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 identifies and profiles hazards that are relevant to Region L as they pertain to lives, property, and infrastructure. The goal is to estimate the potential for loss of life, personal injury, property damage or loss, and economic loss from a hazard event. This assessment encourages communities within Johnson, Leavenworth, and Wyandotte to understand their potential risk, and to help them develop and prioritize mitigation actions that can reduce these risks in future hazard events.

The Federal Emergency Management Agency (FEMA) defines risk assessment terminology as follows:

- **Hazard**—A hazard is an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.
- **Vulnerability**—Vulnerability is susceptibility to physical injury, harm, damage or economic loss. It depends on an asset's construction, contents and economic value of its functions.
- **Exposure**—Exposure describes the people, property, systems, or functions that could be lost to a hazard. Generally, exposure includes what lies in the area the hazard could affect.
- **Risk**—Risk depends on hazards, vulnerability, and exposure. It is the estimated impact that a hazard would have on people, services, facilities and structures in a community. It refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage.
- **Risk Assessment**—Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from hazards.

The risk assessment in this 2013 plan update for Region L will reflect recent events, the availability of new information, and a reevaluation of the hazards that threaten the region. This section will summarize Region L as a whole, followed by the counties of Johnson, Wyandotte, and Leavenworth. Only in the case of unique or varied hazards will any participating jurisdictions be assessed. The three parts to be covered in this chapter are:

• **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 Region's total exposure to natural hazards, considering critical facilities and other community assets at risk, and assessing growth and development trends. Hazards that vary geographically across the planning area

are addressed in greater detail. This section includes an inventory of assets and estimates losses from the identified hazards.

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.

The Planning Committee reviewed data and discussed each of the 22 natural, man-made, and technological hazards identified in the State of Kansas Hazard Mitigation Plan (SHMP). It was noted that while fog was removed from the SHMP, civil disorder was added as its own entity. The Region L Planning Committee supports these changes, agrees that all 22 hazards currently identified in the SHMP could affect the region and has modified its list of hazard profiles to match the State plan. The Planning Committee also noted that in previous plans, counties within Region L addressed slightly different lists of hazards; these variations are identified in summaries for individual counties at the end of each hazard section.

Profiled hazards, listed alphabetically, are:

Agricultural Infestation	Hailstorm	Soil Erosion and Dust
Civil Disorder	Hazardous Materials	Terrorism/Agro-Terrorism
Dam and Levee Failure	Land Subsidence	Tornado
Drought	Landslide	Utility/Infrastructure Failure
Earthquake	Lightning	Wildfire
Expansive Soils	Major Disease Outbreak	Windstorm
Extreme Temperatures	Radiological	Winter Storm
Flood		

The following natural hazards identified by FEMA are not included in this analysis because they do not threaten Kansas: avalanche, coastal erosion, coastal storm, hurricane, tsunami and volcano.

3.1.1 Methodology

The first part of the risk assessment is an analysis of the overall risk for each hazard with a tool called the Calculated priority Risk Index (CPRI). The CPRI value is obtained by assigning a numerical ranking to each of four hazard characteristics, then calculating an index value based on a weighting scheme. The characteristics, definitions of rankings and weighting scheme are presented below.

The CPRI is the methodology that the State of Kansas has adopted to utilize as the basis for the hazard rankings and, as such, this regional plan uses the same methodology in order to maintain consistency. It is not a 100% accurate methodology, however, it offers a platform for discussion so that the planning committee can make a more informed determination on the ranking of each hazard. Another area of consideration is noting that even though a jurisdiction may have a high probability to experiencing a hazard, it does not necessarily mean their vulnerability is higher. For instance, the denser the population is the more vulnerable they are to the impacts of an EF1 tornado, whereas a sparsely populated area may have a high probability for an EF1 tornado, but their vulnerability overall is less.

Table 3.1 Calculated Priority Risk Index (CPRI)

Characteristic Ranking	Definition
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 is possible of occurring
Magnitude / Severity**	
4 - Catastrophic	Multiple deaths Complete shutdown of facilities for 30 or more days More than 50% 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% of property is severely damaged

Characteristic Ranking	Definition
2 - Limited	Injuries and/or illnesses do not result in permanent disability Complete shutdown of critical facilities for more than one week 10–25% of property is severely damaged
1 - Negligible	Injuries and/or illnesses are treatable with first aid Minor quality of life lost Shutdown of critical facilities and services for 24 hours or less Less than 10% of property is severely damaged
Warning Time	
4 3 2 1	Less Than 6 Hours 6-12 Hours 12-24 Hours 24+ Hours
Duration	
4 3 2 1	More Than 1 Week Less Than 1 Week Less Than 1 Day Less Than 6 Hours

* 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 rankings described in Table 3.1, the following formula is used to determine each hazard's CPRI.
(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 (2.0-2.95) and Low (1.1-1.95). These categories determin the level of analysis given to a hazard in subsequent the risk assessment process; they do not suggest that a hazard would have only a limited impact. In order to focus on the most critical hazards, those assigned a level of high or moderate 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.

Hazards, and their corresponding CPRI ranking were reviewed and verified by all members of the planning committee during the plan update. The hazard ranking was based on the CPRI for the Region as a whole, followed by the county. Table 3.2 indicates the ranking established by the Region using the method described above.

Table 3.2 Region L Hazard Rankings

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Regional CPRI						
Tornado	4	4	4	1	3.70	High
Flood	4	3	3	4	3.55	High

Winter Storm	4	3	2	3	3.30	High
Windstorm	4	2	3	2	3.05	High
Utility/Infrastructure Failure	4	1	4	3	3.00	High
Drought	4	2	3	4	2.95	Moderate
Hazardous Materials	4	1	4	2	2.90	Moderate
Lightning	4	2	2	1	2.80	Moderate
Wildfire	4	1	4	1	2.80	Moderate
Civil Disorder	2	4	4	1	2.80	Moderate
Major Disease Outbreak	2	4	1	4	2.75	Moderate
Hailstorm	4	1	2	1	2.65	Moderate
Terrorism/Agro-terrorism	1	4	4	4	2.65	Moderate
Extreme Temperatures	3	2	1	4	2.50	Moderate
Agricultural Infestation	3	2	1	4	2.50	Moderate
Expansive Soils	3	1	1	4	2.20	Moderate
Dam and Levee Failure	1	3	3	3	2.10	Moderate
Radiological	1	3	3	3	2.10	Moderate
Landslide	1	2	4	1	1.75	Low
Soil Erosion and Dust	2	1	1	4	1.75	Low
Earthquake	1	2	4	1	1.75	Low
Land Subsidence	1	1	3	2	1.40	Low

Each hazard is profiled on a regional basis; distinctive local circumstances or conditions relative to the hazard are noted when appropriate.

3.1.2 Disaster Declaration History

Historical events of significant magnitude or impact can result in a Secretarial or Presidential Disaster Declaration. Disaster Declarations within Region L are provided in the tables below.

Table 3.3 Presidential Declarations that Include Region L, 1967 – Present

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
Major Disaster Declarations				

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
4035	09/23/2011 (6/1-8/1/2011)	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	$7,462,881
1885	03/09/2010 (12/9/2009-1/8/2010)	Severe Winter Storms and Snowstorm	Allen, Anderson, Atchison, Bourbon, Brown, Butler, Cherokee, Cheyenne, Clay, Cowley, Crawford, Decatur, Doniphan, Elk, Franklin, Gove, Graham, Greenwood, Jackson, Jefferson, Jewell, Labette, Linn, Logan, Lyon, Marshall, Miami, Morris, Nemaha, Neosho, Norton, Osage, Phillips, Pottawatomie, Rawlins, Republic, Riley, Shawnee, Sheridan, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte	$19,100,658
1741	02/01/2008	Severe Winter Storms	Atchison, Barber, Barton, Brown, Butler, Chase, Cherokee, Clark, Clay, Cloud, Comanche, Crawford, Dickinson, Doniphan, Edwards, Ellis, Ellsworth, Ford, Geary, Graham, Gove, Harvey, Hodgeman, Jackson, Jefferson, Jewell, Kingman, Kiowa, Labette, Leavenworth, Lincoln, Logan, Lyon, Marion, Marshall, McPherson, Miami, Mitchell, Morris, Nemaha, Osage, Osborne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Republic, Rice, Riley, Rooks, Rush, Russell, Saline, Sedgwick, Shawnee, Sheridan, Smith, Stafford, Thomas, Wabaunsee, Wallace, Washington, and Woodson.	$359,557,345
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	$117,565,269
1638	4/14/2006 (3/12-13/2006)	Severe Storms, Tornadoes, and Straight-Line Winds	Douglas, Wyandotte	$6,233,044
1615	11/21/2005 (10/1-2/2005)	Severe Storms and Flooding	Atchison, Jackson, Jefferson, Leavenworth, Shawnee	$10,286,064
1579	2/8/2005 (1/4-6/2005)	Severe Winter Storm, Heavy Rains, and Flooding	Anderson, Atchison, Barber, Brown, Butler, Chase, Chautauqua, Clark, Coffey, Comanche, Cowley, Crawford, Douglas, Elk, Franklin, Greenwood, Harper, Harvey, Jackson, Jefferson, Kingman, Kiowa, Leavenworth, Lyon, Marion, McPherson, Morris, Osage, Pratt, Reno, Rice, Sedgwick, Shawnee, Sumner, Wabaunsee, Woodson, Wyandotte	$106,873,672
1562	09/30/2004 (8/27-30/2004)	Severe Storms, Flooding, and Tornadoes	Douglas, Wyandotte	$2,103,376

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
1535	8/3/2004 (6/12-7/25/2004)	Severe Storms, Flooding, and Tornadoes	Barton, Butler, Cherokee, Decatur, Ellis, Geary, Graham, Jewell, Labette, Lyon, Marion, Mitchell, Morris, Ness, Osborne, Pawnee, Phillips, Rooks, Rush, Russell, Shawnee, Sheridan, Smith, Thomas, Trego, Wabaunsee, Wallace, Woodson, Wyandotte	$12,845,892
1462	5/6/2003 (5/4-30/2003)	Severe Storms, Tornadoes, and Flooding	Allen, Anderson, Cherokee, Crawford, Douglas, Haskell, Labette, Leavenworth, Meade, Miami, Neosho, Osage, Seward, Woodson, Wyandotte	$988,056
1402	2/6/2002 (1/29-2/15/2002)	Ice Storm	Allen, Anderson, Barber, Bourbon, Butler, Chautauqua, Cherokee, Coffey, Comanche, Cowley, Crawford, Douglas, Elk, Franklin, Greenwood, Harper, Jefferson, Johnson, Kingman, Kiowa, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Pratt, Sedgwick, Shawnee, Sumner, Wilson, Woodson, Wyandotte	$60,185,754
1258	11/5/1998 (10/30-11/15/1998)	Severe Storms and Flooding	Butler, Chase, Coffey, Cowley, Douglas, Franklin, Greenwood, Harper, Harvey, Johnson, Leavenworth, Lyon, Marion, Neosho, Saline, Sedgwick, Sumner, Wilson, Woodson, Wyandotte	
1254	10/14/1998 (10/1-10/8/1998)	Severe Storms, Flooding, and Tornadoes	Bourbon, Cherokee, Douglas, Franklin, Jackson, Jefferson, Johnson, Leavenworth, Linn, Seward, Wabaunsee, Wyandotte	

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
1000	7/22/1993 (6/28-10/5/1993)	Flooding, Severe Storms	Atchison, Barton, Brown, Chase, Cherokee, Clay, Cloud, Crawford, Dickinson, Doniphan, Douglas, Edwards, Ellis, Ellsworth, Geary, Graham, Harvey, Hodgeman, Jackson, Jefferson, Jewell, Johnson, Lane, Leavenworth, Lincoln, Lyon, Marion, Marshall, McPherson, Mitchell, Morris, Nemaha, Ness, Osage, Osborne, Ottawa, Pawnee, Pottawatomie, Reno, Republic, Rice, Riley, Rooks, Rush, Russell, Saline, Sedgwick, Shawnee, Sheridan, Smith, Stafford, Sumner, Thomas, Trego, Wabaunsee, Washington, Wyandotte	$99,790,368
539	9/20/1977	Severe Storms, Flooding	Atchison, Brown, Doniphan, Jackson, Jefferson, Johnson, Leavenworth, Nemaha, Shawnee, Wyandotte	$4,041,566
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	$4,296,913
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	$1,954,624
267	7/15/1969	Tornadoes, Severe Storms, Flooding	Allen, Anderson, Bourbon, Crawford, Dickinson, Douglas, Ellsworth, Franklin, Johnson, Leavenworth, Linn, Lyon, McPherson, Miami, Morris, Neosho, Osage, Saline, Woodson, Wyandotte	$733,524
229	7/18/1967	Tornadoes, Severe Storms, Flooding	Anderson, Atchison, Chase, Cloud, Coffey, Crawford, Doniphan, Douglas, Finney, Franklin, Harper, Jackson, Jefferson, Kingman, Leavenworth, Linn, Lyon, Marion, Miami, Mitchell, Nemaha, Ness, Osage, Pottawatomie, Republic, Washington, Wabaunsee	$847,439
Emergency Declarations				

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
3324	6/25/2011	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	n/a
3282	12/12/2007	Severe Winter Storms	All	n/a
3236	9/1/0/2005	Hurricane Katrina Evacuation	All	n/a

Table 3.4 lists the U.S. Department of Agriculture Secretarial Disaster Declarations relevant to Region L for the period 2010 – 2012. Secretarial Disasters are designated from a natural disaster and require a minimum production loss of 30 percent for at least one crop.

Table 3.4 USDA Secretarial Disaster Declarations for Region L

Declaration Number	Declaration Date	Disaster Description	Counties Involved
S3313	07/24/2012	Drought-Fast Track	Primary: Atchison, Brown, Doniphan, Jackson, Contiguous: Jefferson, Leavenworth, Nemaha, Pottawatomie, Shawnee
S3302	07/17/2012	Drought-Fast Track	Primary: Chase, Dickinson, Douglas, Ellis, Ellsworth, Franklin, Geary, Jefferson, Johnson, Leavenworth, Lincoln, Marion, Miami, Mitchell, Morris, Ness, Osage, Osborne, Ottawa, Rush, Russell, Saline, Shawnee, Smith, Wabaunsee, Wyandotte; Contiguous: Anderson, Atchison, Barton, Butler, Clay, Cloud, Coffey, Greenwood, Harvey, Jackson, Jewell, Linn, Lyon, McPherson, Pawnee, Phillips, Pottawatomie, Rice, Riley, Rooks, Trego,
S3299	04/1/2012	Drought and Heat	Primary: Missouri counties, Contiguous: Atchison, Bourbon, Cherokee, Crawford, Doniphan, Johnson, Leavenworth, Linn, Miami, Wyandotte
S3209	12/08/2011	Severe Storms, Thunderstorms, Hail & High Winds	Primary: Missouri counties: Contiguous: Atchison, Doniphan, Leavenworth, Wyandotte
S3186	10/14/2011	Drought & excessive heat	Primary: Missouri counties; Contiguous: Atchison, Bourbon, Cherokee, Crawford, Johnson,

Declaration Number	Declaration Date	Disaster Description	Counties Involved
			Leavenworth, Linn, Miami, Wyandotte
S3189	04/04/2011	Drought, High Winds & Excessive Heat	Primary: Franklin, Geary, Johnson, Miami, Morris, Osage, Riley, Shawnee, Wabaunsee; Contiguous: Anderson, Chase, Clay, Coffey, Dickinson, Douglas, Jackson, Jefferson, Leavenworth, Linn, Lyon, Marion, Marshall, Pottawatomie, Washington, Wyandotte
S3020	08/20/2010	Flood, Excessive Rain, High Winds	Primary: Missouri counties; Contiguous: Atchison, Bourbon, Crawford, Doniphan, Johnson, Leavenworth, Linn, Wyandotte

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.

Each hazard profile describes the hazard's location, extent, previous occurrences and the probability of future events.

Location: location is the geographic areas within the planning area that are affected by a hazard, such as a floodplain. Hazard areas may be further defined, such as high landslide hazard areas versus low landslide hazard areas. The entire planning area may be uniformly affected by some hazards, such as drought or winter storm.

Previous occurrences: previous occurrences document the number of events experienced within the planning area over a specified period of time. This information supports estimates of the probability of future events.

Extent: extent is the strength or magnitude of the hazard. Extent can be described in a combination of ways depending on the hazard. Examples include established scientific scales or measurement systems such as the Enhanced Fujita Scale or the Richter Scale. Water depth or wind speed can also indicate the extent of various weather phenomena. Speed of onset or duration offer other options for characterizing a hazard.

Probability of future events: Probability is the likelihood of a hazard occurring in the future.

Impact/Vulnerability: The impact and vulnerability of a hazard on a community and how it affects the people, economy and infrastructure. The impact of a hazard directly affects the vulnerability of the people, property, and environment, but so too does the vulnerability determine the level of the impact.

All profiles have been updated to include events that have occurred since the last plans were completed, amended to reflect any subsequent changes in probability and realigned to follow the organization of the SHMP. Profiles were further updated with more historical impact information where it was available. The vulnerability assessment and regional estimates of potential losses have been expanded, and statewide flood and earthquake losses have been quantified using HAZUS-MH. Resources used to compile these profiles can be found in Appendix D.

3.2.1 EMAP Consequence Analysis

A consequence analysis of the potential for detrimental impacts of each hazard was conducted for the Emergency Management Accreditation Program (EMAP). The analyses are included at the end of each hazard profile to support plan accreditation through that program.

Each analysis addresses the following elements:

- Impact on the Public:
  – Health and safety of persons in the area of the incident

- Impact on Responders:
  – Health and safety of responders (i.e., firefighters, law enforcement, emergency management personnel, etc) in the area responding to the incident

- Continuity of Operations:
  – Activation of the Continuity of Operations Plan – will organization need to relocate in order to fulfill duties

- Delivery of Services:
  – Delivery of services such as food, medical, or any other life sustaining entities

- Impact on Property, Facilities, and Infrastructure:
  – Damages to structures (private and public), utilities, treatment plants, electric grid, roads, bridges, etc.

- Impact on the Environment:
  – How has the incident affected the surrounding environment, i.e., contamination (water , soil or air), erosion, crop damage, etc.

- Impact on the Economy:
  – Affects to the economy due to loss of revenue, clean up efforts, and reconstruction

- Impact of the Public Confidence in the jurisdiction's governance
  – How has the hazard affected public confidence

The Consequence Analysis includes ranking determinations for each of the above elements. The ranking elements are categorized as Minimal, Moderate, or Severe. The Hazard

Identification and Risk Assessment portion of the Regional Mitigation Plan was used to ascertain prior damages in an effort to estimate ratings on future impacts. The ratings are meant to be a guide, and not all inclusive, due to the variances that could apply such as population, location, time, hazard type, and the amount of jurisdictions within the hazard area. For instance, an F5 tornado in Overland Park at 2:00 p.m. would have a greater impact than an F5 tornado in western Kansas at the same time but located in a set- aside field. **Table 3.5** presents the methodology for determination of the ranking level (minimal, moderate, or severe)

Table 3.5. Methodology for Consequence Analysis Ranking Levels

Impact On:	Minimal	Moderate	Severe
Public (people)	< 5	= 5<15	15 or >
Responders (people)	<5	=5<15	15 or >
COOP (days) Based of the tiers of the Coop	≤0	1 to 7	8 or more
Delivery of Svcs (days) Based on the Tiers of the Coop	<1	1 to 7	8 or more
Property, Facilities, & Infrastructure ($ per capita) Based on FEMA minimum disaster requirements	<1.37	1.37 to 10.00	10.01 and up
Environment (%)	<10	10 – 20	20.01 and up
Economy (%) Based on unemployment percentage, applied as an indicator of the economy for the jurisdiction affected	<8%	8% to 15%	15% or more
Public Confidence (%)	<1%	1.0% - 10%	10% or more

The actual ranking for each hazard listed was based on the proximity of the hazard on the specific entity. Some were ranked across the board, due to the variances that could apply. For instance, Lightening has a severe impact if a home is directly hit. This could cause a fire that could spread to nearby homes. However, if a shed is hit then the impact would not be severe, therefore the ranking would be minimal to severe. Another example is hail. If individuals are in their home then impact to their health and safety would be minimal. However, if they are caught outdoors at a golf course or lake then the impacts could be severe.

The Hazard Profiles and Regional Risk Assessment that follow in are in alphabetical order by hazard title for ease of reference. The Regional CPRI is addressed first, followed by the county CPRI.

3.2.2 Agricultural Infestation

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

Description

Agricultural infestation is the naturally occurring infection of vegetation, crops or livestock with insects, vermin (to include lice, roaches, mice, coyote, fox, fleas, etc), or diseases that render the crops or livestock unfit for consumption or use. The levels and types of agricultural infestation will vary according to many factors, including cycles of heavy rains and drought. A certain level of agricultural infestation is normal; however, infestation becomes an issue when the level of an infestation escalates suddenly, or a new infestation appears, overwhelming normal control efforts. Infestation of crops or livestock can pose a significant risk to state and local economies due to the dominance of the agricultural industry.

Onset of agricultural infestation can be rapid. Controlling an infestation's spread is critical to limiting impacts through methods including quarantine, culling, premature harvest and/or crop destruction when necessary. Duration is largely affected by the degree to which the infestation is aggressively controlled, but is generally more than one week. Maximizing warning time is also critical for this hazard, and is most affected by methodical and accurate monitoring and reporting of livestock and crop health and vigor, including both private individuals and responsible agencies.

Animal Disease

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 and bovine spongiform encephalopathy (BSE) disease, to Region L. Because Kansas is a major cattle state, with cattle raised locally as well as imported into the state, the potential for highly contagious diseases such as these is a continuing, significant threat to the economy of the state. The loss of milk production, abortion, decrease in production, and other lasting problems resulting from an outbreak could cause continual and severe economic losses, as well as widespread unemployment. It would affect not only farmers, ranchers, and butchers, but also support and related industries

The Kansas Department of Agriculture, Division of Animal Health monitors and reports on animal reportable diseases such as Avian Influenza, Bovine Spongiform Encephalopathy (BSE) Disease, Chronic Wasting Disease, Exotic Newcastle Disease, Foot and Mouth Disease, Johne's Disease, PseudoRabies, Scrapie and West Nile Virus. Producers are required by state law to report any of the reportable animal diseases.

Crop Pests/Diseases

Many factors influence disease development in plants, including hybrid/variety genetics, plant growth stage at the time of infection, weather (e.g., temperature, rain, wind, hail, etc.), single versus mixed infections, and genetics of the pathogen populations.

Field crops in the region are also subject to various types of infestation. Significant wheat crop losses because of these diseases are well documented in various areas of this region. Sorghum losses can occur when a crop is infected with sooty stripe early in the growing season. Aspergillus Ear Rot (Alfatoxin) is a growing problem for corn crops.

According to the Kansas Department of Agriculture, Plant Protection and Weed Control Division, the following are the highest risk crop pests to to this region:

- **Corn** – Aspergillus Ear Rot (Alfatoxin)
- **Soybean** – Austro-Asian Rust
- **Wheat** – Black Stem Rust, Blast – South American strains, Stripe Rust, Leaf Rust, Karnal Bunt

Infestation is not only a risk to crops in the field, but insect infestation can also 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.

Tree Pests

According to the Kansas Department of Agriculture, Plant Protection and Weed Control Division, the following are the highest risk plant pests by host to Kansas:

- **Ash Trees** – Emerald Ash Borer
- **Maple, Birch, Willow, Mimosa, Ash, Sycamore & Poplar Trees** – Asian Longhorned Beetle
- **Walnut Trees** – Thousand Cankers

The Asian Longhorned Beetle is an exotic insect that threatens a wide variety of hardwood trees in Kansas. It is suspected that Asian Longhorned Beetle came to the U.S. via wood packing material from Asia. Tens of thousands of trees have been destroyed since it was first discovered in Brooklyn, New York in 1996. This beetle feeds on a wide variety of hardwood tree species that are native or planted in Kansas. It kills trees by creating large tunnels as larvae causing branches or stems to break and eventually lead to tree death. Because this beetle is not native to North America, it has no known natural enemies, and our trees have low resistance to this pest. While it has not been detected in Kansas, vigilance is paramount to prevention.

The Thousand Cankers is newly recognized disease in 2008 and first noticed in the western U.S. Currently it is located in both the east and western parts of the U.S. It has not been detected in Kansas. This disease is caused by a combination of a fungus and the walnut twig beetle. The walnut twig beetles carries fungal spores, and when they tunnel through the outer bark into the tree the fungus is transmitted during gallery construction. This has also been found if the beetle “tastes” the tree and does not produce a gallery. The fungus kills an area under the bark and the areas of dead tissue are called cankers. When the walnut twig beetles are abundant, numerous cankers can form and coalesce to girdle twigs and branches, restricting movement of water and nutrients. Black walnut, the most valuable native species to the state, is the most susceptible to this disease.

