville	56	56	0.0	0
Norwich	208	216	3.8	8
Penalosa	12	19	58.3	7
Spivey	43	49	14.0	6
Zenda	49	60	22.4	11
Unincorporated	1,554	1,671	7.5	117
Total	3,645	3,852	5.7	207

Source: U.S. Census Bureau, www.census.gov/

Table 3.19. Kingman County Population Density, 2000-2007

Jurisdiction	Area in Square Miles	2000 Population Density	2007 Population Density
Cunningham	0.36	1427.8	1275.0
Kingman	3.49	970.5	875.6
Nashville	0.22	504.5	459.1
Norwich	0.46	1197.8	1089.1
Penalosa	0.07	385.7	357.1
Spivey	0.52	153.8	142.3
Zenda	0.23	534.8	491.3
Unincorporated	861.35	4.5	4.1
Total	866.70	10.0	9.0

Sources: Kansas Division of the Budget, http://budget.ks.gov/ecodemo.htm;
U.S. Census Bureau, www.census.gov/

Despite the overall lack of population growth, development continues and the communities should monitor new development to ensure that it does not take place in hazard-prone areas, specifically in the floodplains, dam inundation areas, and the wildland-urban interface.

3.4 Summary of Key Issues

The following sections summarize key issues identified by the risk assessment.

- Over ninety percent of the land in Kingman County is used for agricultural purposes, such as pasture for livestock grazing or fields planted with crops. A prolonged drought could severely impact the economic base of Kingman County.
- The 100-year floodplain divides the City of Kingman
- Due to the potential for fatalities and the possibility of the loss of electric power, periods of extreme heat can severely affect the planning area.
- There has been a development trend involving construction of residential dwellings in pasture areas or rural areas that are more prone to wildfire.
- Tree limbs falling on utility lines cause most of the damage during ice/winter storms.
- Loss of power has been particularly problematic for many nursing homes.