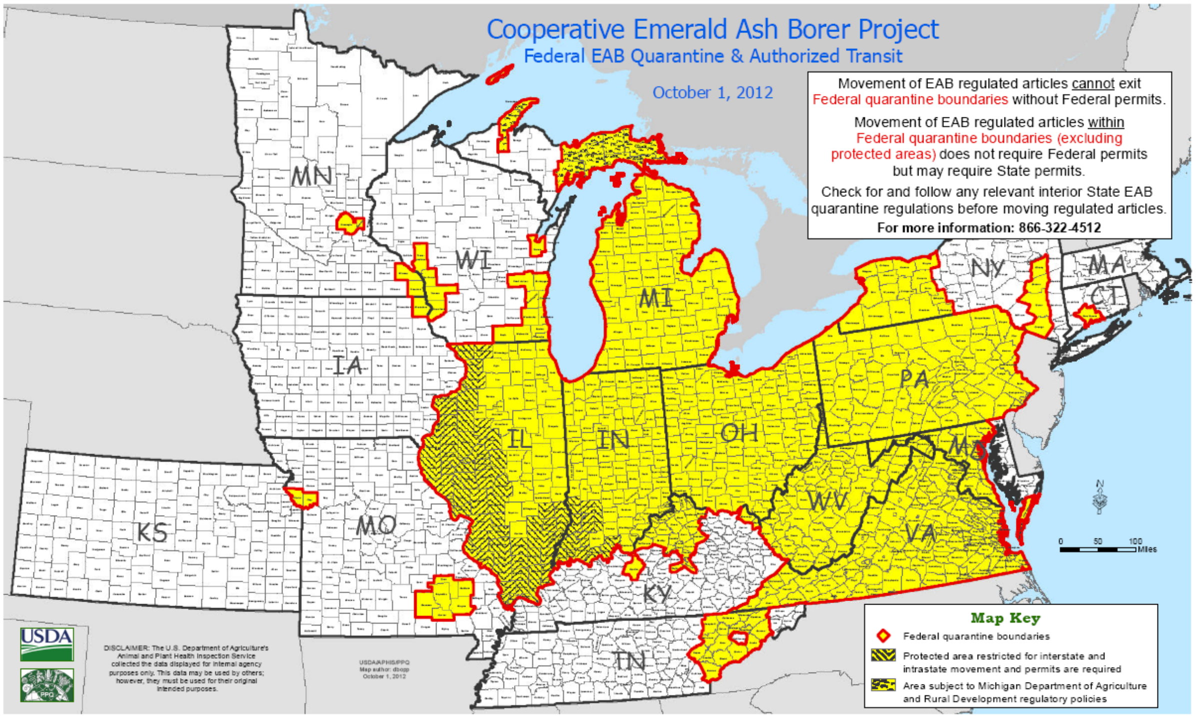
Emerald ash borer is a pest of ash trees native to Asia. This pest is a slender, emerald green beetle that is ½ inch long, and responsible for the destruction of approximately 20 million ash trees in Indiana, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin and Ontario, Canada. In 2012, it was detected in Kansas, Connecticut and Massachusetts. Financially, the United States risks an economic loss of $20 billion to $60 billion because of this pest. A complete devastation of ash trees could seriously affect our ecosystem.

According to the *Kansas Forest Action Plan*, revised 2011 from Kansas State University, ash trees are the third most common species of trees found in the native woodlands of Kansas. The Thousand Cankers Disease has not yet been found in Kansas. However, there are an estimated 26.2 million black walnut (35.3 million cubic feet) and 56.1 million green and white ash (60.8 million cubic feet) in Kansas rural and urban landscapes at risk. Most of these trees occur in the rural landscape (94 percent black walnut and 97 percent ash). It also estimates that there are 1.5 million ash trees in Kansas towns and cities.

On August 29, 2012, the Emerald Ash Borer pest was confirmed at the Wyandotte County Lake in Wyandotte County, Kansas. Previously in July 2012, it had been detected in Parkville, Missouri which is four miles from the Wyandotte County line. Immediately after confirmation by USDA, the Kansas Secretary of Agriculture implemented an emergency intrastate quarantine for Wyandotte County.

Figure 3.1 is a map of the Cooperative Emerald Ash Borer Project from the USDA, Animal and Plant Health Inspection Service. It shows the Federal Emerald Ash Borer (EAB) Quarantine and Authorized Transit areas as of October 1, 2012. Kansas is not shown as a Federal EAB Quarantine area. Neighboring Clay and Platte, Missouri counties are in the quarantine area.

Figure 3.1 Map of Cooperative Emerald Ash Borer Project in the U.S. October 1, 2012



Source: USDA, Animal and Plant Health Inspection Service
http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/index.shtml

Wildlife Pests

The region's farmers also lose a significant amount of crops each year as a result of wildlife foraging. This can be particularly problematic in areas where natural habitat has been diminished or in years where weather patterns such as early/late frost deep snow, or drought has caused the wild food sources to be limited.

Also there are several fatal diseases that can affect the deer or captive elk population in Kansas. One is the Chronic Wasting Disease (CWD) and there is no known treatment or eradiation method. There have been 48 positive cases of CWD found in Kansas since surveillance started in 1996. The only preventive measure is for people to not transport live or dead deer or elk to those areas which have not been exposed to CWD.

Another disease called Hemorrhagic Disease (HD) is the most devastating viral disease of white-tailed deer in the U.S. according to the Southeastern Cooperative Wildlife Disease Study. The HD is transmitted by biting flies and the HD occurs seasonally in late summer and fall. Death losses during outbreaks are usually well below 25 percent of the deer population, but in a few instances have been 50 percent or more. There are no wildlife management tools or strategies available to prevent or control HM.

Other diseases such as bovine tuberculosis and a host of detrimental parasites such as exotic lice, meningeal worms, flukes, and stomach worms are fatal to deer and are transmitted more efficiently when deer are concentrated in a small area.

These diseases can seriously damage the populations of the captive deer and elk farms and the wild deer populations but also affect the annual $350 million dollar hunting economy in Kansas.

Location

The entire planning area may be affected by agricultural infestation. While rural areas within the region are more susceptible to crop and livestock infestation, urban and suburban areas are also at risk: landscaping, urban gardens and parks, all of which add value to homes and communities, may be susceptible to damage or loss. Agricultural infestation does not cause damage to buildings or critical facilities.

Previous Occurrences

- **August 29, 2012:** The emerald ash borer pest was confirmed at the Wyandotte County Lake in Wyandotte County, Kansas. Immediately after confirmation by USDA, the Kansas Secretary of Agriculture implemented an emergency intrastate quarantine for Wyandotte County. The stipulations for the quarantine can be found on the Kansas Department of Agriculture's website: http://www.ksda.gov/plant_protection/content/379.
- **2001:** A major infestation of webworms attacked the State's alfalfa crop particularly in eastern Kansas.
- **1989:** Gray leaf spot of corn was first identified in the State in the Republican River Valley. The disease reached economic threshold levels by 1992 and has caused economic damages somewhere in the State every year from 1992 to 1998. In 1998, it was the most

severe in northeast Kansas and in the irrigated areas of south central and southwest Kansas.

Extent

The magnitude and severity of an Agricultural Infestation is relative to the type of infestation. A foreign animal disease like foot and mouth could potentially cause the economy to crumble, whereas an infestation of fleas would be manageable. The planning committee has determined that the magnitude of this hazard in the planning area would be limited, as most infestations are manageable in scope.

Probability of Future Hazard Events

Region L experiences agricultural losses every year as a result of insects, vermin or diseases that impact plants and livestock. The Probability for this hazard is "**Highly Likely**". This probability does not denote that a major incidence will occur, but rather that incidences of any etiology will occur, regardless of the size.

Impact and Vulnerability

Table 3.6 provides an indication of the impact of agricultural infestation in Region L. This table only reflects insured losses that were claimed. According to the 2011 Kansas Crop Insurance profile Report issued by the USDA Risk Management Agency, 82 percent of Kansas row crops were insured in 2011 (there is no information available for the 18 percent of uninsured crop losses).

Data regarding the number or value of livestock and wildlife lost to disease or infestation was not available for this planning effort. An action for the Region has been submitted to facilitate a process by which animal loss can be tracked due to disease or infestation.

Table 3.6 Total Insured Crop Insurance paid per County in Region L from 2002 -2007, Top Livestock Inventory Number and Top Crop in Acres from USDA Census 2007

County	Annualized Crop Insurance Paid for Agricultural Infestation Damage	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lamb Inventory, Wool Production	Corn Harvested in Acres	Forage Harvested in Acres	Sorghum For Grain Harvested in Acres	Soybeans for Beans Harvested in Acres	Wheat Harvested in Acres
Mitigation Planning Region L											
Johnson	$2,501	659	13,911	2,717	2,303	2,519	11,992	17,841	941	20,993	5,755
Leavenworth	**$2,03**8	367	28,134	1,919	1,796	576	15,736	38,890	0	25,687	6,804
Wyandotte	$0	225	1,734	37	368	0	1,963	2,814	0	6,013	(D)
Total	**$4,538**	**1,251**	**43,779**	**4,673**	**4,467**	**3,095**	**29,691**	**59,545**	**941**	**52,693**	**12,559**

Source: USDA Risk Management Agency, 2012; USDA Census of Agriculture, 2007.

Note: (D) is cannot be disclosed.

Depending on the type of infestations and location, the impact of an agricultural infestation could be moderate to severe. Leavenworth County has 1203 farms, which provides a market value of $33,219,000 of products sold. 63% is in crop sales and 37% is in livestock sales. Johnson County has 610 farms, which provides a market value of $40,659,000 in products sold. 72% is in crop sales and 28% is in livestock sales. Wyandotte County elected to not disclose this information for public use.

Should Region L have an agricultural infestation that affects crops or livestock, the impacts would reverberate throughout the community. With potential losses in the millions of dollars, the vulnerability of the Region would be felt throughout the economy.

Summary

Agricultural Infestation is a concern in the planning area as it pertains to crops, livestock, cultivated and landscaped gardens. While Leavenworth County is in the top 10 counties of Kansas for total number of farms with 1203, Johnson County has the highest market value of crop sales at $40,659.000. Should a potential infestation affect the Region, both counties could potentially take a large revenue loss which would hurt the local economy. Livestock sales in Leavenworth County supersede the value of livestock in Johnson or Wyandotte Counties at an estimated $12,236,000. Should a FAD or other infestation occur in this region the losses due to livestock contamination could also greatly hurt the farmers and the economy. While Wyandotte does not give actual market value of crops and livestock, at $5,112,000 total its loss would be less, but still painful.

Local Mitigation Concerns

- Region L has growers of sensitive and organic crops such as blueberries, grapes, fruit and nut trees, strawberries, and tomatoes which are vulnerable to vermin and disease. Another concern is the risk of pesticides used for crops to the west of the Region that through the easterly flow of the wind can damage these crops. The Kansas Department of Agriculture hosts a sensitive crop registry where growers can make their sensitive crop locations known. Pesticide applicators can use this registry to identify where extra care should be taken to protect these vulnerable crops. http://www.ksda.gov/pesticides_fertilizer/content/177

- There is the possibility of the Emerald Ash Borer pest spreading in Kansas. Cooperation from the public, firewood dealers, arborists, and the nursery industry to prevent further spreading is paramount to the success of isolating this pests. Prevention is far more cost-effective than trying to contain it as an established pest. The 1.5 million ash trees that grow in Kansas towns and cities will pose a great cost to Kansas in removal, stump grinding and replacement if the pest is found throughout the State.

- While Wyandotte County has the least amount of agricultural land in the state, it does have meat processing/distribution plants, and dairy processing/distribution facilities. These entities could be greatly impacted should a foreign animal disease hit any part of Kansas.

- Johnson County saw a 7% decrease in the number of farms between the years of 2002 – 2007. Total land in farms decreased by 23%, and the average size of farms decreased by 17% (see Table 3.8). With the decrease in agricultural land comes a decrease in agricultural infestation. However, domesticated plants are still at risk, which include nurseries, and landscapes in residential and commercial areas.

Table 3.7. Johnson County Agricultural Land, 2002 – 2007

Farms	2007	2002	% Change
Number of farms	610	659	**(7)**
Land in farms	114,202 acres	148,606 acres	**(23) acres**
Average Size of Farm	187 acres	226 acres	**(17) acres**

Source: USDA, 2007 Census of Agriculture, www.agcensus.usda.gov

- According to the USDA, Leavenworth County has 1,203 farms, ranking it in the top 10 counties in Kansas. While the amount of land used for agricultural purposes decrease between the years 2002 – 2007, the number of farms increased, which lends itself to a higher risk of crop or animal infestation.

- **Table 3.8. Leavenworth County Agricultural Land, 2002 - 2007**

Farms	2007	2002	% Change
Number of farms	1203	1094	**10**
Land in farms	194,854 acres	197,168 acres	**(1)**
Average Size of Farm	162 acres	180 acres	**(10)**

Source: USDA, 2007 Census of Agriculture, www.agcensus.usda.gov

- Wyandotte County saw an increase of farms by 19% between the years 2002 – 2007. The amount of land in farms increased by 31%. This statistically raises the potential for agricultural infestation in the county.

Table 3.9. Wyandotte County Agricultural Land, 2002 - 2007

Farms	2007	2002	% Change
Number of farms	191	161	**19**
Land in farms	18,107 acres	13,804 acres	**31 acres**
Average Size of Farm	95 acres	86 acres	**10 acres**

Source: USDA, 2007 Census of Agriculture, www.agcensus.usda.gov

The CPRIs for each county of Region L is provided below:

Johnson County

Johnson County CPRI: 2.65 – Moderate planning significance

Table 3.10. Johnson County Agricultural Infestation Ranking

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Agricultural Infestation	4	1	1	4	2.65	Moderate

Leavenworth County

Leavenworth County CPRI: 2.95 – Moderate planning significance

Table 3.11 Leavenworth County Agricultural Infestation Ranking

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Agricultural Infestation	4	2	1	4	2.95	Moderate

Wyandotte County

Wyandotte County CPRI: 2.65 – Moderate planning significance

Table 3.12 Wyandotte County Agricultural Infestation Ranking

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Agricultural Infestation	4	1	1	4	2.65	Moderate

Development in Hazard Prone Areas

Agricultural Infestation does not cause damage to buildings and critical facilities; however, as more agricultural land is converted to developed land, it will decrease agriculture infestation.

Consequence (Impact) Analysis

The information in Table 3.11 provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency management Accreditation Program (EMAP).

Table 3.13. EMAP Consequence Analysis: Agricultural Infestation

Subject	Ranking	Impacts/Agricultural Infestation
Health and Safety of Persons in the Area of the Incident	Minimal	Impact for this incidence on the Health and Safety of Persons in the area would be minimal. If the infestation is unrecognized, then there is the potential for the food supply to be contaminated.
Responders	Minimal	Impact to responders would be minimal with protective clothing, gloves, etc as these diseases cause no risk to humans.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP.
Property, Facilities, and Infrastructure	Minimal	Localized impact to facilities and infrastructure in the incident area is minimal to non-existent.
Delivery of Services	Minimal	Impacts to the delivery of services would be non-existent to minimal. Impact could be larger depending on the extent of the contaminated crop/crop loss.
Environment	Minimal to Severe	Impact could be severe to the incident area, specifically, plants, trees, bushes, and crops.
Economic Conditions	Minimal to Severe	Impacts to the economy will depend on the severity of the infestation. The potential for economic loss to the community and state could be severe if the infestation is hard to contain, eliminate, or reduce. Impact could be minimized due to crop insurance.
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Confidence could be in question depending on timeliness and steps taken to warn the producers and public, and treat/eradicate the infestation.

3.2.3 Civil Disorder

Regional Calculated Priority Risk Index	Planning Significance
2.80	Moderate

Description

Civil disorder is a term that generally refers to groups of people purposely choosing not to observe a law, regulation, or rule, usually in order to bring attention to their cause, concern, or agenda. According to U.S. Code (18 U.S.C. §232), civil disorder is "any public disturbance involving acts of violence by a group of three or more persons causing immediate danger, damage, or injury to the property or person of another individual." In Kansas, civil disorder is recognized as a societal hazard because of the associated potential for injury, loss of life, property damage, and economic disruption. Civil disorder can take the form of small gatherings or large groups impeding access to a building or disrupting normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot. Even in its more passive forms, a group that blocks roadways, sidewalks, or buildings interferes with public order.

Types of Crowds

Crowds can be classified into four general categories:

- **Casual Crowd**—A casual crowd is merely a group of people who happen to be in the same place at the same time. Examples of this type include shoppers and sightseers. The likelihood of violent conduct is all but nonexistent.

- **Cohesive Crowd**—A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshiping, dancing, or watching a sporting event. Although they may have intense internal discipline (e.g., rooting for a team), they require substantial provocation to arouse to action.

- **Expressive Crowd**—An expressive crowd is one held together by a common commitment or purpose. Although they may not be formally organized, they are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group assembled to protest something.

- **Aggressive Crowd**—An aggressive crowd is made up of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and will taunt authorities. They tend to be impulsive and highly emotional and require only minimal stimulation to arouse them to violence. Examples of this type of crowd include demonstrations and strikers.

Types of Mobs

A mob can be defined as a large disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Like crowds, mobs have different levels of commitment and can be classified into four categories:

- **Aggressive Mob**—An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.

- **Escape Mob**—An escape mob is attempting to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs have lost their capacity to reason and are generally impossible to control. They are characterized by unreasonable terror.

- **Acquisitive Mob**—An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property. Examples of acquisitive mobs would include the looting in South Central Los Angeles in 1992, or food riots in other countries.

- **Expressive Mob**—An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent up emotions in highly charged situations. Examples of this type of mob include the June 1994 riots in Canada following the Stanley Cup professional hockey championship, European soccer riots, and those occurring after other sporting events in many countries, including the United States.

Although members of mobs have differing levels of commitment, as a group they are far more committed than members of a crowd. As such, a “mob mentality” sets in, which creates a cohesiveness and sense of purpose that is generally lacking in crowds.

Location

The entire planning area of Region L is susceptible to Civil Disorder. Region L is the most densely populated portion of Kansas, making it easier for crowds or mobs to gather for a purported cause. The arena venues available for large crowds is also greater in this region, such as the Kansas Speedway, Sprint Center, and ABA sports arenas, and the shopping malls that cater to not only the residents of the region, but outside the region also. While the region varies in its economic interest, this does not negate the risk to the people and property. Leavenworth has a high military footprint, whereas Wyandotte County is more industrialized. Johnson County is the most populated county in Kansas and has an urban landscape. Each of these counties carry their own risk for Civil Disorder, from protest at the Leavenworth Penitentiary to Fighting Clubs in Wyandotte County. This hazard carries the risk to both people and property.

Previous Occurrences

The following are isolated events that show that the potential for civil disorder of any etiology or size can occur.

- Summer of 2012 saw a Bradley Manning Protest in North Leavenworth. Bradley Manning was arrested on suspicion of leaking information which contributed to the Wiki Leaks controversy. While being incarcerated at the Leavenworth Prison, the County spent over 30,000 in protecting or mitigation the protest of people in support of Manning. Business was at a standstill for over 6 hours to maintain a safe and secure passage of people traveling through Leavenworth City. This event involved over 80 officers from the Leavenworth area, along with the Kansas Highway Patrol. While there were no injuries, and Leavenworth County saw minimal damage, this event could have escalated but for Leavenworth's proactive stance

- While not considered a civil disorder event, in November 2012 a video surfaced of a "Fight Club" at Wyandotte High School. This club was allegedly set up for entertainment for the kids involved, and there was no adult supervision or referees. These type of events could potentially get out of control, resulting in a civil disorder event, particularly in the case of a knife or gun being drawn

Extent

While civil disorder is not an everyday occurrence in the planning area, when they do occur they are extremely disruptive and difficult to control. Law enforcement presence is often staffed below the peak loads at the start of an event like civil disorder, which in turn gives the event time to escalate. This hazard can occur anytime a large group gathers, which makes Region L particularly susceptible due to its venues for large gatherings and events. Political, social, or other causes make it difficult to determine when and where they will occur. Pre-planning is done to quell potential civil disturbances simply through the presence of sufficient law enforcement personnel and pre-planning for crowd control. Because Region L , specifically Johnson County, is the most densely populated area in Kansas, it is even more important that pre-planning be considered during events that have large crowd participation. Should a civil disorder event occur in the planning area the result could be measured in loss of life, economic upheaval, and destruction of property.

Probability of Future Hazard Events

Nationally, riots and civil disorder are likely to be a feature of life. Region L will no doubt not be unaffected by events that could lead to civil disorder, due to protests, demonstrations, or marches. Of notable concern is the rise nationally in school shootings and random shootings by individuals looking to make a statement or incite the masses. As depicted in the previous occurrences above, there have been only a couple of notable incidents in the past couple of years. While this is not a statistically significant amount, it does show that incidents are becoming disconcerting enough to report. The probability of this type of hazard occurring in Region L is "**Possible**" within the next 5 years.

Impact and Vulnerability

Potential losses from Civil Disorder include infrastructure, critical facilities, and human life. The degree of impact would be directly related to the type of incident and the target. Potential losses could include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses, loss of human life, injuries to persons, and immediate damage to the surrounding environment.

While it is not possible to predict the location of civil disorders, those locations with a higher population count are somewhat more likely to be susceptible to such incidents. The cost of a response and recovery from a civil disorder is difficult to determine.

As discussed previously, it is difficult to quantify potential losses in terms of the jurisdictions most threatened by Civil Disorder due to the many variables and human elements. Therefore, for the purposes of this plan, the loss estimates will take into account a hypothetical scenario. Please note that the hypothetical scenarios are included to provide a sample methodology for local jurisdictions to estimate potential losses.

****THE FOLLOWING HYPOTHETICAL SCENARIO IS FOR INSTRUCTIONAL AND ILLUSTRATIVE PURPOSES ONLY****

Riot Event

Scenario Overview: A large mob is formed following a football game which descends on the local downtown area. Potential losses with this type of scenario include both human and structural assets.

Assumptions: (1) The population density in the parking lot during the beginning and ending of the games is high, at least 5 persons per 25 square feet. (2) The level of violence among persons is moderate. (3) 6,000 persons crowd the streets.

Table 3.14. Described Losses:

Total Traumatic Injuries	250 persons
Total Urgent Care Injuries	1,000 persons
Injuries not Requiring Hospitalization	2,500 persons
Structures and Other Physical Assets (Damages would certainly occur to vehicles and depending on the proximity of other structures. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of violence and the amount of insurance held by vehicle owners.)	Vehicles – Window /headlight replacement cost for approximately 200 vehicles @ $400 = $ 8,000 Repair / repainting cost for approximately 200 vehicles @ $ 4,000 per vehicle inside the BATF described Falling Glass Hazard = $800,000 Buildings – Window replacement cost for approximately 50 buildings @ $1600 per building = $80,000

Source: Kansas State Hazard Mitigation Plan

Summary

With a dense population of 1,149.6 people per square mile in Johnson County, 1,039 per square mile in Wyandotte County, and 164.7 people per square mile in Leavenworth County, a Civil Disorder event has the potential to affect a multitude of people. The more densely populated an area, the more damage that can be inflicted. This Region also has large venues for outdoor gatherings which can create the atmosphere for unrest, such as the Kansas Speedway, and large shopping malls. Leavenworth County has a presence of penitentiaries that can invite protest such as in the Bradley Manning case. These protest affect the businesses in the community and create an unsafe atmosphere for the residents, costing the community revenue.

Local Mitigation Concerns

- Region L is the most densely populated area in the State of Kansas, making it a high visibility region for the gathering of crowds and mobs. It is also a part of the Kansas City Metro area which also lends itself to varying degrees of emotions as they relate to current issues that can spark protest, whether controlled or uncontrolled. While there has not been any noteworthy riots or protest that have caused catastrophic economic, structural, or population loss, the potential is there due to the make-up of the region.

- Leavenworth County houses the Leavenworth Federal Penitentiary which has documented protests aimed at subject matter that creates a high emotional impact in various groups. The military presence itself is a deterrent to uncontrolled mobs, however, the risk remains due to the various high profile inmates that are serving their time there.

- Leavenworth, Wyandotte, and Johnson County's are located approximately 65 miles from Topeka, KS, which is home to the Westboro Church. Known as a hate group due to its extreme ideologies and protest against gays, it is significant to the planning area due to its close proximity to the church's headquarters. Headed by Fred Phelps, it is mainly made up of his large extended family who gather and protest at the funerals of fallen soldiers. Region L has been the recipient of these protest, and while they are normally peaceful, the potential for violence is always there.

Future Development

With human-caused hazards such as this that can have multiple variables involved, increases in development, and increases in the replacement cost of the built environment, can be a factor in increased cost of the event. The cost for such an event is largely related to the location and the level of violence the crowd chooses.

The CPRI for each county of Region L is broken out below:

Johnson County

Table 3.15. Johnson County CPRI:

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Civil Disorder	2	4	4	1	2.80	Moderate

Leavenworth County

Table 3.16. Leavenworth County CPRI:

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Civil Disorder	2	4	4	1	2.80	Moderate

Wyandotte County

Table 3.17. Wyandotte County CPRI:

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte						
Civil Disorder	2	4	4	1	2.80	Moderate

Hazard Consequence Analysis Impact Overview

When rioting does break out, it generally proves extremely difficult for law enforcement authorities to stop the violence promptly. The rules of constitutional law set stringent limits on how police officers can behave toward the people they try to arrest. Restraint also plays a crucial part in avoiding any action that “fans the flames.” Initial police presence is often undermined because forces may be staffed below the peak loads needed to bring things back under control. As a result, the riot may continue until enough state police or National Guard units arrive to bolster the arrest process and subsequently restore order. In many cases, damage to life and property may already be extensive.

The information in **Table 3.18** provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.18. Regional Consequence Analysis: Civil Disorder

Subject	Ranking	Impacts/Civil Disorder
Health and Safety of Persons in the Area of the Incident	Severe	Impact could be severe for persons in the incident area.

Responders	Minimal to Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Depending on damage to facilities/personnel in the incident area, re-location may be necessary and lines of succession execution (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe for explosion, moderate to low for Hazmat.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the affected area especially if communications, road and railways, and facilities incur damage (minimal to severe).
Environment	Minimal to Severe	Localized impact within the incident area could be severe depending on the type of human caused incident.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation (minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Impact will be dependent on whether or not the incident could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes. (minimal to severe)

3.2.4 Dam and Levee Failure

Calculated Priority Risk Index	Planning Significance
2.10	Moderate

Description

Region L has with many dams and levees. The failure of these structures could result in injuries, loss of life and property, and environmental and economic damage. While levees are built solely for flood protection, dams often serve multiple purposes, one of which may be flood control. Severe flooding and other storms can increase the potential that dams and levees will be damaged and fail as a result of the physical force of the flood waters or overtopping.

Dams and levees are usually engineered to withstand a flood with a computed risk of occurrence. If a larger flood occurs, then that structure will likely be overtopped. If during the overtopping the dam or levee fails or is washed out, the water behind it is released as a flash flood. Failed dams and levees can create floods that are catastrophic to life and property because of the tremendous energy of the released water.

Dams

A dam is defined by the National Dam Safety Act as an artificial barrier that impounds or diverts water and (1) is more than 6 feet high and stores 50 acre feet or more or (2) is 25 feet or more high and stores more than 15 acre feet. Dam owners have primary responsibility for the safe design, operation, and maintenance of their dams. They also have responsibility for providing early warning of problems at the dam, for developing an effective emergency action plan, and for coordinating that plan with local officials.

Dams can fail for many reasons. The most common are as follows:

- **Piping**—Internal erosion caused by embankment leakage, foundation leakage, and/or deterioration of pertinent structures appended to the dam;
- **Erosion**—Inadequate spillway capacity causing overtopping of the dam, flow erosion, and/or inadequate slope protection;
- **Structural Failure**—Caused by an earthquake, slope instability, and/or faulty construction.

State-Regulated Dams

In Kansas, the State has regulatory jurisdiction over non-federal dams that meet the following definition of a "jurisdictional" dam as defined by K.S.A. 82a-301 et seq, and amendments thereto:

> *any artificial barrier including appurtenant works with the ability to impound water, waste water 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 a dam or barrier shall be determined as follows: (1) A*

barrier or dam that extends across the natural bed of a stream or watercourse shall be measured from the downstream toe of the barrier or dam to the top of the barrier or dam; or (2) a barrier or dam that does not extend across a stream or watercourse shall be measured from the lowest elevation of the outside limit of the barrier or dam to the top of the barrier or dam.

The Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) is the State agency responsible for regulation of jurisdictional dams. Within the Division of Water Resources, the Water Structures Program has the following Responsibilities: reviewing and approving of plans for constructing new dams and for modifying existing dams, ensuring quality control during construction, and monitoring dams that, if they failed, could cause loss of life, or interrupt public utilities or services

Dam classifications have been developed to describe the level of risk associated with dam failure. These classifications do not reflect the physical condition of the dams, but rather describe areas downstream of the dams that could be impacted in the event of failure, which is generally unlikely. The KDA-DWR classifies jurisdictional 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. Emergency Action Plans (EAPs) are required for all High Hazard Dams.
- 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.

At the time this plan was developed there were 320 state-regulated jurisdictional dams in Region L. Of those, 73 were Class C (High Hazard Dams), 14 were Class B (Significant Hazard Dams), and 256 were Class A (Low Hazard Dams).

Location

Table 3.19 provides the numbers of state-regulated low, significant, and high hazard dams for each county in Region L.

County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Total Dams
Region L					
Johnson	68	9	31	15	108
Leavenworth	159	3	6	3	168
Wyandotte	29	2	13	5	44
Total	**256**	**14**	**50**	**23**	**320**

The map in **Figure 3.2** provides the point locations of Significant and High Hazard State-regulated dams in the Region L planning area. High and Significant Hazard Dams for each county will be listed under the county summary.

Figure 3.2. High and Significant Dams

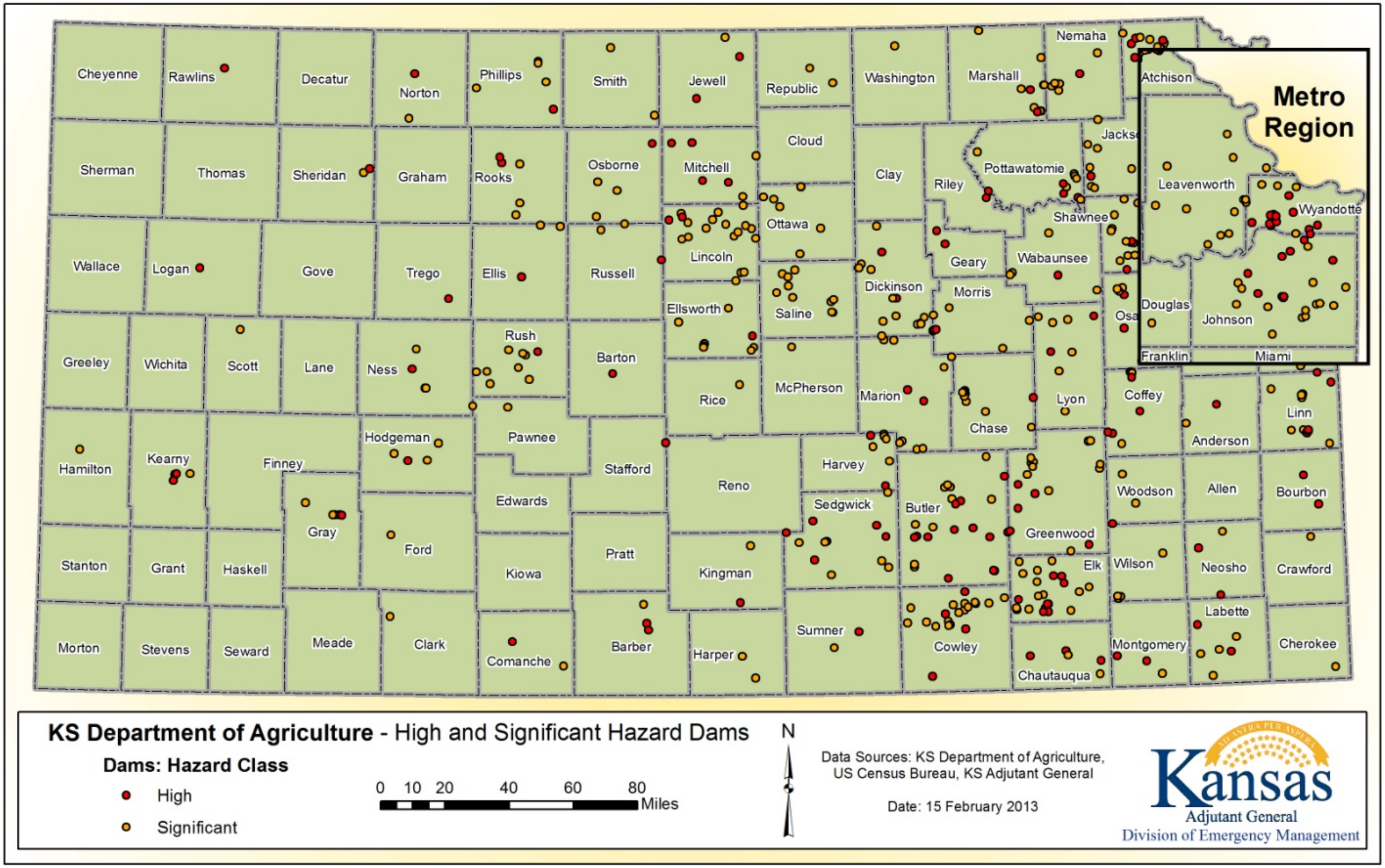


Figure 3.3.   Dams in Johnson County, Kansas

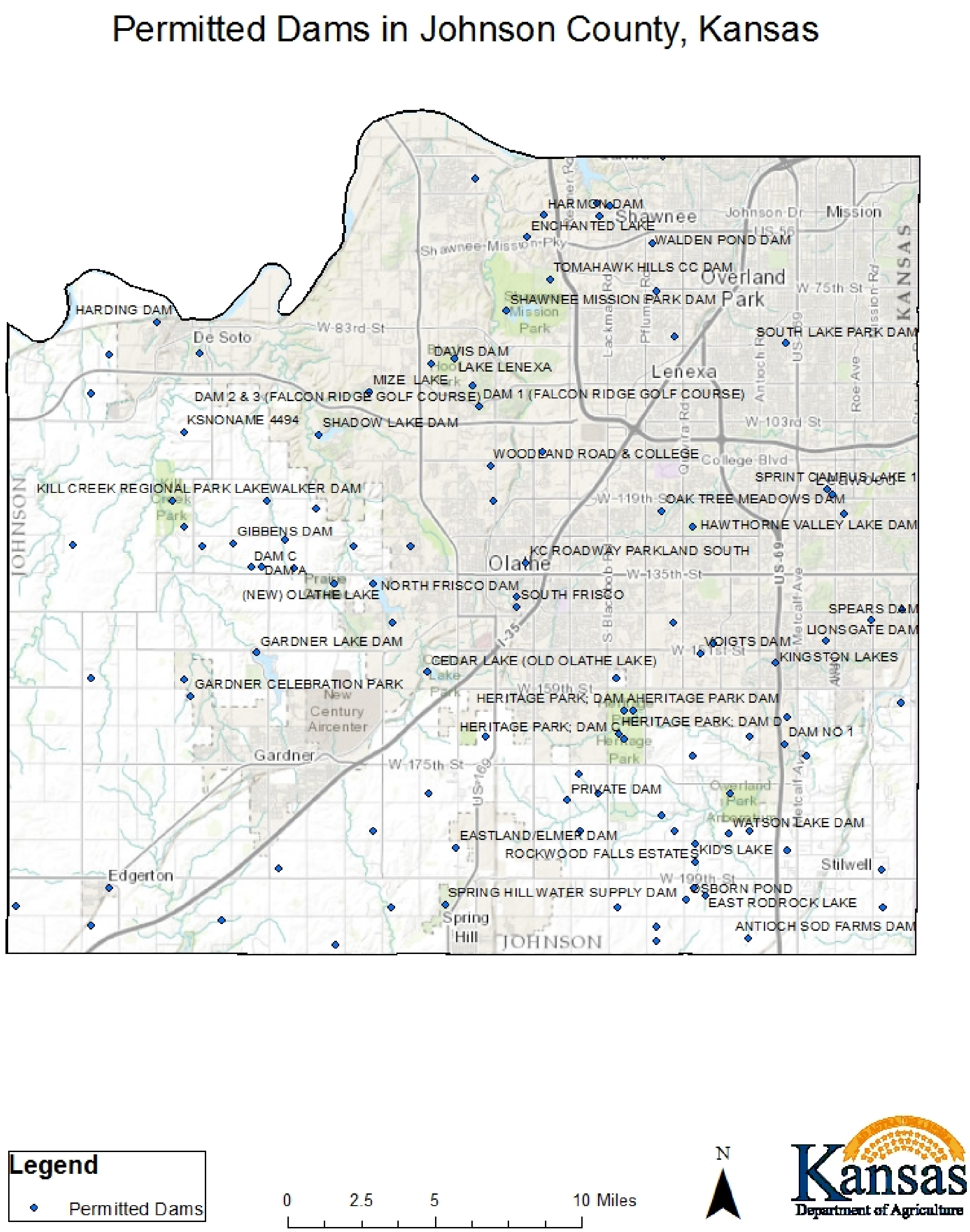


Figure 3.4. Dams in Leavenworth County, Kansas

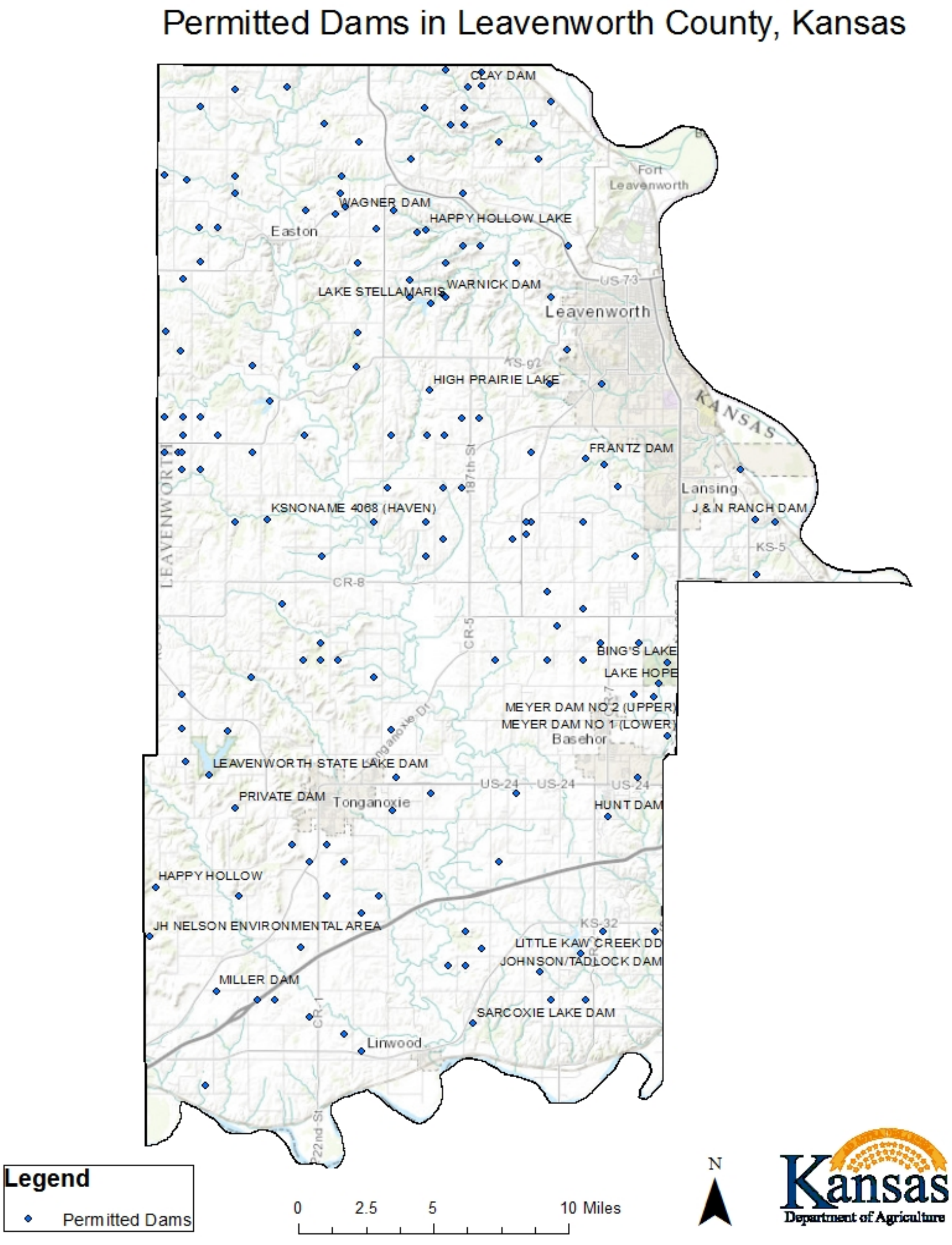
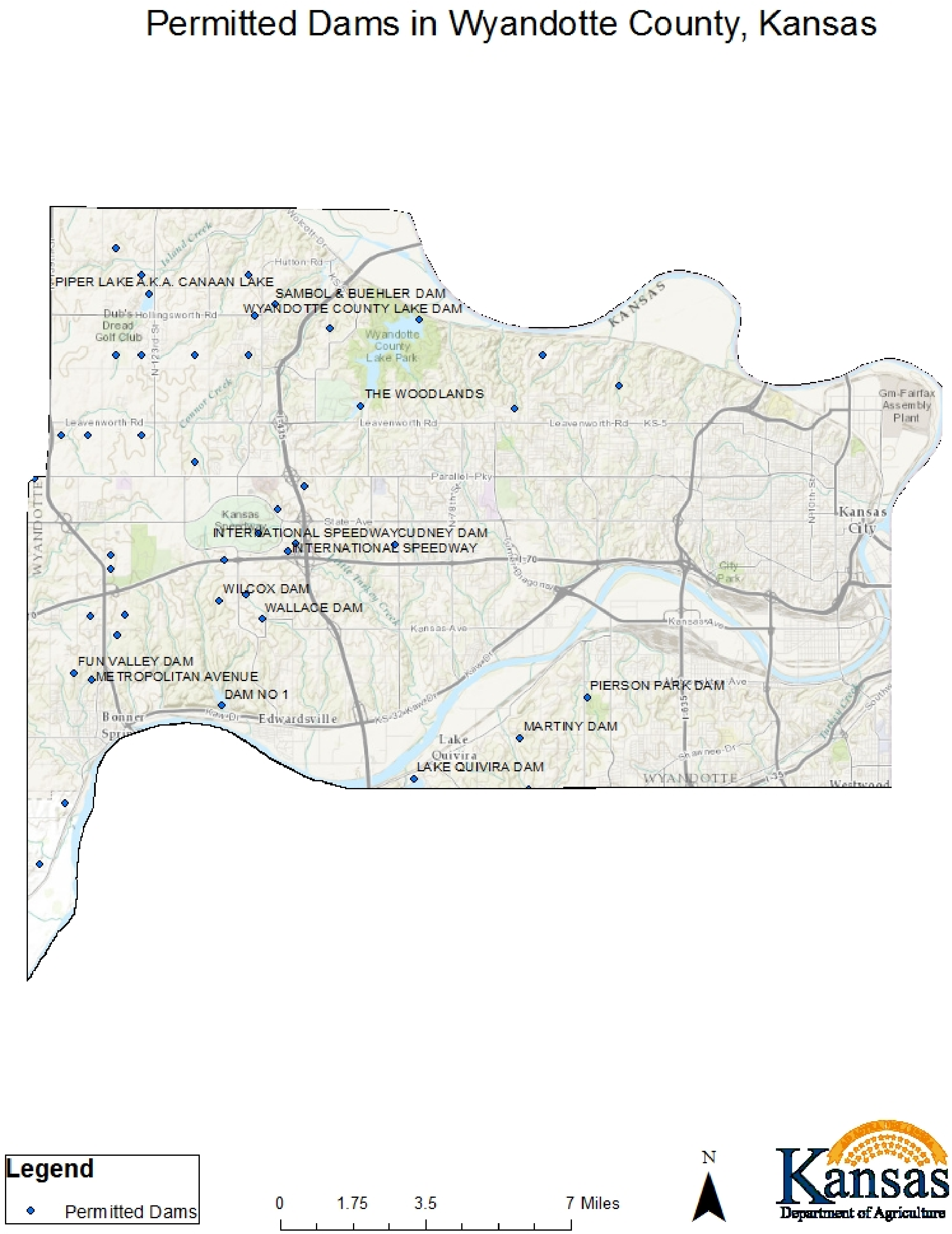


Figure 3.5. Dams in Wyandotte County, Kansas



Federal Dams/Reservoirs

Within the planning area there are 3 dams that are maintained and operated by the federal government. The following table shows the federally operated reservoirs in Region L.

Table 3.20 Federal Reservoirs in Region L

MT Planning Region	Reservoir	County	Year Storage Began	Operating Agency*	River Basin	Contributing Drainage Area (Sq. miles)	Surface Area (acres)	Est. Storage Capacity (acre feet)
L	Merritt Lake	Leavenworth	1/1/1942	US ARMY		NR	NR	19
L	Smith Lake	Leavenworth	1/1/1942	US ARMY		NR	NR	9
L	Sunflower Pond B Dam	Johnson	1/1/1943	US ARMY		NR	NR	36

Of particular interest for Region L are the Dams/Reservoirs in Nebraska. As evidenced during the 2011 Missouri River flooding, the dams upstream can play a huge role in what happens downstream. When releases exceed capacity it creates a domino effect on the dams and levees downstream in Kansas, ultimately leading to the planning area via the Missouri River.

Nebraska: There are nine high hazard dams in southern Nebraska Counties that border Kansas as follows:

- Harlan county-Harlan County Dam
- Thayer County-Hebron Dam
- Gage County-Little Indian Creek 15A Dam, Upper Big Nemaha 25C Dam, Mud Creek 2A Dam, and Big Indian Creek 14B Dam.
- Richardson County-Long Branch 21 Dam

Page 3.46 describes the impact of the 2011 Missouri River Flood on the levee's in Kansas.

Levees

Levees are earth embankments constructed along rivers and coastlines to protect adjacent lands from flooding. Floodwalls are concrete structures, often components of levee systems, designed for urban areas where there is insufficient room for earthen levees. Levees are usually engineered to withstand a flood with a computed risk of occurrence. When a larger flood occurs and/or levees and floodwalls and their appurtenant structures are stressed beyond their capabilities to withstand floods, levee failure can result in loss of life and injuries as well as damages to property, the environment, and the economy. In Kansas, there are hundreds of levees ranging in size from small agricultural levees that were constructed primarily to protect farmland from high frequency flooding to large urban levees that were constructed to protect people and property from larger, less frequent flooding events, such as the 100-year and 500-year flood events. For purposes of this plan, the levee failure hazard will refer to both overtopping and breach of a levee as defined in FEMA's publication "So You Live Behind a Levee" (http://content.asce.org/ASCELeveeGuide.html)

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

Levees are usually engineered to withstand a flood with a computed risk of occurrence. Many levees in the planning are were largely constructed to protect agricultural land and are not built to design standards established to protect people and property. Their presence can, in some cases, generate a false sense of security.

Levees have been constructed across the region by public and private entities with varying levels of protection, inspection oversight, and maintenance. Currently there is no one comprehensive database of all levees in the planning area. However, significant strides have been made toward compiling such an inventory. In 2010, FEMA published the Midterm Levee Inventory (MLI) database of levees. The MLI contains levee data gathered primarily for structures that were designed to provide protection from at least the base (1-percent-annual-chance) flood. Levees that provide protection for less than the base flood event are included, but only were data was readily available. The MLI was developed to complement the USACE National Levee Database (NLD). During development of this plan update, USACE was in the process of integrating the MLI with the NLD to provide a more comprehensive database of levees. Every effort was made during development of this plan to consider all known levees from both databases.

The levee failure hazard profile and risk assessment in this plan are further discussed in four categories:

1. Levees in the USACE levee Safety Program
2. FEMA Accredited Levees
3. Levees that are both in the USACE Levee Safety Program and Accredited by FEMA
4. All other levees

Levees in the USACE Levee Safety Program

The Levee Safety program (LSP) was created by the USACE in 2006 to assess the integrity and viability of levees and to make sure levee systems do not present unacceptable risk to the public, property, and environment. Under this program the USACE conducts levee inspections. These inspections are used to rate levee systems to determine compliance with operation and maintenance requirements, understand the overall levee condition, and determine eligibility for federal rehabilitation assistance under P.L. 84-99.

According to the National Levee Database managed by USACE, there are currently 12 levees in Region L that are included in the Levee Safety Program, of which 7 are rated minimally acceptable, and 5 were not reported. **See Table 3.22** for ratings of specific levees in the USACE Levee Safety Program.

FEMA Accredited Levees

Many levees shown on effective Flood Insurance Rate Maps (FIRM) were mapped in the 1970s and 1980s and have never been remapped by FEMA. Prior to 1986, levees were shown on FIRMs as providing protection from the base flood when they were designed and constructed in accordance with sound engineering practices. Since 1986, levees have been shown as accredited on FIRMs only when they meet the requirements of 44 CFR 65.10 "Mapping Areas Protected by Levee Systems", including certification by a registered professional engineer or a Federal agency with responsibility for levee design.

Levees that do not meet the requirements of 44 CFR 65.10 cannot be shown as accredited on a FIRM. Furthermore, floodplain areas behind the levee are at risk to base flood inundation and are mapped as high risk areas subject to FEMA's minimum floodplain management regulations and mandatory flood insurance purchase requirement.

In 2004, as it initiated work under the Flood Map Modernization Initiative (Map Mod), FEMA determined that analysis of the role of levees in flood risk reduction would be an important part of the mapping efforts. A report issued in 2005 noted that the status of the Nation's levees was not well understood and the condition of many levees and floodwalls had not been assessed since their original inclusion in the NFIP. As a result, FEMA established policies to address existing levees.

For the remainder of this discussion, FEMA Accredited levees will be discussed in two main types: Those mapped on Digital Flood Insurance Rate Maps (DFIRM) since the Flood Map Modernization Initiative and those that were mapped prior to the Flood Map Modernization Initiative and are not mapped on DFIRMs.

FEMA Accredited Levees mapped on DFIRMs

As DFIRMs are developed, levees fall under one of the three following categories:

Accredited Levee - With the except of areas of residual flooding (interior drainage), if the data and documentation specified in 44 CFR 65.10 is readily available and provided to FEMA, the area behind the levee will be mapped as a moderate-risk area. There is no mandatory flood insurance purchase requirement in a moderate-risk area, but flood insurance is strongly recommended.

Provisionally Accredited Levee (PAL) - If data and documentation is not readily available, and no known deficiency precludes meeting requirements of 44 CFR 65.10, FEMA can allow the party seeking recognition up to two years to compile and submit full documentation to show compliance with 44 CFR 65.10. During this two-year period of provisional accreditation, the area behind the levee will be mapped as moderate-risk with no mandatory flood insurance purchase requirement.

De-Accredited Levees – If the information established under 44 CFR 65.10 is not readily available and provided to FEMA, and the levee is not eligible for the PAL designation, the levee will be de-accredited by FEMA. If a levee is de-accredited, FEMA will evaluate the level of risk associated with each non-accredited levee through their Levee Analysis Mapping Procedures (LAMP) criteria to consider how to map the floodplain and which areas on the dry side of the levee will be shown as high risk. The mapping will then be updated to reflect this risk..

Location – Levee's

Region L has all of their accredited levees through FEMA on DFIRMs. Figure 3.6 shows the status within the region.

Figure 3.6. Status of DFIRMs

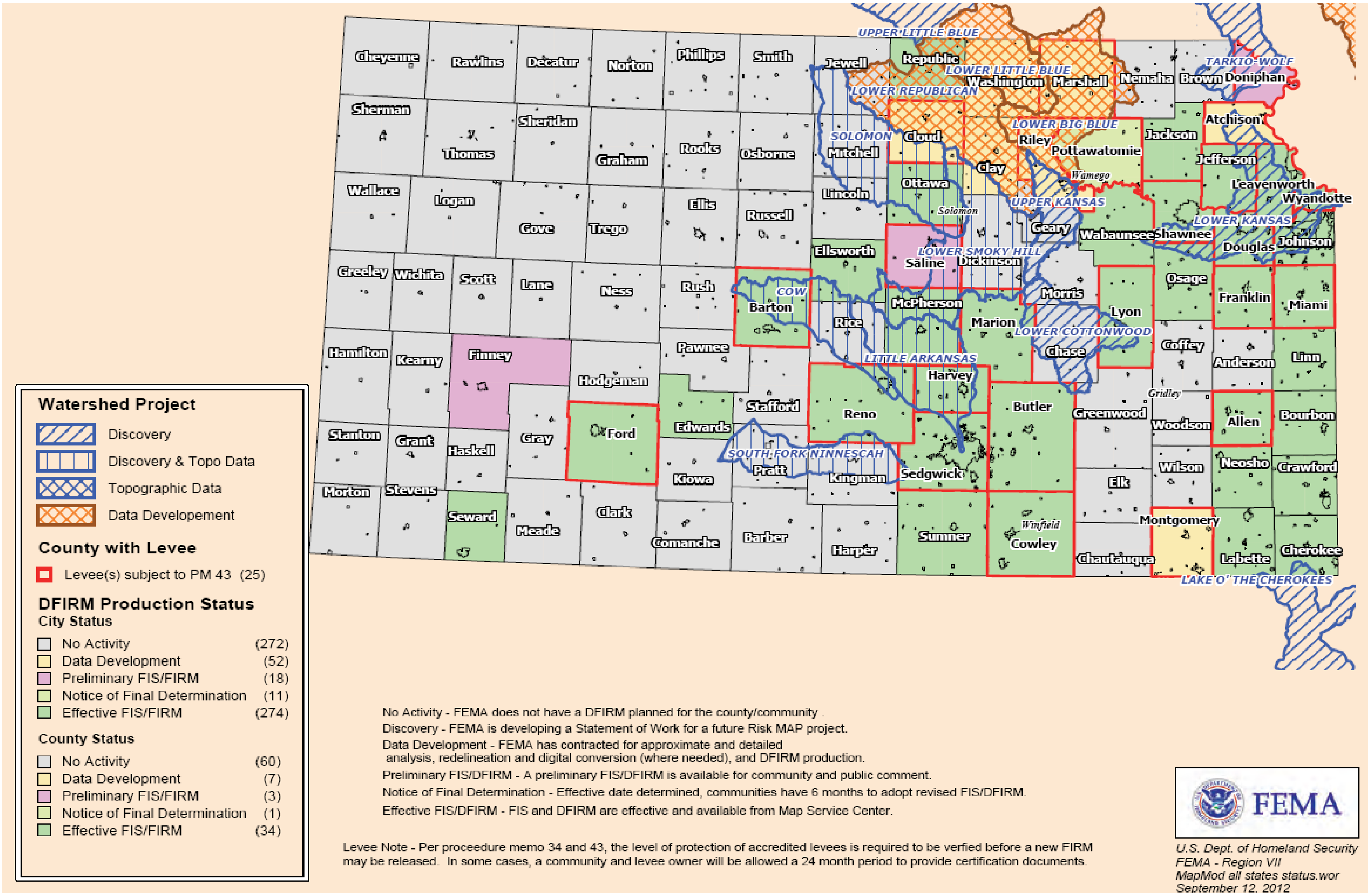


Table 3.21. Region L DFIRM With Levees

Mitigation Planning Region	DFIRM Counties with Levees
L	Leavenworth
L	Wyandotte

FEMA Accredited Levees not Mapped on DFIRMs

All accredited levees in Region L have been mapped on DFIRMs.

Levees that are both in the USACE Levee Safety Program and Accredited by FEMA

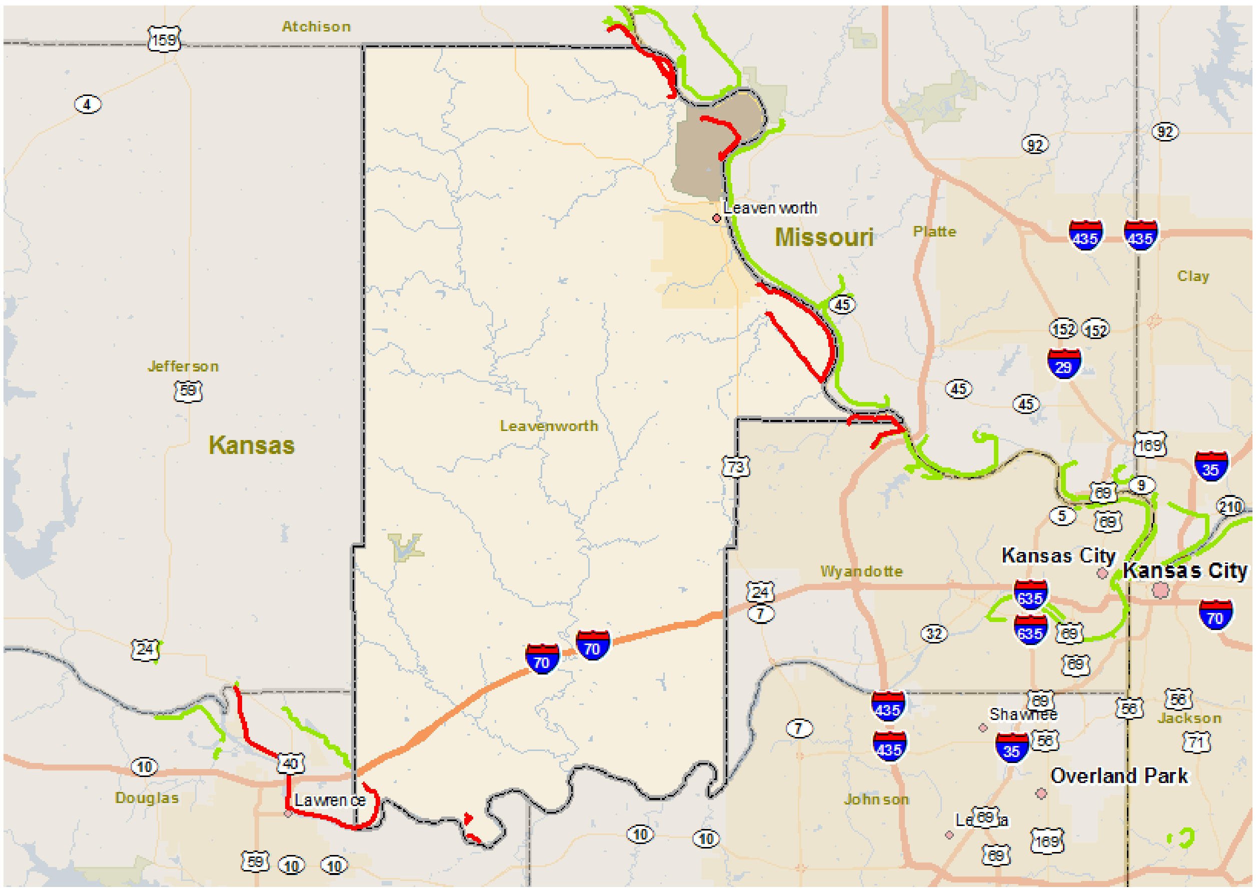
Table 3.22 shows the list of levees in Region L that are in the USACE levee Safety Program and accredited through FEMA.

Table 3.22. Levees in Region L

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
L	Johnson	Johnson_Kansas_River_1	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
L	Johnson	Johnson_Kansas_River_2	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
L	Leavenworth	Fall Leaf Drainage District	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	No	Yes	< 1% Annual Chance
L	Leavenworth	Ft. Leavenworth	Yes	KC	Not Reported	Yes	MISSOURI RIVER	No	Yes	<1% Annual Chance
L	Leavenworth	Grape-Bollin-Schwartz Levee Association-Leavenworth	Yes	KC	Not Reported	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
L	Leavenworth	Kansas Department Of Corrections	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
L	Leavenworth	Lawrence Unit-Leavenworth	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
L	Leavenworth	Lower Iatan Bend	No	N/A	N/A	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
L	Leavenworth	Wolcott Drainage District Section 1	Yes	KC	Not Reported	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
L	Wyandotte	Argentine Unit	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
L	Wyandotte	Armourdale Unit	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
L	Wyandotte	Cid, Kansas	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	Yes	Yes	1% Annual Chance
L	Wyandotte	Fairfax-Jersey Creek	Yes	KC	Minimally Acceptable	Yes	KS & MO RIVERS	Yes	Yes	1% Annual Chance
L	Wyandotte	Lower Fairfax	No	N/A	N/A	Yes	KS & MO RIVERS	Yes	Yes	1% Annual Chance
L	Wyandotte	Nearman Creek Power Station Levee	No	N/A	N/A	Yes	MISSOURI RIVER	Yes	Yes	1% Annual Chance
L	Wyandotte	Wolcott Drainage District Section 2	Yes	KC	Not Reported	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
L	Wyandotte	Wolcott Drainage District Section 3	Yes	KC	Not Reported	No	Not Reported	No		Unknown

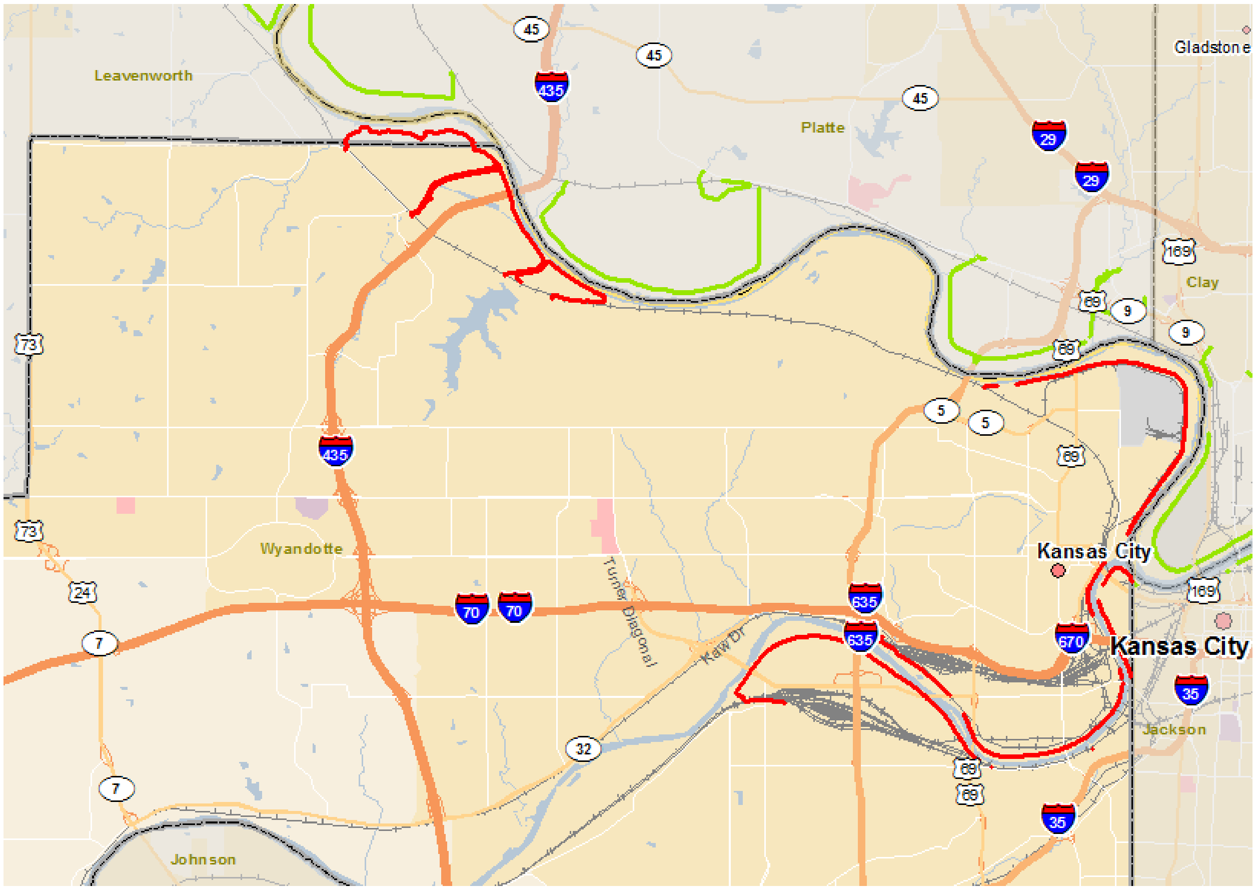
Figure 3.7 Shows the location of the accredited levees in Leavenworth County, and Figure 3.8 and 3.8a show the location of the Levees in Wyandotte County.

Figure 3.7. Levee's In Leavenworth County



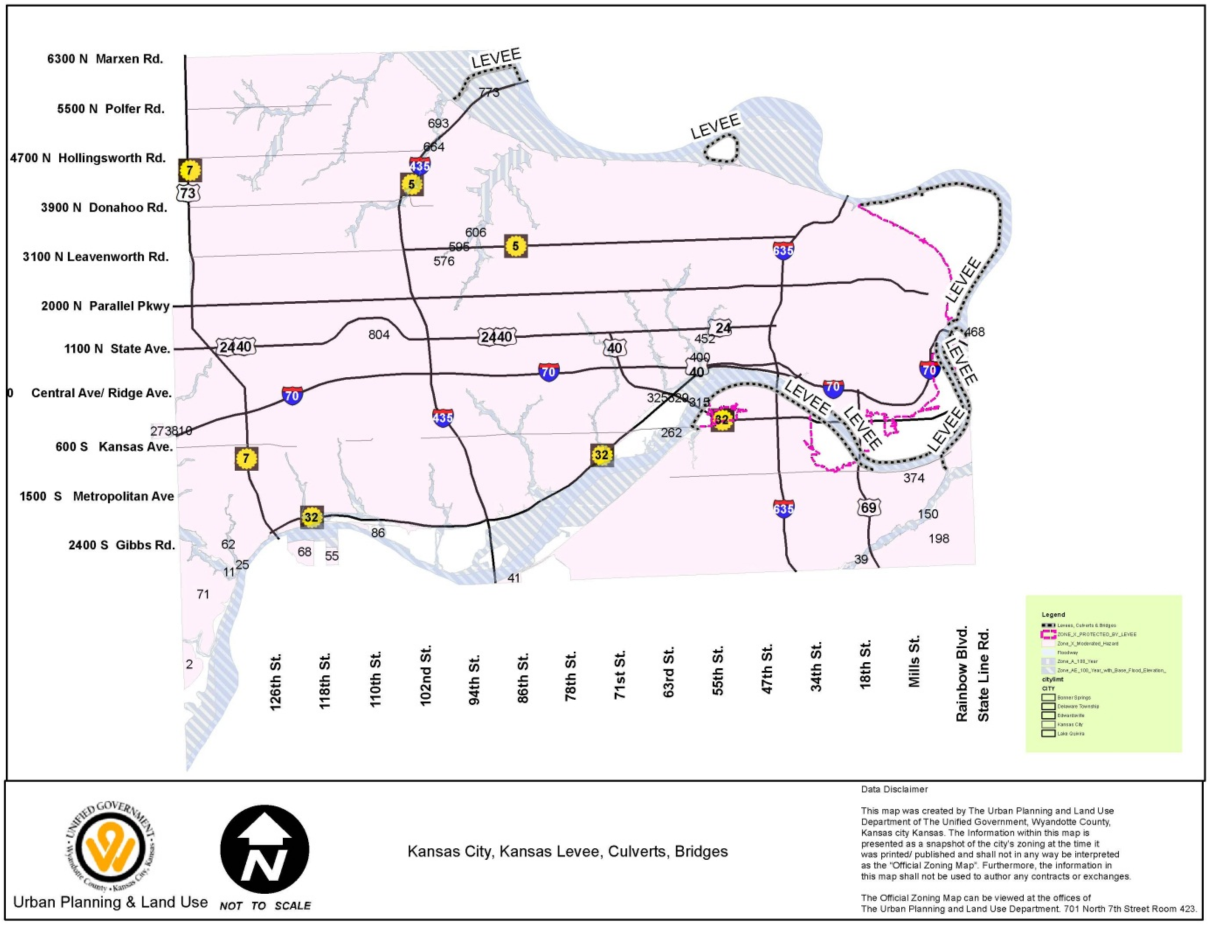
Source: FEMA.gov

Figure 3.8. Levee's in Wyandotte County



Source: FEMA.Gov

Figure 3.8A. Levee's in Wyandotte County



Previous Occurrences

This section discusses previous occurrences for dam and levee failure in Region L:

Dam Failure

According to Stanford University's National Performance of Dams Program, there were 31 dam incidents in Kansas between 1925 and 2002. Of these 31 incidents, 7 (23 percent) of them were failures. While Region L had 4 incidences, none of them were dam failures. Table 3.23 reflects the dams in Region L that had incidences.

Table 3.23. Region L Dam Incidence

MT Planning Region	County	NID #	Dam Name	Incident Date	Incident Type	Dam Failure
L	Wyandotte	KS02987	Ksnoname 2987	5/14/1997	Seepage; Piping	No
L	Leavenworth	KS01253	Demaranville, Don, Sarcoxie Lake Dam	7/25/2001	Seepage; Headcut in the emergency spillway	No
L	Leavenworth	KS01251	Larson, Dr. O.M.	1/22/2001	Piping; Seepage	No
L	Wyandotte	KS02987	Ksnoname 2987	3/6/2002	Seepage	No

Source: Stanford University's National Performance of Dams Program, http://ce-npdp-serv2.stanford.edu/DamDirectory/DamIncidentQuery/IncidentForm.jsp; *=These dams could not be located in the current state inventory. It is possible that these dams have been removed.

Levee Failure

- **2011 Flood:** USACE reported that every non-federal levee from Rulo to Wolcott, Kansas on both sides of the river were either overtopped or breached as a result of this flood. Specifically, the following levees along the Missouri River and tributaries in Leavenworth County were breached.
  - Grape Bollin-Schwartz levee
  - Sherman Airfield Levee (federal levee)—water reached the hangars which had been evacuated.
  - Ft. Leavenworth levee
  - Kansas Department of Corrections Levee

The Levee Repair Working Group of the Missouri River Flood Task Force, established in response to the Missouri River Basin flood of 2011, reported that the following federal and non-federal levees in Region L were damaged by the flooding.

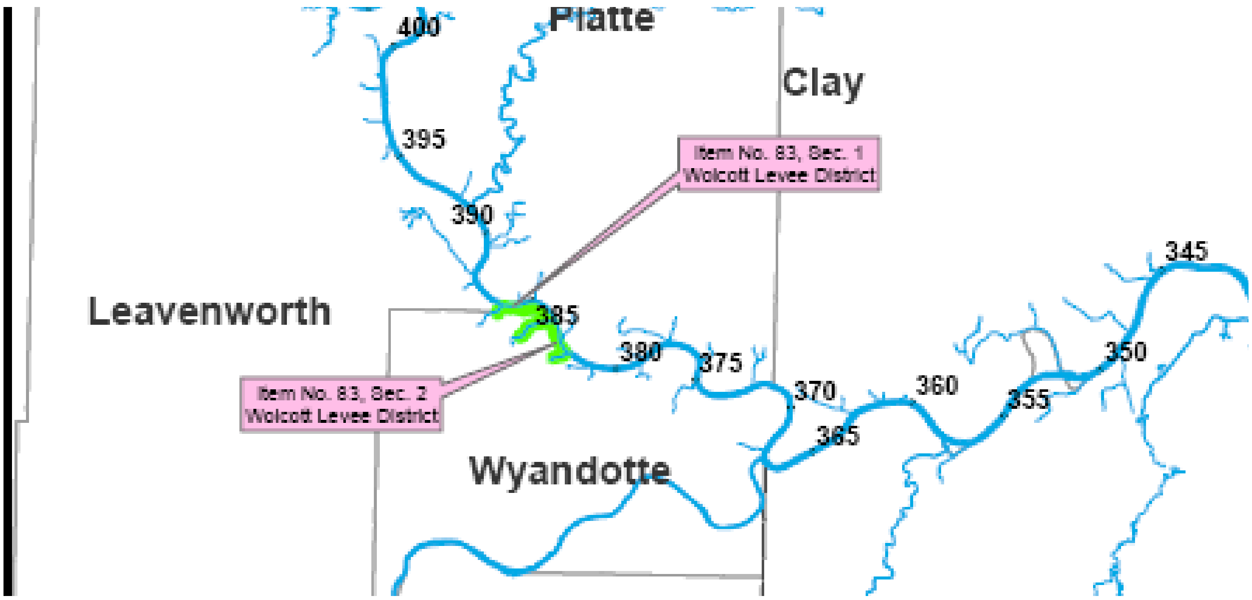
Table 3.24 Region L levees damaged during Missouri River Flooding of 2011

Project Type	Project Name	MR Mile Markers	State	City
Non-Federal	Grape-Bollin-Schwartz Levee Association	409.9 to 406.2	KS	Leavenworth
Non-Federal	Kansas Department of Corrections	394.0 to 388.0	KS	Leavenworth
Non-Federal	Wolcott Drainage District Section 1	386.4 to 383.7	KS	Wyandotte
Non-Federal	Wolcott Drainage District Section 2	386.4 to 383.7	KS	Wyandotte
Non-Federal	Wolcott Drainage District Section 3	382.3 to 381.3	KS	Wyandotte

Source: Missouri River Flood Task Force, http://www.nwdmr.usace.army.mil/rcc/MRFTF/docs/20JunListofLeveeRehabsv1.pdf

- **2009 Flooding:** Two non-federal Kansas levees were damaged by flooding in 2009 as follows: Wolcott Levee Section 1 and Wolcott Levee Section 2.

Figure 3.9. 2009 Flood Damaged Levees in Region L



Source: USACE KC District Website, http://www.nwk.usace.army.mil/Portals/29/docs/emergencymanagement/leveerehab/2009-LeveeRepairs-Status-MO.pdf

- **1993 Floods:** During the spring floods of 1993, which covered nine Midwest states, a high percentage of crop acres in the U.S. Army Corps of Engineers KC District floodplain areas suffered losses because of overtopping of nine of the 15 units in the federally constructed Missouri River Levee System and virtually all the nonfederal farm levees in the district

Extent

Region L is a highly populated and traveled area within the state which is co-located with the Missouri and Kansas Rivers. The levees and dams that protect the planning area are critical to ensuring the safety of the population, property, and infrastructure. The planning committee has determined that a dam or levee failure could be critical to population and property in the Region.

Probability of Future Hazard Events

Dam Failure

Due to the variability of the size and construction of the dams in Region L, estimating the probability of dam failure is difficult on any scale greater than a case-by-case basis. The limited data on previous occurrences indicates that in the last 87 years, there have been 7 recorded dam failure events in Kansas which is less than 1 event in 10 years, and no failures within the Region. Therefore, this hazard's CPRI probability is "**Unlikely**" (event is possible within the next 10 years)

Levee Failure

Although both federal and nonfederal levees have been damaged in previous regional flood events such as the floods in 1993, 2007, and 2011, the damage has not resulted in catastrophic failure and/or damages. Table 3.25 and Table 3.26 show the estimated losses and damages should a levee fail in the planning area. Levees in the Region, and Kansas that have been constructed to protect development and populations from the 1-percent annual chance flood are routinely inspected and maintained. Based on current historical data pertaining to damaging/significant Levee Failure incidents, this hazard's CPRI probability is "**Unlikely**" (event is possible within the next 10 years).

Impact and Vulnerability

The probability is unlikely that a failure will occur, however, in the event it did the potential losses to Region L through dam or levee failure could be catastrophic. The following table shows the population and structural losses should a levee failure occur. Data limitations exists to include lack of delineation for all levees.

Table 3.25. Populations and Values Protected by Levees (by Mitigation Planning Region)

Region	County	Structural Exposure ($1000's)	Contents Exposure ($1000's)	Total Exposure ($1000's)	Population
L	Leavenworth	$6,166	$3,617	$9,783	76
L	Wyandotte	$1,298,365	$1,421,835	$2,720,200	3,936

Source: FEMA Mid-term Levee Inventory, 2010

To estimate potential losses associated with levee failure, 20% loss was considered for all development (structural and content).

Table 3.26 Estimates of Potential Loss-Levee Failure for Region L

Region	County	Value of Development in levee Protected Areas ($1000s)	Loss Estimates at 20% Damage ($1000s)
L	Wyandotte	$2,720,200	$544,040
L	Leavenworth	$9,783	$1,957
L Total		**$2,729,983**	$545,997

The impact on lives, structures, and the economy could be catastrophic, depending on the size of the dam or levee failure. During the Missouri River floods of 2011, levee failure in Wyandotte and Leavenworth Counties was extensive; however there was no loss of life due to these failures. The expense was concentrated in the rebuilding of the levees.

Dams

All high and significant hazard dams are required to have and maintain emergency action plans in the event of an incident. This has not been re-enforced and throughout the state the number of dams far exceeds the number that have plans. State-wide this number is 111 plans for the 227 high hazard dams, and only 19 plans for the 209 significant dams.

The Kansas Water Plan noted in 2009 that some of the dams are exhibiting structural deficiencies due to age, and post-construction development downstream of others has raised their hazard class.

Some of the common problems seen with aging dams are:

- Deteriorating metal pipes and structural components
- Inadequate hydrologic capacity
- Increased runoff because of upstream development

To complete an analysis of vulnerability to dam failure as well as attempt to describe vulnerability in terms of the jurisdictions most threatened by dam failure, points were assigned to each type of dam and then aggregated for a total point score for each county. Points were assigned as follows for each dam: Low Hazard Dams, 1 point, Significant Hazard Dams, 2 points, High Hazard Dams, 3 points, High Hazard Dams without an EAP, an additional 2 points, Federal Reservoir Dams, 3 points. This analysis does not intend to demonstrate vulnerability in terms dam structures that are likely to fail, but rather provides a general overview of the counties that have a high number of dams, with weighted consideration given to dams whose failure would result in greater damages. Table 3.27 shows the results of this analysis for each county in Region L.

Table 3.27 Dam Failure Vulnerability Analysis

County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Federal Reservoirs	Vulnerability Rating	Vulnerability Level
Mitigation Planning Region L							
Johnson	68	9	31	15	1	212	High
Leavenworth	159	3	6	3	2	195	Medium-High
Wyandotte	29	2	13	5		82	Medium
Total	**256**	**14**	**50**	**23**	**3**	**489**	

Source: Kansas Department of Agriculture, Division of Water Resources, Water Structures program, U.S. Army Corps of Engineers, Bureau of Reclamation, U.S. Army, U.S. Fish and Wildlife, State Hazard Mitigation Plan

Table 3.28 shows the top ten counties by dam failure vulnerability rating based on the vulnerability analysis methodology described above. The top ten counties for the state are shown to put the placement of the counties of Region L in perspective.

Table 3.28 Top 10 Counties by Dam Failure Vulnerability Rating

Mitigation Planning Region	County	Vulnerability Rating
K	Jefferson	327
G	Butler	277
K	Jackson	267
K	Brown	243
K	Atchison	225
L	Johnson	212
K	Nemaha	206
L	Leavenworth	195
J	Shawnee	190
H	Greenwood	187

Source: State Hazard Mitigation Plan, 2013

Levees

Delineation of areas protected is included in the MLI geo-database for 107 of the 136 levees cataloged. To complete an analysis of vulnerability to levee failure as well as attempt to describe vulnerability in terms of the jurisdictions most threatened by levee failure, this data was used, along with census block data available in HAZUS MH 2.1 to determine the number of people and the value of development in these identified levee protected areas. This analysis does not attempt to evaluate which levees are more prone to overtopping or failure, but rather provide a general picture of those counties that have more people and property protected by levees and therefore the potential for more damage if failure or overtopping were to occur.

Table 3.29 provides a breakdown by county of the population, structure value, contents value, and total value in levee protected areas for the planning area levees in the MLI with available delineated protection areas. This data is to be used only for general determination of those areas of the state that *could* suffer the greatest losses in the event of levee failure events. Data limitations prevent a more accurate analysis including: lack of delineation of protected areas for all levees and, lack of statewide parcel-type data which would provide more accurate results in determining structures and values within levee protected areas.

Table 3.29 Populations and Values Protected by Levees

Mitigation Planning Region	County	Structure Exposure (1,000s)	Contents Exposure (1000s)	Total Exposure (1000s)	Population
L	Leavenworth	$6,166	$3,617	$9,783	76
L	Wyandotte	$1,298,365	$1,421,835	$2,720,200	3,936
L Total		**$1,304,531**	**$1,425,452**	**$2,729,983**	**4,012**

Table 3.30 Top 10 Counties – Development and Populations Protected by Levees

Development		
Mitigation Planning Region	**County**	**Total Development in Levee Protected Areas**
G	Sedgwick	$18,180,862
G	Reno	$5,090,378
F	Saline	$4,621,575
L	Wyandotte	$2,720,200
J	Shawnee	$2,278,254
E	Barton	$1,848,122
G	Cowley	$1,441,248
B	Ellis	$1,164,170
I	Riley	$521,874
F	Dickinson	$438,595

Population		
Mitigation Planning Region	**County**	**Population**
G	Sedgwick	140,247
G	Reno	45,171
F	Saline	41,580
J	Shawnee	19,047
E	Barton	16,751
G	Cowley	12,904
B	Ellis	9,603
D	Ford	4,728
L	Wyandotte	3,936
F	Dickinson	3,543

Source: State Hazard Mitigation Plan, 2013

Summary

Region L has low, significant and high hazard dams within its borders (see page 3.32, Table 3.19), and numerous accredited and unaccredited levees. The levees provide protection to $2,729,983 in property with a 20% loss estimate of $545,997, and approximately 4000 individuals. A levee failure could be catastrophic for the planning area, however, the probability of this happening is unlikely. While there have been four dam incidences in Region L (see Table 3.23), there have been no dam failures within the planning area. The criticality of dams and levees in this particular region is the large population and property base. Maintaining and inspecting the dams and levees in the region is paramount for the safety and well-being of these individuals. Actions for maintenance, upgrades, inspections, and continued public education on this hazard are addressed in Chapter 4.

Local Mitigation Concerns

- Region L has its borders on the Missouri River and the Kansas River, which are prone to flooding during high precipitation events. As with the floods of 2011, even states as far north as Montana can add to this problem when they have record snow or rainfall, even when Kansas is in a drought. Ensuring that the levees and dams maintain their structural integrity to protect against breeches, overtopping, and failure continues to be a main priority.

- Johnson and Leavenworth County have grown since the census of 2000 was taken and with that population growth is the critical area of housing growth, and ensuring that the floodplains remain in a green zone as construction on new housing ensues (see the land use maps in Section 2, Jurisdictional Profiles).

- While Wyandotte County has not seen the growth of Johnson and Leavenworth Counties, it does have a high industrial and commercial footprint. Mitigating against commercial loss can be an expensive endeavor for the county and its residents.
- The USACE maintains many levee's in and around the planning area, however, there are also levees that are not federally maintained, so local jurisdictions or private property owners are responsible for maintaining the structures. As the levees age, the costs to repair and rebuild them will increase.

Development in Hazard Prone Areas

Of the top 10 counties with the highest vulnerability rating for dam failure, 4 were also in the top 10 for greatest housing unit gains from 2000 to 2010. Two of those four counties are Johnson and Leavenworth. The potential exists for development to occur within the Region's many dam inundation zones, increasing the vulnerability of the population and structures, however, Region L has strict policies, ordinances, and codes in place that all developers must adhere to in order to prevent damages that could incur. (Future land use maps can be found in Chapter 2). While no dam failures have occurred in the planning area, the ageing of the existing dams suggest that it could happen. Reasons attributed to an ageing dam failure could be deteriorating metal pipes and structural components, inadequate hydrologic capacity, and increased runoff because of upstream development. Ensuring the maintenance, inspections, and needed repairs of the dams and levees in the region can help prevent the potential for loss of life and property, as well as carefully managing any development in the vicinity of the dams in the area. The region has numerous actions identified to address this hazard to include repairs, upgrades, and maintenance which can be found in their entirety in chapter 4.

Levee Failure

Of the top 10 counties in terms of development protected by levees, none in Region L made the list. However, Leavenworth and Wyandotte counties do have numerous levees that do protect property and lives. If additional development and population growth is occurring in levee protected areas this increases the vulnerability should a levee failure or overtopping occur. It is paramount to the Region to monitor development in the areas that have levee's, and maintain, upgrade, and mitigate repairs when needed. The region has identified a multitude of actions in Chapter 4 that address these steps in order to protect the population and structures that are protected by levees.

Johnson County

Table 3.31. Johnson County CPRI

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Dam and Levee Failure	1	3	2	3	1.95	Low

Leavenworth County

Table 3.32. Leavenworth County CPRI

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Dam and Levee Failure	1	3	4	4	2.35	Moderate

Wyandotte County

Table 3.33. Wyandotte County CPRI

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Dam and Levee Failure	1	4	3	3	2.40	Moderate

Consequence (Impact) Analysis When a dam fails, the stored water can be suddenly released and have catastrophic effects on life and property downstream. Homes, bridges, and roads can be demolished in minutes. At least 7 dam failures have occurred in Kansas since 1924. Residents near a Significant or High Hazard dam should become familiar with the dam's emergency actions plans, if available. Emergency plans written for dams include procedures for notification and coordination with law enforcement and other governmental agencies, information on the potential inundation area, plans for warning and evacuation, and procedures for making emergency repairs.

The impact of levee failure during a flooding event can be very similar to a dam failure in that the velocity of the water caused by sudden release as a result of levee breach can result in a flood surge or flood wave that can cause catastrophic damages. If the levee is overtopped as a result of flood waters in excess of the levee design, impacts are similar to flood impacts.

The information in **Table 3.30** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.34 Consequences Analysis: Dam and Levee Failure

Subject	Ranking	Impacts/Dam and Levee Failure
Health and Safety of Persons in the Area of the Incident	Severe	Localized impact expected to be severe for the inundation area and moderate to minimal for other affected areas.
Responders	Minimal	Impact to responders is expected to be minimal with proper training. Impact could be severe if there is lack of training.
Continuity of Operations	Minimal	Temporary relocation may be necessary

		if inundation affects government facilities.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens to minimal to moderate.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to the inundation. Minimal to severe depending on area size and location affected.
Environment	Severe	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the scope of the inundation and the amount of time it takes for the water to recede.
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Depending on the perception of whether the failure could have been prevented, warning time, and the time it takes for response and recovery will greatly impact the public's confidence.

3.2.5 Drought

Calculated Priority Risk Index	Planning Significance
2.95	Moderate

Description

Drought is defined as a condition of moisture levels significantly below normal for an extended period of time over a large area that adversely affects plants, animal life, and humans. It can also be defined in terms of meteorology, agricultural, hydrological and socio-economic.

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

Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evaporation, soil water deficits, reduced ground water or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. Deficient topsoil moisture at planting may hinder germination, leading to low plant populations per hectare and a reduction of final yield. However, if topsoil moisture is sufficient for early growth requirements, deficiencies in subsoil moisture at this early stage may not affect final yield if subsoil moisture is replenished as the growing season progresses or if rainfall meets plant water needs.

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

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

The four different definitions all have significance in the planning area. A meteorological drought is the easiest to determine based on rainfall data and is an easier drought to monitor from rain gauges and reports. A hydrological drought means that stream and river levels are low, which also has an impact for surface water and ground water irrigators. In addition, discharges from reservoirs that are made to meet in stream targets, further reduce the levels in the reservoirs—some of which are set to protect threatened and endangered mussel populations. An agricultural drought represents difficulty for the region's agricultural-based economy and is also relatively easy to monitor based on crop viabilities for different regions.

Periods of drought are normal occurrences in the region as a whole. Drought in the area 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. Drought can also create favorable conditions for wildfires and wind erosion (See Section 3.3.20 Wildfire and Section 3.3.16 Soil Erosion and Dust).

The impacts of drought can be categorized as economic, environmental, or social. Many economic impacts occur in agriculture and related sectors, including increasing food prices globally. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of wildfires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected.

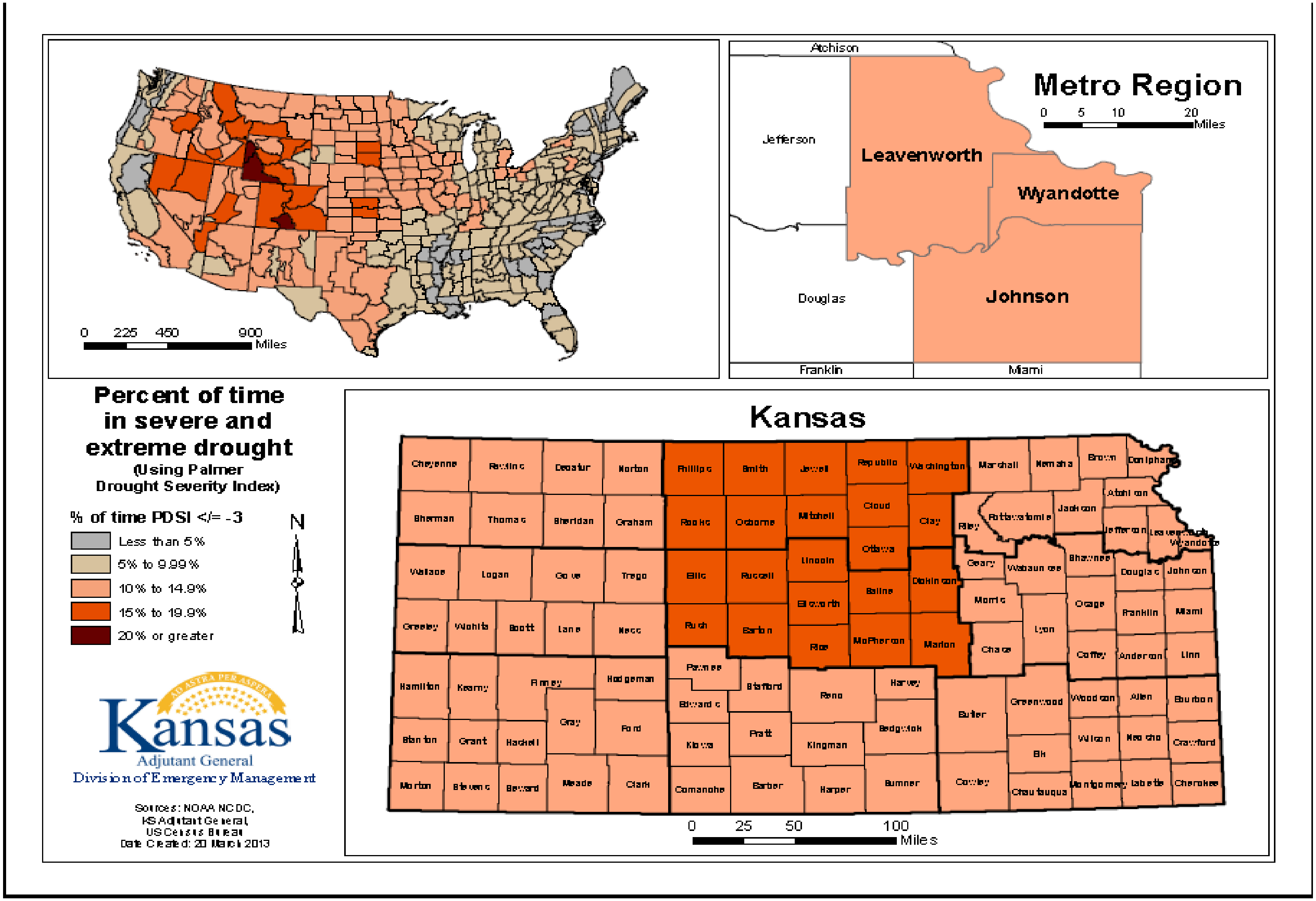
Although environmental losses are difficult to quantify, increasing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects. Environmental losses are the result of damages to plant and animal species, wildlife habitat, and air and water quality, wildfires, degradation of landscape quality, loss of biodiversity, and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, with increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape.

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 http://www.drought.gov/drought/). 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.

Location

All of Region L is at risk, and has been in a drought 10% to 14.9% of the 100 years that span 1895 – 1995. Drought affects agricultural land as well as the urban landscape and can put stress on homeowners should their property have structural issues due to lack of moisture content in the soil. Another issue would be power production should the Missouri and Kansas Rivers become extremely low, and wildfires could increase threatening land, property, and people.

Figure 3.10. Region L Drought Index 1895-1995



In Region L, the primary source of water is surface water from rivers, federal reservoirs, multipurpose small lakes, and municipal lakes. Region L is bordered by the Missouri River and the Kansas River at various points, which are a main source of water for the Region.

As of 26 Feburary 2013, the U.S. Drought Monitor shows Region L as being in a severe drought, down from an exceptional drought, as shown in figure 3.10.

Previous Occurrences

Drought specifics that apply to only Region L are difficult to ascertain due to the wide area of land mass that is affected. Because of this hazard anomaly, the following depicts drought for the whole state and not just the region.

Kansas has had recurring periods of drought throughout history, some of them lasting for extended periods of time. Figure 3.10 shows Kansas was in severe or extreme drought between 10 and 14.9% Percent of the last century. The Dust Bowl years of the 1930s being the most well known. But, as Table 3.34 shows, drought in Kansas is a recurring theme.

Table 3.34. Drought State Declaration Summary 2000-2012

Date	Executive Order	Emergency	Warning	Watch	Total Counties
7/24/2012	12-10	105	0	0	105
7/03/2012	12-08	36	55	14	105
5/04/2012	12-07	0	16	75	91
11/21/2011	11-48	40	24	37	101
10/05/2011	11-37	30	29	27	86
9/02/2011	11-29	17	42	21	80
8/24/2011	11-27	15	26	36	77
4/07/2011	11-06	0	20	27	47
8/22/2008	08-11	0	4	7	11
6/11/2008	08-07	0	5	8	13
5/14/2007	07-13	0	0	0	0
3/06/2007	07-04	0	3	57	60
8/21/2006	06-09	0	105	0	105
3/20/2006	06-04	0	80	25	105
2/07/2006	06-03	0	6	66	69
9/08/2004	04-09	0	6	9	15
6/15/2004	04-08	31	12	14	57
10/27/2003	03-22	28	77	0	105
8/22/2003	03-19	11	0	0	11
8/22/2003	03-18	0	94	0	94
7/31/2003	03-16[3]	0	0	52	52
7/31/2003	03-15[3]	0	53	0	53
7/30/2002		0	83	22	105
7/03/2002		0	61	0	61
5/03/2002		0	0	41	41

Date	Executive Order	Emergency	Warning	Watch	Total Counties
7/12/2000				UREP & SO	
6/09/2000				KLR & MO	

Source: Kansas Water Office, www.kwo.org/Reports%20&%20Publications/Drought/Tbl_drought_declarations_051107_twl.pdf
No declarations were made in 2001, 2005, 2009, or 2010
Declaration issued for river basins rather than counties. URER (Upper Republican) and SO (Solomon); KLR (Kansas Lower Republic and MO (Missouri) River Basins.

Because drought has affected the whole state, the data provided below includes Region L in its synopsis:

- **2012:** The Kansas Water Office increased the frequency of the Drought/Climate report (found at www.kwo.org) to weekly for much of the year due to intensity of conditions. The Governor signed 3 executive orders this year for drought with all 105 counties were declared in emergency drought status with the last order. The Governor approved the June 2012 Operations Plan for the Governor's Drought Response Team which updated activities and responses. The Governor's Office created a Drought Resources Website, http://governor.ks.gov/kansasdrought-resources, to provide drought information for all Kansans and to utilize drought relief assistance initiatives.

  Drought conditions continued from 2011, although appeared to lessen in the early months of 2012, when above normal precipitation occurred in February, March and April compared to 30 year averages. By May 3rd however, precipitation was well below normal and temperatures above. These conditions prompted the first 2012 Executive Order for drought watch and warning declarations for 91 counties. Conditions also included extremely low soil moisture for crops and vegetation. May was the second driest and third warmest on record. By June 5th, 58 percent of the State was in moderate drought (D2) according to the U.S. Drought Monitor, with drought affecting all but portions of the south east to some degree. By the end of June, severe (D2) and extreme drought (D3) impacted in the majority of the State with the worst in western areas. By July, the entire state was in severe (D2) or worse, with areas of extreme (D3) and exceptional (D4) expanding. The areas of severity of drought changed, but the entire state remained at some level of drought for the rest of 2012. Temperatures and precipitation both contributed to the severity of drought conditions. July thru August was the warmest period on record, with numerous months ranking as driest or warmest for various locations, regions or the entire state. October to September was also the warmest on record. Overall, only two small areas of the State received near normal precipitation in 2012 with the majority receiving 25-90 percent of normal precipitation (through Dec 5). As of December 1, precipitation needed to return to normal moisture levels using the Palmer Drought Severity Index ranged from 3.5 inches in the southwest to 9.31inches in east central division.

  USDA agricultural disaster due to drought was declared for all 105 counties in Kansas based on crop losses through a series of six designations in July and August. This makes producers eligible for certain emergency. The crop losses were estimated at $1.5 billion. At least 197communities and rural water districts in Kansas had voluntary or mandatory restrictions on water use as drought and high demand depleted public water supplies and challenged treatment and distribution. Mandatory restrictions were placed on water right holders junior to minimum desirable streamflow (MDS) in as many as 17 locations affecting 540 water appropriations. Livestock ponds, feed and pasture were insufficient to meet needs. Contingencies for feed and water were made available to producers through hay networks, motor carrier authorities and emergency water from state fishing lakes and federal reservoirs. Despite these efforts, livestock numbers in June marked the lowest cattle inventory since 1973. The risk of wildfires was high throughout the State with as many as 78 counties issuing burn bans over some period of 2012. At least 41,000 acres burned. Dry conditions in the fall resulted in dust storms visible by satellite.

- **2011:** Precipitation for 2011 was -8.92 inches below normal for the year statewide, with climatic divisions varying from -3.51 to -14.36 inches below normal. The Governor signed 6 executive orders between April and November for various drought stages over the year, increasing the number of counties to 100 in the November order including 40 counties in emergency stage. The year began with extraordinarily low winter moisture and the very little precipitation continued throughout the year. Throughout the year the severity and area affected varied. Drought conditions reached their greatest extent as reflected by the Drought Monitor October 4 when exceptional drought (D4) covered 18 percent of the State while 93 percent of the State was shown as abnormally dry (D1-D4), 54 percent severe (D2-D4) and 33 percent extreme (D3-D4). Conditions improved slightly through the end of the year.

  USDA agricultural disaster due to drought was declared for 70 counties in Kansas based on crop losses. Kansas agricultural losses were estimated by the Kansas Department of Agriculture at over $1.77 billion due to drought. The hot dry conditions in Kansas were centered in southwest and south central Kansas, being the hottest and driest for these climatic areas since 1895. Many locations set new records for the number of days with temperatures of 100^{o} F or more, June through August. Statewide, soil moisture was around 50 percent adequate as 2011 began but never exceeded 55 percent for topsoil moisture until November. Very little surplus existed all year for topsoil or subsoil moisture.

  The U.S. Army Corps of Engineer lakes and most rivers in Kansas received less than normal inflow during 2011, but the total reservoir inflows were sufficient to allow the lakes to operate near normal levels.

  At least 38 public water suppliers in 22 counties initiated conservation measures due to drought conditions. These include municipal, rural water districts and a community college. In 2011 MDS administration occurred on at least eight river systems effecting about 279 water rights. 2011 marked the lowest January 1 cattle inventory in the U.S since 1958. Drought contributed to a three percent decrease in inventory by January 2012.

- **May 4, 2002–October 1, 2003:** Beginning on May 4, 2002, the Palmer Drought Severity Index reached -2.5 in the northwest and southwest districts of the state and remained below that value, triggering activation of the Governor's Drought Response Team. At its worst in

2002, the PDSI was below -3.0 in six of nine meteorological districts. In 2002, rainfall was less than the Dust Bowl years in some parts of western Kansas. Lakes decreased significantly in size and ground water levels dropped. Low water in the Missouri River interfered with river barge traffic and necessitated the release of water from Milford, Tuttle Creek, and Perry Lakes.

This drought caused many counties to impose water use restrictions and burn bans. Grazing was prohibited on government lands to protect the drought-stressed grass, affecting thousands of cattle. Emergency haying and grazing was allowed by the U.S. Department of Agriculture (USDA) on Conservation Reserve Program lands. All 105 counties were eligible for federal assistance through the U.S. Department of Agriculture (USDA). The drought had a $1.1 billion impact on crop production.

- **1988–1992:** The severity of this drought varied across the state. It was most severe in the southwestern, central, and northeastern parts of the state but minimal in the northwestern and southeastern parts. Surface-water supplies were sufficient to meet demands through the end of water year 1988, but rainfall during this period was less than 50% of the long-term average, so quantities were insufficient to maintain soil moisture or contribute to ground-water supplies. Estimated drought-related losses to 1988 crops were $1 billion. Water levels in shallow aquifers declined rapidly and led to the abandonment of many domestic water wells. The drought of 1988 continued into the 1990s, but at a reduced level.

- **1974–1982:** This appeared to be a series of relatively short droughts at some stream gauging stations, but longer droughts at others (similar to the 1962–1972 droughts). The recurrence interval of this drought was greater than 25 years in the north-central and southeastern parts but was between 10 and 25 years across the remaining eastern two-thirds of the state. The severity of this drought could not be determined for the western third of the state.

- **1962–1972:** The duration of this regional drought varied considerably across Kansas. Many of the stream flow records indicated alternating less than average and greater-than-average flows, while others indicated less than average flows for the entire period. The recurrence interval was generally greater than 25 years but was between 10 and 25 years in parts of the northwestern, northeastern, southern, and southeastern areas of the state.

- **1952–1957:** This regional drought had a recurrence interval greater than 25 years statewide. One exception was in the Big Blue River Basin, where the recurrence interval was 10-25 years. Because of its severity and areal extent, this drought is used as the base period for studies of reservoir yields in Kansas. In 1954, 41 counties were declared eligible for aid under the Emergency Feed program. During this period, 175 cities reported water shortages, most of which restricted water use.

- **1929–1942:** This drought, which includes the Dust Bowl of the 1930s, was regional in scale and affected many of the Midwestern and western states. Nevertheless, it ranks among the most significant national events of the twentieth century. The recurrence interval was greater than 25 years throughout Kansas. Drought, wind, and poor agricultural practices combined to result in enormous soil erosion. Agricultural losses were extreme, and many farms were abandoned. Effects of the drought sent economic and social ripples throughout the country, contributing to the economic, physical, and emotional hardships of the Great Depression.

Extent

The severity of a drought in Kansas has been deemed to be limited in nature by the planning committee. Injuries and illness would not result in permanent disability and critical facilities would not be shut down for extemded periods. **Figure 3.11** shows the extent of the drought in the planning area for the period ending February 26, 2013. Region L's drought is categorized as severe.

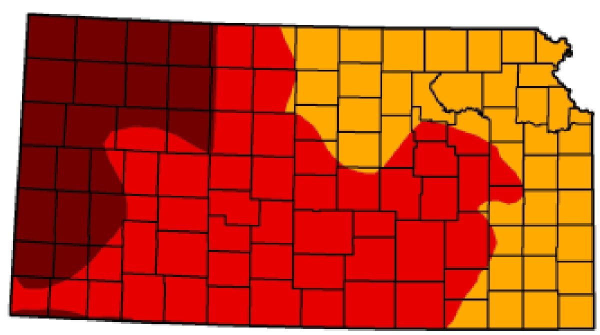
Figure 3.11

U.S. Drought Monitor — **February 26, 2013**
Valid 7 a.m. EST

Kansas

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	69.75	21.58
Last Week (02/19/2013 map)	0.00	100.00	100.00	100.00	75.19	36.13
3 Months Ago (11/27/2012 map)	0.00	100.00	100.00	98.78	77.61	35.97
Start of Calendar Year (01/01/2013 map)	0.00	100.00	100.00	100.00	79.36	35.97
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	100.00	88.34	51.04
One Year Ago (02/21/2012 map)	38.89	61.11	47.07	19.36	9.36	0.22



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

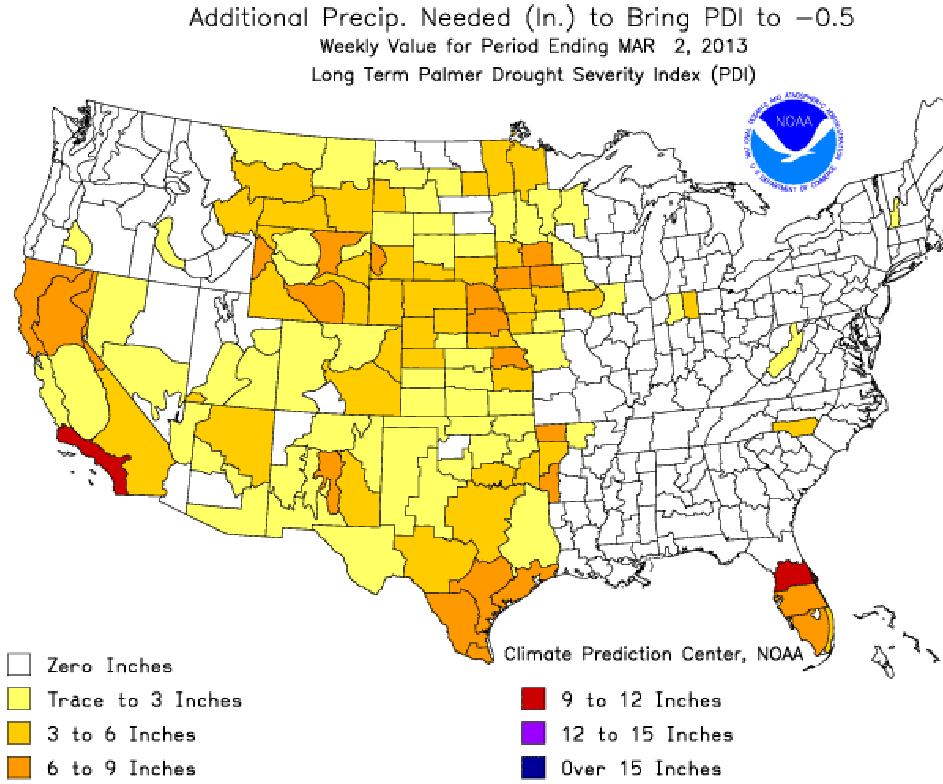
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, February 28, 2013
Brian Fuchs, National Drought Mitigation Center

Figure 3.12 shows the amount of precipitation needed to bring the PDI to -0.5, with Region L needing 3 – 9 inches.

Figure 3.12. Region L Additional Precipitation Needed



Probability of Future Hazard Events

Based on historical data for Kansas, (26 disasters in 11 years), the State of Kansas, and by extension Region L, will experience drought conditions on a yearly basis. This hazard's CPRI probability is **"Highly Likely**" (probable within the calendar year). With the advent of climate change, the hazard of drought may become a 'normal' condition for the state.

Impact and Vulnerability

There are 3 phased drought stages (Watch, Warning, and Emergency Stages) that mirror the stages used in the *Kansas 2007 Municipal Water Conservation Plan Guidelines*. The following are all factors monitored to determine the drought stage: Palmer Drought Severity Index, Standardized Precipitation Index, Percent of Normal Precipitation, Soil Moisture Percentile, Crop Moisture Index, Satellite Vegetative Health Index and the 7-Day Median Flow Percentile.

The stages identified consider impacts along with moisture/water resource conditions. Kansas drought response transitions from primarily local response under a Drought Watch, with increases in the State and Federal roles at the Drought Warning and Drought Emergency stages. **Table 3.35** shows the drought stage descriptions and impacts as a combination of U.S. Drought Monitor and the Municipal Guidelines.

Table 3.35 Phased Drought Response Summary

Stage	U.S. Drought Monitor Description	Declared by	Possible Impacts	Response Summary
Drought Watch	Moderate Drought	Governor	Some damage to crops and pastures; high rangeland fire danger, streams or reservoirs low, serious public water system shortage not imminent, but likelihood of shortages growing.	Governor notified by Kansas Water Office, Governor's Drought Response Team activated, public notification, outdoor burning bans may be imposed; public water systems may implement State 1 Water Watch phase of municipal water conservation plan, Governor may request USDA disaster Declaration for drought.
Drought Warning	Severe Drought	Governor	Crop damage to crops and pastures; high rangeland fire danger; streams or reservoirs low, serious public water system water shortages not imminent, but likelihood of shortages growing.	Public water systems may implement Stage 2 Water Warning phase of municipal water conservation plan; Hay and Pasture Exchange activated; urgent surplus water contracts from state controlled storage authorized; Governor may request authorization for haying and grazing of Conservation Reserve Program acres; Governor may request USDA disaster declaration for drought.
Drought Emergency	Extreme and Exceptional Drought	Governor	Widespread major crop and pasture losses; extreme rangeland fire danger; stock water shortage; widespread public water system water shortages or restrictions; streamflow targets not met; reservoir supplies low.	Governor may declare outdoor burning ban upon advice of Adjutant General; public water systems may implement Stage 3 Water Emergency phase of municipal water conservation plans; emergency surplus water contracts from state controlled storage authorized; emergency water withdrawals from USACE emergency water assistance; Governor may request Presidential disaster declaration and/or USDA disaster declaration for drought.

Source: Kansas Drought Operations Plan, Governors Drought Team, June 2012
Note: Adopted from U.S. Drought Monitor and Kansas 2007 Municipal Water Conservation Plan Guidelines.

One of the most costly impacts of drought is the damage to foundations, parking lots, and other asphalt or concrete structures that are damaged as a result of the shrinking off soil that occurs along with drought, followed by the rapid swell that can occur when rains do come. Determining the direct and indirect costs associated with droughts is difficult because of the broad impacts of drought and the difficulty in establishing when droughts begin and end.

Another impact due to drought is its ability to severely challenge a public water supplier through depletion of the raw water supply and greatly increased customer water demand. Even if the raw water supply remains adequate, problems due to limited treatment capacity or limited distribution system capacity may be encountered. A 2007 assessment of 800 city or rural water district drinking water systems by the Kansas Water Office found 132 to be drought vulnerable. Also, in the drought of 2012, there are 197 communities and rural water districts, some that are also on the 2007 list, that have triggered some sort of water conservation to extend their supply (Source: http://www.kwo.org/reports_publications/Drought.htm). These two lists have been combined in **Table 3.36** and create a new list of Drought Vulnerable Public Water Suppliers. Basic source limitations were the most common cause of drought vulnerability, followed by distribution system limitations.

Table 3.36. Region L Drought Vulnerable Public Water Suppliers

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
Mitigation Planning Region L				
Bonner Springs	Wyandotte	Water Watch		X
Desoto	Johnson	Water Watch		X
Easton	Leavenworth	Basic Source	X	
Edgerton	Johnson	Water Watch		X
Gardner	Johnson	Water Watch		X
Johnson RWD 06c	Johnson	Water Watch		X
Johnson RWD 07	Johnson	Water Watch		X
Leavenworth RWD 06	Leavenworth	Unknown	X	
Leavenworth RWD 07	Leavenworth	Contractual	X	
Leavenworth RWD 10	Leavenworth	Water Watch		X
Leawood (WaterOne customer)	Johnson	Water Watch		X
Olathe	Johnson	Water Watch		X
Prairie Village (WaterOne customer)	Johnson	Water Watch		X
Spring Hill	Johnson	Water Watch		X
Tonganoxie	Leavenworth	Contractual	X	

The statistical analysis below uses two significant factors in determining the drought vulnerability for Region L. One is the USDA Risk Management Agency's annualized insured crop losses as a result of drought conditions during the ten-year period of 2002-2011 and the number of drought vulnerable public water suppliers in Kansas from Table 3.25 from above. It was determined that all counties in Region L have either insured crop loss and/or drought vulnerable public water suppliers thus all counties are rated at least at a medium vulnerability rating since agriculture is a major economic factor in most of the Region L counties and public water supply is an essential service to all of the region.

The rating values of the two factors were divided by 50 percent to determine the total drought vulnerability rating. The total drought vulnerability rating put all counties in either the medium, medium-high or high category. Table 3.37 provides the factors considered and the rating values assigned.

medium-high or high category. Table 3.26 provides the factors considered and the rating values assigned.

Table 3.37. Ranges for Drought Vulnerability Factor Ratings

Factors Considered	Low (1)	Low-Medium (2)	Medium (3)	Medium-High (4)	High (5)
Crop Loss Ratio Rating	.599 to 2.817	2.818 to 4.595	4.596 to 6.373	6.374 to 8.151	8.152 to 14
Drought Vulnerable Public Water Supplies Ratio Rating	1	2	3-6	7-9	10-14
Total Drought Vulnerability Rating	n/a	n/a	1	2 to 3	4 to 5

Table 3.38 below shows the variance of drought conditions by county in Region L.

Table 3.38. Total Crop Exposure, Annualized Insured Crop Insurance Paid from 2002-2011, Number of Drought Vulnerable Public Water Suppliers and Vulnerability Rating per County.

County	Crop Exposure (2007 Census of Agriculture)	Annualized Crop Insurance Paid/Drought Damage	Annual Crop Claims Ratio	Crop Loss Ratio Rating	Number of Drought Vulnerable Public Water Suppliers	Drought Vulnerable Public Water Suppliers Rating	Total Rating (Crops & Water Suppliers)	Vulnerability Rating
Mitigation Planning Region L								
Johnson	$29,472,000	$488,597	1.658%	1	9	4	5	Medium-High
Leavenworth	$20,983,000	$246,024	1.172%	1	5	3	4	Medium-High
Wyandotte*	$0	$0	0.000%	0	1	1	1	Medium
total	**$50,455,000**	**$734,620.70**			**15**			

Source: USDA Risk Management Agency

It is difficult to determine the direct and indirect costs associated with droughts because of the broad impacts of drought. This analysis only took into consideration the crop loss data and public water suppliers with drought vulnerability. Thus, there may be more accurate documented in regional and local mitigation plans and direct costs associated with droughts.

Summary

The vulnerability to drought for the planning area is centered on transportation nodes, parking lots, utility poles and structural integrity. Individual homes are vulnerable to foundation cracks and impairment. Water supply in the Region could be affected as the Kansas and Missouri Rivers are main sources of potable water and when their levels go down, the population, crops, and livestock are affected. Loss estimates are too varied to estimate as the loss is dependent on the degree of the drought and the length of time it is within the area.

Local Mitigation Concerns

- Drought can severely challenge a public water supplier through depletion of the raw water supply and greatly increased customer water demand. Even if the raw water supply remains adequate, problems due to limited treatment capacity or limited distribution system capacity may be encountered.

- http://www.kwo.org/reports_publications/Drought.htm). These two lists have been combined in Table 3.39 and create a new list of Drought Vulnerable Public Water Suppliers for Region L. Basic source limitations were the most common cause of drought vulnerability, followed by distribution system limitations. **Table 3.39** shows these drought vulnerable public water suppliers by county.

Table 3.39 Drought Vulnerabilities of Public Water Suppliers by Region L County

Public Water Supplier	County	2007 Limitation Category List* And/or 2012 conservation State **	2007 List	2012 Conservation List
Region L				
Bonner Springs	Wyandotte	Water Watch		X
Desoto	Johnson	Water Watch		X
Easton	Leavenworth	Basic Source	X	
Edgerton	Johnson	Water Watch		X
Gardner	Johnson	Water Watch		X
Johnson RWD 06c	Johnson	Water Watch		X
Johnson RWD 07	Johnson	Water Watch		X
Leavenworth RWD 06	Leavenworth	Unknown	X	
Leavenworth RWD 07	Leavenworth	Contractual	X	
Leavenworth RWD 10	Leavenworth	Water Watch		X
Leawood (WaterOne customer)	Johnson	Water Watch		X
Olathe	Johnson	Water Watch		X
Prairie Village (WaterOne customer)	Johnson	Water Watch		X
Spring Hill	Johnson	Water Watch		X
Tonganoxie	Leavenworth	Contractual	X	

Source: Kansas Water Office

* Drought Limitation Categories

Basic Source Limitation—The supplier's primary raw water source is particularly sensitive to drought as evidenced by depleted streamflow, depleted reservoir inflow and storage, or by declining water levels in wells. Restrictions imposed due to inability to use a well(s) because water quality problems were considered indicative of a basic source limitation.

Contractual Limitation—The supplier's sole water source is purchased from another system that is drought vulnerable and there is a drought-cut-off clause in their water purchase contract. In such situations where there is not a drought cut-off clause, the purchaser is considered drought vulnerable under the same limitation category as the seller.

Distribution System Limitation—The supplier has difficulty or is unable to meet drought-induced customer demand for water because of inadequate finished water storage capacity, inadequate finished water pumping capacity, inadequate transmission line sizes, etc.

Minimum Desirable Streamflow—The supplier reported imposing restrictions because of minimum desirable streamflow administration. Water rights junior to those granted for maintenance of established minimum desirable flows are subject to such administration.

Single Well Source—The supplier relies upon a single well as its sole source for raw water. Suppliers with one active well and one emergency well were considered drought vulnerable because emergency wells are not a dependable long-term water source. Excessive hours of operation to meet drought-induced customer demand for water will result in the increased likelihood of mechanical breakdown with no alternative water supply source available.
Treatment Capacity Limitation—The supplier has difficulty or is unable to meet drought-induced customer demand for water due to inadequate raw water treatment capacity.
Water Right Limitation—The supplier reported imposing restrictions because the quantity of water they are authorized to divert under their water right(s) was insufficient to meet customer demands.
** 2012 Conservation Implementation Stages are Water Watch =1, Water Warning = 2 and Water Emergency =3 as per local water conservation plans. State level may reflect State Drought Stages but should be tied to local supply conditions. Source: Kansas Drought Operations Plan, June 2012

- The Missouri River flows to the east of Leavenworth and Wyandotte counties, and is a main navigation route for commercial vessels. With the decrease in precipitation, the Missouri River water levels could potentially hurt the shipping industry as well as power production for the extended Region.

- Agricultural crops and livestock could potentially be affected should the drought continue. Both of these entities require water in order to flourish and should water levels become restricted they will suffer, ultimately affecting the farmers that rely on the agricultural industry as their livelihood.

- Drought comes with a host of other issues that can affect the property and people that live in the Region. With low moisture content wildfires could potentially increase, threatening crops, livestock, and urban living areas.

Development in Hazard Prone Areas

Drought does not normally cause damage to buildings and critical facilities, however, severe and exceptional drought over an extended period of time can cause integrity issues to foundations. This in turn can affect new development as construction of new buildings are built on soil that has been depleted of its moisture content leading to instability when rains do come.

Another issue for development is the increase of populations within the planning area will create greater demands on the public water suppliers.

Johnson County

Table 3.40. Johnson County CPRI for Drought

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Drought	4	2	1	4	2.95	Moderate

***Drought for Johnson County went from a low to a Moderate ranking due to various factors. The county has been included in no less than four drought warnings in the past 10 years. This does not include the watch declarations they were included in between the years 2003 – 2012. The probability of a drought affecting Johnson County is 40% in any given year. In order to have a Highly Likely probability the percentage is 33% probability in any given year. In addition, the**

magnitude increase from a negligible to a limited due to the damages the drought inflicts on structural foundations, agriculture, and the water supply.

Leavenworth County

Table 3.41. Leavenworth County CPRI: Drought

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Drought	4	2	1	4	2.95	Moderate

Wyandotte County

Table 3.42. Wyandotte County CPRI: Drought

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Drought	4	2	1	4	2.95	Moderate

Consequence (Impact) Analysis

The information in Table 3.43 provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.43. Consequence Analysis: Drought

Subject	Ranking	Impacts/Drought
Health and Safety of Persons in the Area of the Incident	Minimal - Moderate	Drought impact tends to be agricultural, however, because of the lack of precipitation that precipitates drought, water supply disruptions can occur which can affect people. Impact is expected to be minimal.
Responders	Minimal	With proper preparedness and protection, impact to the responders is expected to be minimal.
Continuity of Operations	Minimal	Minimal expectation for utilization of the COOP.
Property, Facilities, and Infrastructure	Minimal to Severe	Impact to property, facilities, and infrastructure could be minimal to severe, depending on the length and intensity of the drought. Structural integrity of buildings, and buckling of roads could occur.
Delivery of Services	Minimal	Impact on the delivery of services should be non-existent to minimal, unless transportation nodes are affected.
Environment	Minimal to Severe	The impact to the environment could be severe. Drought can severely affect farming, ranching, wildlife and plants due to the lack of precipitation.
Economic Conditions	Minimal to Moderate	Impacts to the economy will be dependent on how extreme the drought is and how long it lasts. Communities that depend on water recreation could be tested, as well as agricultural. Minimal to Moderate.
Public Confidence in Jurisdiction's	Minimal	Confidence could be at issue during periods of

Governance		extreme drought if planning is not in place to address intake needs and loss of agricultural crops.

3.3.5 Earthquake

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description

Earthquakes are defined as shifts in the earth's crust causing the surface to become unstable. The earth's crust is made up of gigantic plates, commonly referred to as tectonic plates. These plates form what is known as the lithosphere, which varies in thickness from 6.5 miles (beneath oceans) to 40 miles (beneath mountain ranges), and has an average thickness of 20 miles. These plates "float over a partly melted layer of crust called the asthenosphere. The plates are in motion, and areas where one plate joins another are referred to as "plate boundaries." Most earthquake faults occur along plate boundaries where plates push or pull the crust so much that the crust breaks.

Seismic waves are the vibrations from earthquakes that travel through the Earth; they are recorded on instruments called seismographs. Seismographs record a zig-zag trace that shows the varying amplitude of ground oscillations beneath the instrument. The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Earthquakes with magnitude of about 2.0 or less are usually called micro-earthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of about 4.5 or greater are strong enough to be recorded by sensitive seismographs all over the world. Great earthquakes, such as the 1964 Good Friday earthquake in Alaska, have magnitudes of 8.0 or higher.

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - total destruction. Although numerous *intensity scales* have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at that place.

The **lower** numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The **higher** numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above.

The following is an abbreviated description of the 12 levels of Modified Mercalli intensity from the U.S. Geological Survey.

> **I.** Not felt except by a very few under especially favorable conditions.
>
> **II.** Felt only by a few persons at rest, especially on upper floors of buildings.
>
> **III.** Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
>
> **IV.** Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
>
> **V.** Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
>
> **VI.** Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
>
> **VII.** Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
>
> **VIII.** Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
>
> **IX.** Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.

XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Location

Region L is in an area of relatively low seismic activity. The Region does lie between three earthquake fault zones, the Humboldt Fault and the associated Nemaha Ridge, also known as the Nemaha Uplift, in central Kansas and the New Madrid Fault in eastern Missouri. All counties in the region carry the same low risk of seismic activity.

Figure 3.13 shows the probability of an earthquake with a magnitude greater than or equal to 4.75 within 100 years in Region L.

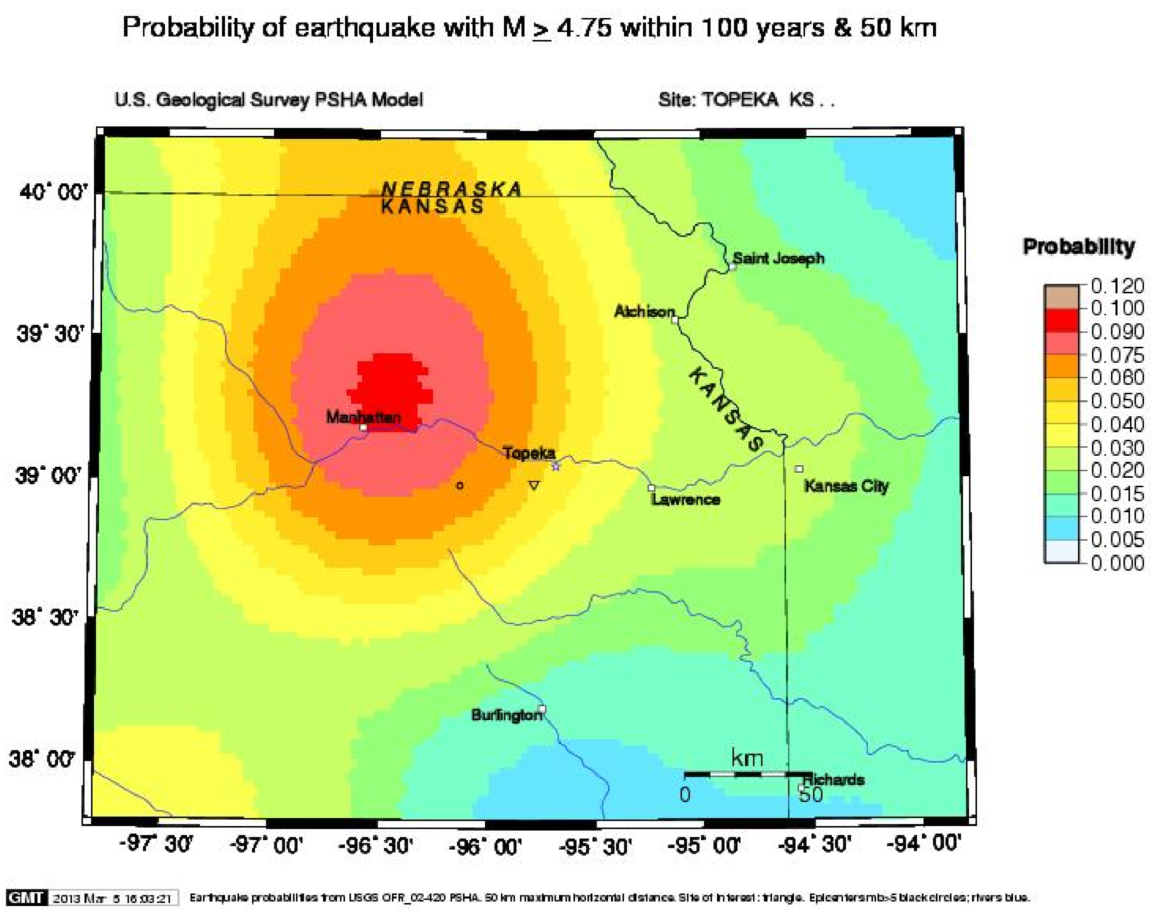
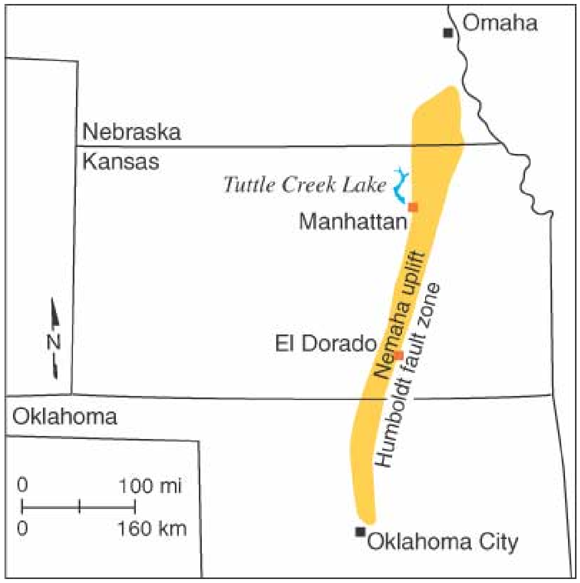


Figure 3.14. Humboldt Fault Zone



Source: Kansas Geological Survey, Earthquakes in Kansas, www.kgs.ku.edu/Publications/GeoRecord/2001/vol7.3/Page1.html

Previous Occurrences

According to a FEMA report, the Kansas City, Missouri, area was ranked 35th among 35 major metropolitan areas for seismic activity. By extension, the planning area, which abuts Kansas City, Mo. Is also a low risk area.

The following events were noticeable in the planning area.

Other Notable Events

- **November 5, 2011**: A 5.6 magnitude earthquake, centered in Oklahoma, sent waves all the way up to KC. It was believed this quake was related to the Humboldt fault line.
- **July 24, 2001:** A 3.0 magnitude earthquake in Butler County rattled computer screens at City Hall and shook several houses in Augusta. It occurred 24 miles above an area where four stems of the main Humboldt Fault line lie. It caused minor damage and injuries and was felt as far away as Dubuque, Iowa.
- **May 13, 1999**: A 40-block section of KC was shaken by a 3.0 magnitude earthquake. About 100 people evacuated from Indian Springs Medical Building, which was damaged in the earthquake. The epicenter was in Kansas.
- **November 9, 1968**: A 5.3 magnitude earthquake centered in southern Illinois was felt in eastern Kansas.
- **April 9, 1952:** A damaging earthquake centered near El Reno, Oklahoma, affected a total area of 140,000 square miles, including the entire eastern half of Kansas. The magnitude 5.5 shock was felt in Kansas most strongly at Medicine Lodge. KC was also strongly affected.

- **March 18, 1927:** An earthquake near White Cloud, in the extreme northeastern portion of the state, rocked houses such that people rushed out of them.
- **January 7, 1906:** A magnitude 4.7 earthquake affected an area of about 10,000 square miles in Kansas, Missouri, and Nebraska. Chimneys were thrown down and some cracks in walls were observed.
- **October 31, 1895**: This earthquake near Charleston, Missouri, affected a million square miles over 23 states, including Region L.

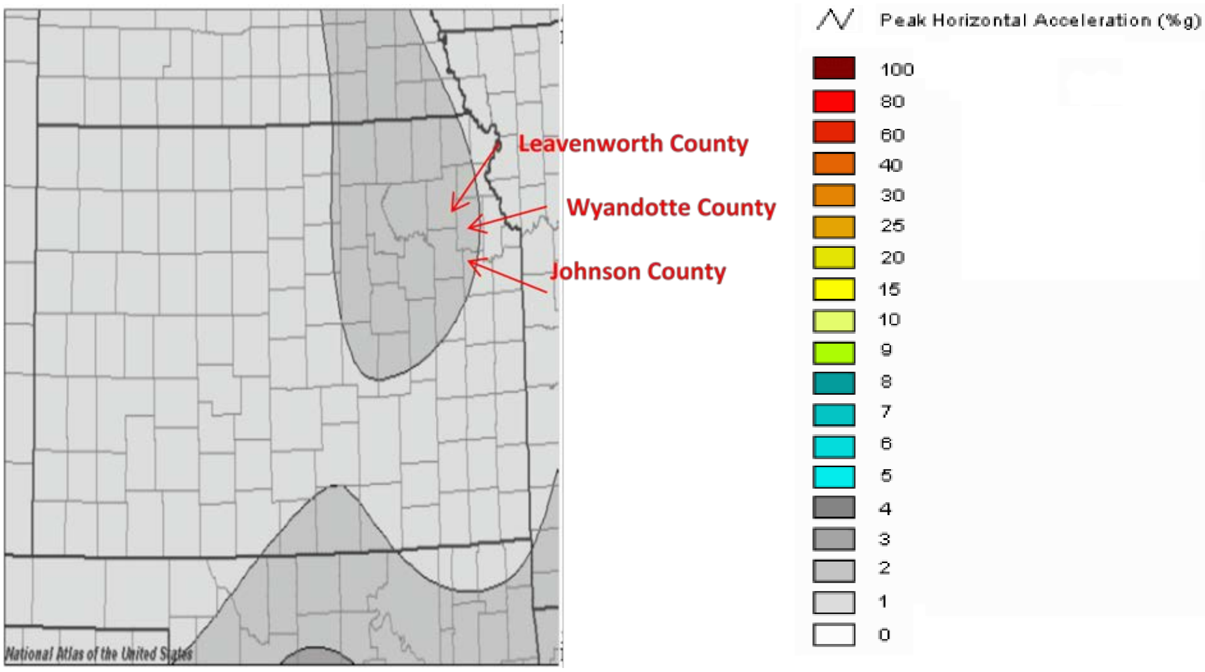
Extent

Overall, Region L is in a low seismic activity area. The Nemaha fault would directly affect Riley and Pottawatomie Counties, and the New Madrid Seismic Zone follows the Mississippi River valley and is not expected to cause Region L any significant damage. Missourian's trying to escape the carnage of the New Madrid Fault having a seismic event could inundate the Region, leading to sheltering and feeding issues. The magnitude of an earthquake in the planning area has been determined to be limited. Injuries and illnesses would not result in permanent disability, and shutdown of critical facilities would not last for more than a week.

Probability of Future Hazard Events

Figure 3.15 below depicts the probability that ground motion will reach a certain level during an earthquake. The data shows peak horizontal ground acceleration (the fastest measured change in speed for a particle at ground level that is moving horizontally because of an earthquake). The shaking level that has a 10 percent chance of being exceeded over a period of 50 years, which is more of a worst-case scenario, depicts the shaking level that has a 2 percent chance of being exceeded over a period of 50 years. Typically, significant earthquake damage occurs when accelerations are greater than 30% of gravity

Figure 3.15. Ground Shaking Horizontal Acceleration



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

This hazard's probability on a Regional level is '**Unlikely**' to occur in the next three years. However, because of the dams and levees within Region L, it is imperative that the counties that make up this region are cognizant of the earthquake risks posed by the faults that reside to the east and west of them, and mitigate in order to prevent dam and levee failure.

Impact and Vulnerability

The impact of an earthquake in Region L would be minimal. Damages would result from earth shaking that is a result of an earthquake not in the Region. Displaced households for the total Region would be 407 in the case of a worst case event. Building loss would be $727,978 for the same worst case event. While Region L does rank in the top 10 counties for damages due to an earthquake during a worst case event, this scenario is based on a 2,500 year span. While Region L is not in a high shake zone, and the counties that make up the region are not alongside of a fault, losses could still potentially be great in terms of damages due to the development and population base being higher. So, although earthquake shaking would be less severe in some populated areas, the damages may be greater due to more buildings and populations in those areas. Particularly if the building structures are more than one story. **Table 3.44** provides estimated building losses and displaced households for Region L, as a result of a 2,500 year probabilistic 6.7 Magnitude earthquake followed by **Table 3.45 that** shows Region L as being in the top 10 counties in terms of building damage. **Table 3.46** shows the top 10 counties in terms of displaced households. These tables reflect damages from a worst case scenario event.

Table 3.44. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Total Building Loss and Displaced Households by County

County	Total Earthquake Losses (1000's)	Displaced Households
Johnson	$522,644	282
Leavenworth	$52,209	29
Wyandotte	$153,125	96
Total	**$727,978**	**<408**

Source: State Hazard Mitigation Plan 2013

Overall, Region L is in a low seismic activity area. The Nemaha fault would directly affect Riley and Pottawatomie Counties, and the New Madrid Seismic Zone follows the Mississippi River valley and is not expected to cause Region L any significant damage. Missourian's trying to escape the carnage of the New Madrid Fault having a seismic event could inundate the Region. Leading to sheltering and feeding issues.

In Table 3.47 data taken from Hazus-MH 2.1 indicates the shake zones in the counties within Region L.

Table 3.45. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Top 10 Counties by Building Loss (1000s)

Mitigation Planning Region	County	Total Earthquake Losses (1000s)
L	Johnson	$522,644
G	Sedgwick	$352,186
J	Shawnee	$175,161
L	Wyandotte	$153,125
K	Douglas	$84,716
I	Riley	$71,807
L	Leavenworth	$52,209
H	Crawford	$45,280
G	Reno	$37,342
G	Butler	$34,313

Source: State Hazard Mitigation Plan 2013

Table 3.46. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Top 10 Counties by Displaced Households

Mitigation Planning Region	County	Displaced Households
L	Johnson	282
G	Sedgwick	233
J	Shawnee	112
L	Wyandotte	96
K	Douglas	86
I	Riley	68
L	Leavenworth	29
H	Crawford	24
I	Lyon	20
U	Geary	20

Source: State Hazard Mitigation Plan 2013

In **Table 3.47** data taken from Hazus-MH 2.1 indicates the shake zones that could potentially affect the counties within Region L. This analysis is based on a worst case 2500 year, 6.7 magnitude earthquake.

Table 3.47. Worst-Case 2500-Year, 6.7 Magnitude Earthquake Ground Shaking Potential for Each Kansas County in Region L.

County	0% to 4.2% PGA	4.3% to 5.0% PGA	5.1% to 6.0% PGA	6.1% to 7.5% PGA	7.6% PGA and Higher
Johnson			x		
Leavenworth			x		
Wyandotte			x		
Subtotal	0	0	3	0	0

Source: State Hazard Mitigation Plan 2013

Summary

The planning area is at a low risk for seismic activity. It lies between two faults, the New Madrid, and the Humboldt Fault, but far enough away that any damages would be due to earth shaking and not a direct quake. At issue for the region would be the influx of people from the fault zones and the subsequent feeding and sheltering of these individuals for an extended period of time.

Local Mitigation Concerns

- Region L is in a low seismic activity area, however, earth shaking at a low magnitude can still cause damage to property and people. The counties that make up the region have tall buildings that are prone to the effects of shaking. Along with the hilly terrain in the region, earth shaking could cause extensive damage.

- An area of concern for the region is the influx of individuals that are relocating due to a seismic event at the New Madrid Fault in Missouri. Short term shelter, and long term residence could strain the infrastructure and economy.

- Region L has various dams and levees that could be an issue due to earth or ground shaking.

Development in Hazard Prone Areas

While Region L is not in a high hazard area for a severe, catastrophic earthquake event, the population density and building count ensure that it will be at risk for damaged buildings and displaced households. With this in mind it could behoove the Region to adopt seismic design standards for any new development, particularly for critical and essential facilities to minimize any tremor or shaking impact.

Table 3.48. Johnson County CPRI: Earthquake

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Earthquake	1	2	4	1	1.75	Low

Leavenworth County

Table 3.49. Leavenworth County CPRI: Earthquake

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Earthquake	1	2	4	1	1.75	Low

Wyandotte County

Table 3.50. Wyandotte County CPRI Earthquake

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Earthquake	1	2	4	1	1.75	Low

Hazard Consequence (Impact) Analysis

The information in Table 3.51 provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.51. EMAP Consequence Analysis: Earthquake

Subject	Ranking	Impacts/Earthquake
Health and Safety of Persons in the Area of the Incident	Minimal	Impact in the incident area expected to be minimal in the State of Kansas.
Responders	Minimal	With proper preparedness and protection, impact to the responders is expected to be non-existent to minimal.
Continuity of Operations	Minimal	COOP is not expected to be activated (minimal).
Property, Facilities, and Infrastructure	Minimal	Impact to property, facilities, and infrastructure could be minimal. Facilities, Infrastructure, and personnel could be minimally affected.
Delivery of Services	Minimal	No expectation of impact on services (minimal).
Environment	Minimal	No expectation of environmental impact (minimal).
Economic Conditions	Minimal	No expectation of economic conditions being impacted (minimal).
Public Confidence in Jurisdiction's Governance	Minimal	No change in confidence in jurisdictions governance (minimal).

3.2.7 Expansive Soils

Calculated Priority Risk Index	Planning Significance
2.20	Moderate

Description

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

Thirty-six states have expansive soils within their jurisdiction. Expansive soils are so extensive within parts of the United States that alteration of the highway routes to avoid expansive soils is virtually impossible. The Midwest is particularly problematic for construction because of the varied mixture of clay soils. Each year in the United States, expansive soils cause billions of dollars in damage to buildings, roads, pipelines, and other structures. This is more damage than that typically caused by floods, hurricanes, tornadoes, and earthquakes combined. It is estimated that approximately 10 percent of the homes built on expansive soils experience significant damage. Because there is limited available data on this hazard and no reported occurrences, the previous plan’s assessment remains valid and will be applicable for the 2013 update.

Location

Expansive soils are a moderate risk that is largely uniform across the Region. Related hazard events are correlated with periods of drought in eastern Kansas. However, developed and developing communities in the Region in the areas of high clay content soils, which commonly experience fluctuations in the water table, are probably the most vulnerable to expansive soils. The distribution of clay soils is an indication of the extent of the vulnerability to this hazard in the Region. Nearly the entire Region has clay containing soils with at least a slight potential for swelling and shrinking that could damage building foundations, roadways, and similar properties.

Per the map below, Region L is located in an area where part of the soil unit consists of clay having slight to moderate swelling potential. While more detail is not available, all jurisdictions within the Region are affected.

Figure 3.16 Swelling Soils Map of Kansas

MAP LEGEND

Red Unit contains abundant clay having high swelling potential
Blue Part of unit (generally less than 50%) consists of clay having high swelling potential
Rust Unit contains abundant clay having slight to moderate swelling potential
Green Part of unit (generally less than 50%) consists of clay having slight to moderate swelling potential
Brown Unit contains little or no swelling clay
Yellow Data insufficient to indicate clay content of unit and/or swelling potential of clay
Source: U.S. Geological Survey publication, http://arcvoid.com/surevoid_web/soil_maps/ks.html

Figure 3.17 depicts the general soil content of Leavenworth and Wyandotte Counties in Region L, which contribute to expansive soils. Figure 3.17a shows the general soil content for Johnson County.

Figure: 3.17. General Soil Content: Leavenworth and Wyandotte Counties

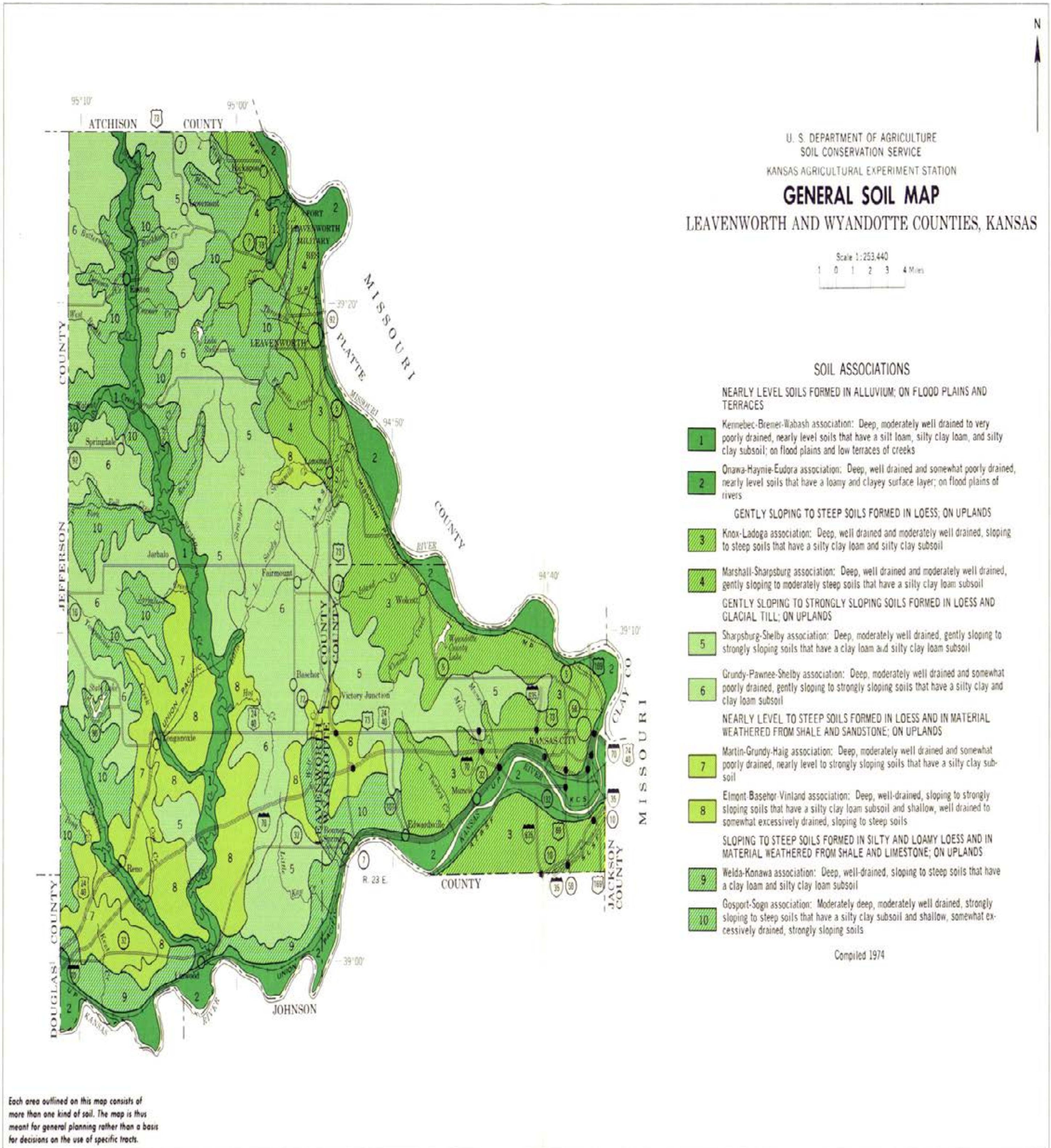
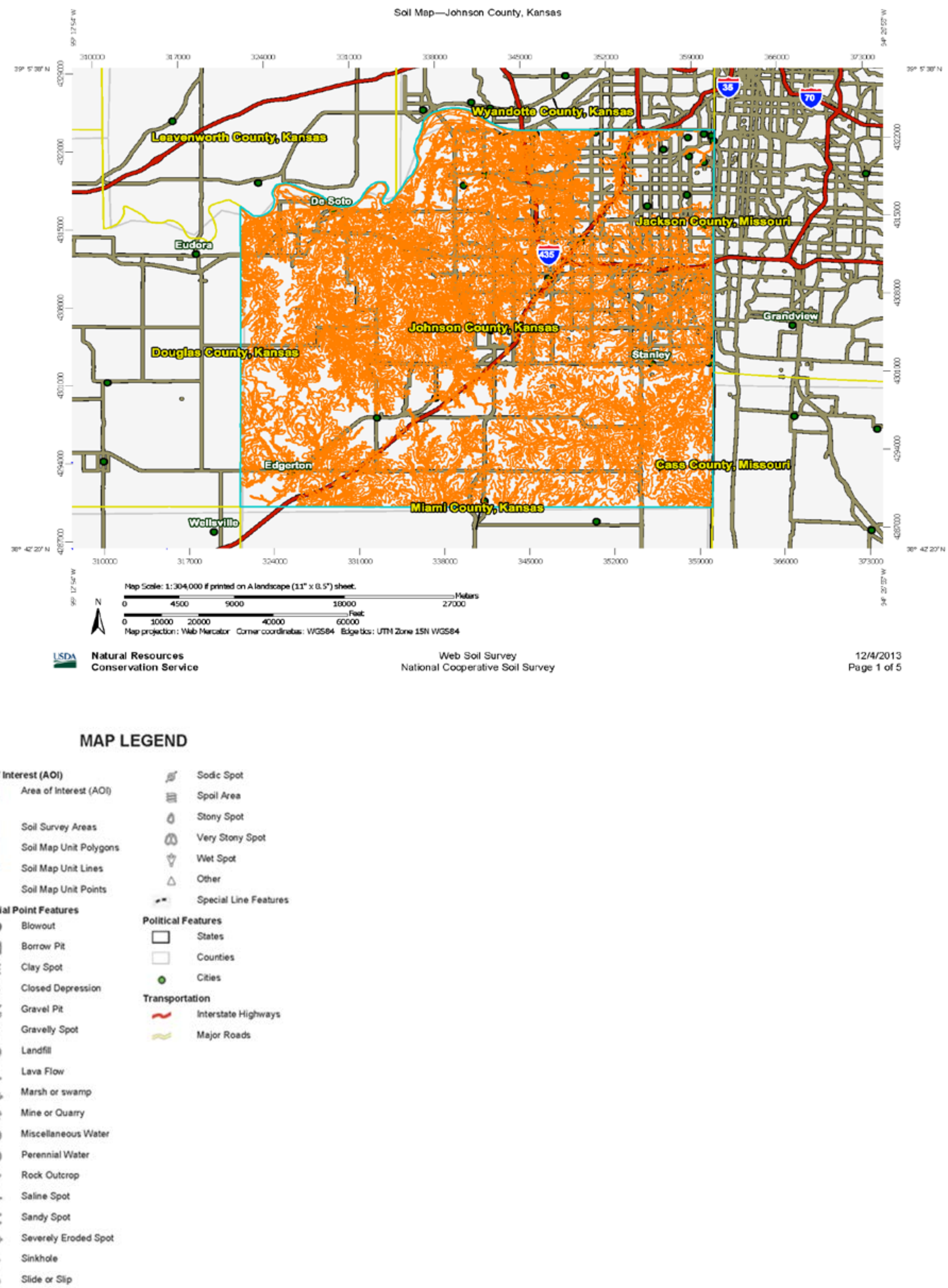


Figure 3.17a. General Soil Content: Johnson County



Previous Occurrences

Highways, airport runways, streets, walkways and parking lots with layers of concrete and asphalt throughout the State are damaged every year by the effects of expansive soils. The frequency of damage from expansive soils can be associated with the cycles of drought and heavy rainfall, which reflect changes in moisture content. Building settlements associated with drought have been noted in Kansas for many years, particularly in buildings located on high ground, further from the water table.

The 2011 - present drought has likely been the worst for home foundations since the late 1950s drought, stated a board member of the Basement Health Association, a Dayton, Ohio-based trade group for basement and foundation repair businesses. Homes from the Dakotas through Louisiana were faring the worst, but damage to foundations from drought has been reported in 40 of the contiguous U.S. Experts estimate that drought damage to houses could reach $1 billion or more. Source: U.S. News and World Report, Aug. 31, 2012

Expansive soil events around Kansas City, Missouri are detailed below. No data is available for events in Region L.

- **1985:** Expansive Soil Event - movement in expansive shales caused damage to St. Teresa's Academy, the 7th Church of Christ, the Kansas City Public Library Country Club Plaza Branch, and the University Center at the University of Missouri, all in Kansas City, Missouri.
- **1950:** Expansive Soil Event - Many homes and buildings in the Kansas City metropolitan area experienced minor damage as a result of the 1950s' drought. Up to 65 percent of the homes were damaged at an estimated cost of $30-$40 million.

- **2012**: According to a report on Fox4 KC.com, the metro area has seen extensive damage to foundations of homes and other structures. Down more than 17 inches of rain, as of December 0f 2012, foundation repair companies are reporting that they have not been this busy in 34 years. The full extent of the issue will hit once the rains do begin again, expanding the soil that has shrunk and leaking into all the cracks brought on by the drought.

Extent

While Region L has a lower clay content overall than many counties in Kansas they are still susceptible to expansive soil damage. The magnitude of expansive soils would be negligible for the planning area. Injuries could be treated with first aid, critical facilities would not be shut down for more than 24 hours.

Probability of Future Hazard Events

Based on the widespread distribution of soils and dry and wet cycles in Kansas, this hazard's CPRI probability (for a damaging swelling soils event) is "**Likely**" within the next three years.

Impact and Vulnerability

While Region L has lower clay content overall than many counties in Kansas they are still susceptible to expansive soil damage. A dollar amount for damages is difficult to ascertain or assign to this particular hazard since very little incident record keeping is done. Highways probably are most susceptible to damage from soil problems but those are usually resolved by using improved construction methods.

The impact of expansive soils in the planning area is ultimately an area of concern for the infrastructure such as roads, bridges, utilities. Any building impacts would be the concern of the building owner whether insured or uninsured. Loss of life is not a concern unless the event is catastrophic to the point of collapsing bridges or buildings where individuals are in close proximity. The impact of this hazard could be minimal to moderate, depending on the location.

Since this hazard develops gradually, it seldom presents a threat to life. Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling clays than are multi-story buildings, which usually are heavy enough to counter swelling pressures.

Summary

Expansive soils is a common hazard in the planning area due to the clay content of the soil and the rise and fall of the moisture levels due to heavy rains and drought conditions. While the hazard is common it does not severely affect the economy other than fixing damages done to roads and buildings. Because this damage is hit or miss it is not possible to have a loss estimate.

Local Mitigation Concerns

- The main issues confronting the Region are the transportation nodes in and around the tri-state area. These traffic ways are heavily travelled and when damaged due to expansive soils they become a threat to human life.

- The structural integrity of the buildings in and around the area are tested during periods of expansive soil, caused by drought and heavy rains, which can create a safety issue. Reparation can be expensive for public buildings, and for private individuals.

Development in Hazard Prone Areas

The presence of clays with high swelling and shrinking potential are lower in the planning area than the rest of the state, however it does still exists. Development in this Region is increasing as the population base increases, however, damage from expansive soil to new construction is often mitigated with modern construction practices.

Soil engineers and engineering geologists test soils for swell potential when designing a building's foundation. Simple observation often can reveal the presence of expansive soils and can make recommendations for septic systems, grading, earth support, drainage, foundation design, concrete slab on grade construction and site remediation.

Johnson County

Table 3.52. Johnson County CPRI – Expansive Soil

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Expansive Soil	3	1	1	4	2.20	Moderate

Leavenworth County

Table 3.53. Leavenworth County CPRI – Expansive Soils

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Expansive Soil	3	1	1	4	2.20	Moderate

Wyandotte County

Table 3.54. Wyandotte County CPRI: Expansive Soil

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Expansive Soil	3	1	1	4	2.20	Moderate

Consequence (Impact) Analysis

Even though expansive soils cause enormous amounts of damage to buildings and infrastructure most people have never heard of them. This is because their damage is done slowly and cannot be attributed to a specific event. The damage done by expansive soils is then attributed to poor construction practices or a misconception that all buildings experience this type of damage as they age.

The information in Table 3.55 provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.55. Consequence Analysis: Expansive Soils

Subject	Ranking	Impacts/Expansive Soils
Health and Safety of Persons in the Area of the Incident	Minimal	Minimal impact.
Responders	Minimal	Minimal impact.
Continuity of Operations	Minimal	Minimal expectation for utilization of the COOP unless facility structures have extensive damage.
Property, Facilities, and Infrastructure	Minimal to Moderate	Localized impact could be moderate as it relates to property, facilities, and infrastructure. Expansive soils could cause structural integrity to be lost, and roadways, railways, etc., to buckle.
Delivery of Services	Minimal	Delivery of services could be impacted if roadways, railways, and all other infrastructure is impacted (minimal).
Environment	Moderate	Expansive soils could cause moderate damage to the environment, particularly dams, levees, watersheds, etc.
Economic Conditions	Minimal to Moderate	The impact to the economy is with the rebuilding of the property, facility, and infrastructure issues that expansive soils cause. During years of drought and extreme rain events the damage could be moderate.
Public Confidence in Jurisdiction’s Governance	Minimal	Confidence will be dependent on development trends and mitigation efforts at reducing the effect of expansive soils on new construction and roadways (minimal).

3.2.8 Extreme Temperatures

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

Description

Extreme temperature events, both hot and cold, can have severe impacts in Region L on human health and mortality, natural ecosystems, agriculture, and other economic sectors.

Heat

According to the Centers for Disease Control and Prevention, 3,981 people died in the United States from heat-related deaths during 1999 and 2005. Those at greatest risk for heat-related illness include older adults and young children. 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.

The contiguous United States now has the summer of 2012 as its third hottest summer on record since recordkeeping began in 1895. According to NOAA's National Climatic Data Center, the average temperature for the contiguous United States between June and August was over 74 degrees F, which is more the 2 degrees above the twentieth-century average. Only the summers of 2011 and 1936 have had higher summer temperatures.

According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index chart shown in Figure 3.18 uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 3.18. Heat Index (HI) Chart

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution · Extreme Caution · Danger · Extreme Danger

Source: National Weather Service (NWS)

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

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

Warm summer days also encourages the growth of blue-green algae blooms in Kansas ecosystems. Blue-green algae are a normal part of the environmental when they are present in low numbers. But in the summer heat, these blooms grow very quickly to extreme numbers and produce chemical compounds which are toxic to warm-blooded creatures (people, pets and livestock),and some are toxic to other organisms like fish. The biggest risk to health comes from coming into contact with or ingesting the toxins produced by the algae while engaging in what is called “full body contact” (during swimming, skiing or jet skiing, for example), or from inhaling spray cast up from the water’s surface by recreational activities or by the wind. Blue-green algae can also cause dermatological symptoms with prolonged skin contact with water or wet clothes. Children and pets are most at risk while engaging in recreation in the water because they are more likely to accidently or intentionally swallow lake water. Pets can become ill after being exposed to spray, or even from eating dried algae along the shore or after licking algae from their fur. No antidote exists for any known algal toxin currently. This makes prevention the best option for protecting human and animal health during a bloom (source: Kansas Department of Health & Environment, http://www.kdheks.gov/algae-illness/index.htm).

Cold

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 specific data sources recording 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.

Also at risk are those without shelters, 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 water pipes.

Wind can greatly amplify the impact of cold ambient air temperatures. Provided by the National Weather Service, Figure 3.19 below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite. The combination of these elements affects the wind chill factor. The wind chill factor is the perceived temperature. As the speed of wind increases, the skin temperature drops as the heat is carried away from the body. As the perceived temperature increases, the risk of frostbite and hypothermia increases.

Figure 3.19. Wind Chill Chart

	Temperature (°F)																	
Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Location

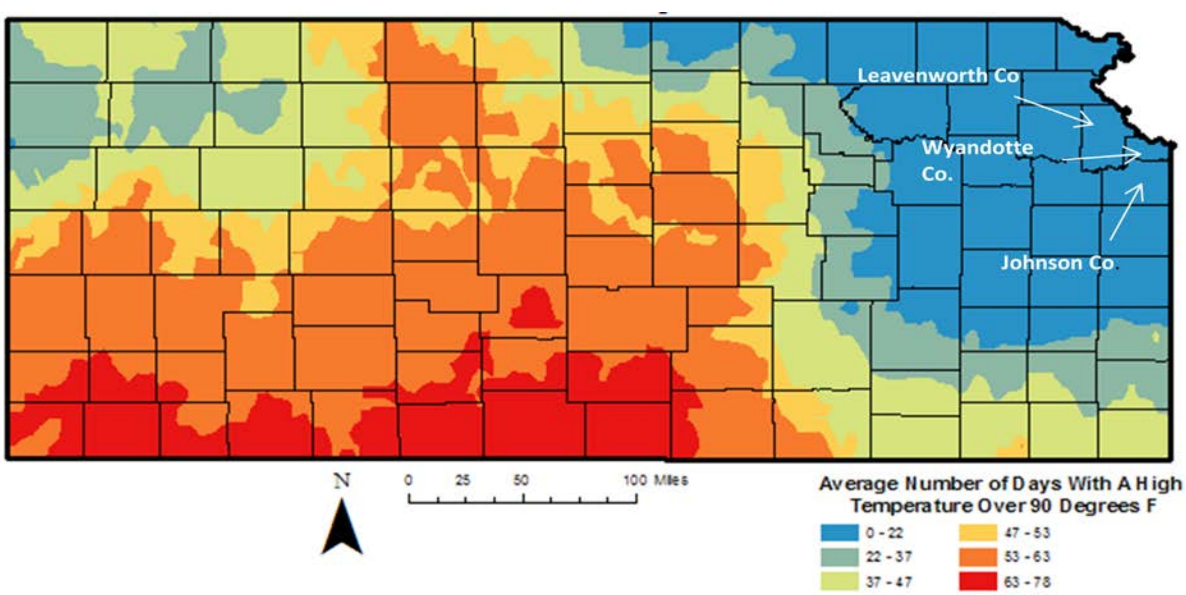
All of Region L is susceptible to extreme temperatures. The heat risk to humans is generally uniform across the State of Kansas, but is slightly higher in the eastern portion that Region L resides in because of a relatively higher heat index. Extreme cold is a factor throughout the Region also, with all jurisdictions susceptible.

Previous Occurrences

For extreme heat, the Kansas Department of Health and Environment's Kansas Environmental Public Health Tracking Program has kept records of the fatalities of Kansas residents since 2000. There have been at least 144 fatalities of Kansas residents since 2000 due to heat. The year of 2011 had the most recorded fatalities with 37.

Recorded temperatures in Kansas have ranged from –40 degrees °F (Lebanon, February 1905) to 121 degrees °F (Alton, July 1934). Also, the average number of days with temperatures over 90 degrees has been recorded from 1981 to 2010 as reflected in Figure 3.20. This map shows that over 2/3rd of the State had over a month of high temperatures over 90 degrees and the southwestern counties that border Oklahoma, average two months of temperatures over 90 degrees. This map does not depict the overnight minimum temperature averages. If the temperature does not drop overnight, it is more important in a global sense than the record highs. People, mainly those without air conditioning and crops need the temperature to drop during the overnight so that they can sustain the heat during the next day. The following figure shows the average number of days per year with high temperatures over 90 from 1981 to 2010.

Figure 3.20. Average Number of Days Per Year with High Temperatures Over 90, 1981 – 2012



Source: Kansas State Research and Extension, Climatic Maps of Kansas, http://www.ksre.ksu.edu/wdl/ClimaticMaps.htm , date October 2012.

Region L falls in the 0 – 22 days over 90 degree category. Note that a graphic is not available for cold temperatures at this time.

Notable Extreme Temperature Events for Region L

- **Summer 2012:** A large high pressure area settled over the Central High Plains resulting in high temperature records being tied or broken in Goodland, Hill City and other Kansas towns. Region L was affected by this high pressure. http://www.crh.noaa.gov/news/display_cmsarchive.php?wfo=gld and Topeka, KS http://www.crh.noaa.gov/news/display_cmsarchive.php?wfo=top).
- **June 2009**—The Kansas City, Kan. Fire Department responded to a number of heat related calls. The Fire Department was dispatched to the Wyandotte County Courthouse on a case ofheat exposure and the Unified Government's Fleet Center at 50th and State on a case of possible heat stroke. Officials also determined high temperatures may have been the cause of death for two elderly people in the 2500 block of Stewart Avenue (*Kansas City Kansan*, June 23, 2009).
- **August 1, 2006**—Oppressive heat and humidity continued from July...with heat indices in the 105 to 115 degree range through August 2nd.
- **July 29, 2006**--Oppressive heat and humidity drove heat indices into the 105 to 115 degree range, from July 29th through July 31st.
- **July 15, 2006**--Oppressive heat and humidity drove afternoon and early evening heat indices into the 105 to 115 degree range, from July 16th through July 20th.
- **July 21, 2005**--Oppressive heat and humidity was observed across the area from July 21st to July 25th. Afternoon heat indices ranged from 105 to 110 degrees. A 78 year old female from Bonner Springs in Wyandotte county died from heat related causes on July 23rd.
- **August 24, 2003**--High temperatures and humidity caused heat indices to reach the 105 degree range
- **August 17, 2003**--High temperatures and humidity caused heat indices to reach the 105 to 110 degree range.
- **July 26, 2003**--Afternoon heat indices ranged from 103 to 106 degrees, from July 26th through July 27th.
- **July 14, 2003**--Oppressive heat and humidity over extreme eastern Kansas from July 14th through July 18th. Heat indices reached 110 degrees
- **August 9, 2001**--Excessive heat and humidity again was observed over eastern Kansas on August 9th. Afternoon heat indices ranged from 105 to 110 degrees.
- **August 1-5, 2001**--Excessive heat and humidity dominated the weather across eastern Kansas. August 1st through August 5th. Afternoon heat indices ranged from 105 to 113 degrees.
- **July 17-24, 2001**--Excessive heat with afternoon heat indices 105 to 110 degrees...dominated the weather across eastern Kansas from July 17th to July 24th.
- **December 10-31, 2000**--Arctic air gripped northeast Kansas for the final 3 weeks of December. Except for a few hours on the 15th and 16th, temperatures remained below freezing for the entire period. Daily temperatures were 10 to 20 degrees below normal through the period. Average highs were in the teens and twenties with average lows in the single digits. Olathe dropped to 10 below zero on the 22nd. Snow cover persisted across the

area from the 13th through the end of the month. Numerous water pipes and water mains were broken, especially in the Kansas City area.

- **October 6-10, 2000**--Unusually strong Arctic high pressure built southward into the central Plains in early October, bringing 4 days of record breaking cold to northeast Kansas. High temperatures did not break the 50 degree mark on October 6th through 8th, and low temperatures dropped into the 20s each day from the 7th through the 9th. After starting the day near freezing on October 10, temperatures finally rebounded into the 60s that afternoon.
- **August 2000:** This August will be remembered as one of the hotter Augusts on record for north-central and northeastern Kansas. The last half of the month was especially hot with nearly all of the monthly highest temperatures reached during this time period. At least 14 people were treated for heat-related illnesses.
- **July 1999:** Excessive heat occurred over north-central and northeastern Kansas throughout the month, but during a two-week period at the end of the month, temperatures exceeded 100 °F in many areas on many days. Two deaths were attributed to the heat.
- **February 1996:** Record setting to near record setting cold covered northeast and north-central Kansas from the 1st through the 4th. Daytime highs in some areas failed to reach zero. These readings were quite extreme and rare for the local area where little if any snow was on the ground during the coldest time. Low temperatures plunged to between 10 below and 20 below zero with wind chills of 40 below to 60 below zero. These extreme readings caused water pipes to burst, water meters to freeze, inoperative vehicles, overworked heating systems and a host of other problems associated with prolonged extreme cold. Most schools, especially rural areas, cancelled classes while many businesses and activities were curtailed or cancelled.
- **September 1995:** The earliest freeze on record hit most of north-central and northeast Kansas causing widespread and heavy damage to immature crops. Damage likely exceeded $25 million.

Extent

The magnitude of extreme temperatures in the Planning area is limited. Injuries and illnesses do not normally result in permanent disability and complete shutdown of critical facilities for more than one week. Property is not expected to be affected.

According the National Climatic Data Center, out of the past 12 years (2000 – 2012), Region L experienced the following extreme temperatures:

Johnson County: 3 events of excessive heat were reported; one in 2007 and two in 2012. 2 events of extreme cold were reported, both of them in 2000.

Leavenworth County: 3 events of excessive heat were reported; one in 2007 and two in 2012. 2 events of extreme cold were reported; both in the year 2000.

Wyandotte County: 3 events of excessive heat were reported; one in 2007, and two in 2012. 2 events of extreme cold were reported, both in 2000.

Probability of Future Occurrences

This hazards CPRI probability is '**Likely**' within a 3 year time period, and could very well get worse. The EPA has projected that with climate changes in the plain states, temperatures will continue to increase and affect all of Kansas to include Region L. A repercussion of this is that people will tend to stay in air conditioned environments to stay cool, or heated environments to stay warm, thus outdoor recreational activities will decline. Another concern is as people move to urban areas, older residents in rural areas may be particularly susceptible to the extreme temperatures as they are isolated from younger family members to assist them in times of need. Region L is particularly vulnerable due to the heat indices that it experiences during the warmer weather.

Impact and Vulnerability

Specific groups of the population such as people aged 65 and older, infants and children, people with chronic medical conditions, low income, outdoor workers and athletes are more at risk because of the heightened vulnerability of this segment of the population. Two specific segments have been looked at closely which are the people aged 65 and older and children under the age of 5 that may be more at risk. The greatest population of under age 5 resides in the counties of Johnson, Sedgwick and Wyandotte in Kansas. According to the Kansas Department of Health and Environment, from 2000 to 2011, Region L experience 21 fatalities with extreme heat as the underlying cause of death. Seventeen of those decedents were male. The youngest was 11 months old, and the oldest was 95 years old. The average age of the decedents were 50.8 years old. The year with the highest number of deaths was 2011 which had 5.

From 2000 – 2011, in Wyandotte, Johnson, and Leavenworth counties, there were 12 deaths with exposure to natural cold as the underlying cause. Eight of those decedents were female. The youngest was 23 years old and the oldest was 90 years old. The average age of the decedents was 66.17 years old. The year with the highest number of deaths was 2010 with four.

Extreme cold often accompanies a winter storm or is left in its wake. Prolonged exposure to the cold can cause frostbite or hypothermia and become life-threatening. Infants and elderly people are most susceptible. Freezing temperatures can cause severe damage to crops and other critical vegetation. Pipes may freeze and burst in homes or businesses that are poorly insulated or without heat. Structure fires occur more frequently in the winter due to lack of proper safety precautions and present a greater danger because water supplies may freeze, and impede firefighting efforts. People die of hypothermia from prolonged exposure to the cold. Indigent and elderly people are most vulnerable to winter storms and account for the largest percentage of hypothermia victims largely due to improperly or unheated homes. The leading cause of death during winter storms is from automobile or other transportation accidents.

According to the USDA Risk Management Agency's insured crop losses as a result of heat and hot wind conditions and freeze and frost conditions during the ten-year period of 2002 – 2011, Region L has experienced an average loss of $207,324.70 in crop losses. **Table 3.56** shows the total insured crop insurance paid per county from 2002-2011 for Region L.

Table 3.56. Total Insured Crop Insurance Paid from 2002 – 2011 for Region L

County	Total Insured Crop Insurance Paid for Extreme Temperature Damages	Annualized Insured Crop Insurance Paid For Extreme Temperature Damages
Mitigation Planning Region I		
Johnson	$1,410,575	$141,058
Leavenworth	$474,195	$47,420
Wyandotte	$0	$0
Subtotal	**$1,884,770**	**$188,477**

Source: USDA Risk Management Agency

This hazard can become more serious when combined with a utility/infrastructure failure or winter storm hazard. Sometimes this hazard contributes to the infrastructure failure, such as overloading of the power grid during hot summer months. Severe temperatures could impact the agriculture industry statewide.

Historically the highest temperatures in Region L occur in June, July, August, and September of every summer. Therefore, the majority of direct and indirect exposure to excessive heat that has caused fatalities also occurs during these months.

There is greater elderly population risk in the urban counties of Johnson, Sedgwick and Shawnee, but overall the State of Kansas has a higher than average elderly population. The two ages the most vulnerable to temperature extremes are individuals 65 years and over, and individuals under 5 years of age. The following table reflects the percentages of these two age groups by jurisdiction within the Region. Townships were not included due to the sampling error size which was not deemed a true reflection of the data required. The following table shows the combined vulnerability for the participating jurisdictions within the region according to the Census Bureau:.

Table 3.57.   Region L Vulnerable Population to Extreme Temperatures

Jurisdiction	65 Years and Over (%)	Less than 5 years (%)	Total Vulnerable Population (%)
Johnson County			
Desoto	9	6.6	15.6
Edgerton	5.2	7.6	12.8
Fairway	16.7	7.3	24.0
Gardner	5.3	11.5	16.8
Lake Quivira	24.7	2.2	26.9
Leawood	15.3	5.5	20.8
Lenexa	10.3	7.1	17.4
Merriam	13.9	6.4	20.3
Mission	13.4	5.6	19.0
Mission Hills	16.5	3.1	19.6
Mission Woods	24.2	9.6	33.8
Olathe	7.2	8.9	16.1
Overland Park	12.3	6.4	18.7
Prairie Village	17.9	6.2	24.1

Roeland	11.1	7.0	18.1
Leavenworth County			
Leavenworth, City of	10	8.1	18.1
Lansing	8.3	5.4	13.7
Tonganoxie	11.8	8.8	20.6
Basehor	11.7	6.2	17.9
Linwood	12.3	7.2	19.5
Easton	22.3	6.4	28.7
Wyandotte County			
Bonner Springs	11.8	7.0	18.8
Edwardsville	13.9	8.0	21.9
Lake Quivira (pt)	0	0	0
Kansas City, Ks	10.5	8.8	19.3

Source: U.S. Census Bureau

As a comparison, the Census Bureau reflects the State of Kansas as follows:
Under 5 years: 7.1% 65 years and older: 13.1%

Summary

Region L is vulnerable to extreme temperatures of hot and cold, specifically the population over the age of 65 and under 5 years of age. Johnson, Wyandotte, and Leavenworth Counties counter attack these temperature extremes by providing warming and cooling shelters for individuals in need. Crop damage is susceptible to extreme temperatures which cause a loss of revenue that reverberates throughout the economy. In a ten year period from 2002 – 2011, the total crop insurance paid was $1,884,770.

Local Mitigation Concerns

- Extreme temperatures affect the population of the whole Region, with the under 5 and over 65 age groups being the most susceptible. However, all ages can succumb to extreme temperatures. Protecting the vulnerable populations is a priority with various programs in place to ensure they are not overlooked or forgotten. Leavenworth County opens warming and cooling centers at the Community Center and relies on the Red Cross to assist in locating other centers when the need arises.

- Another mitigation concern with extreme heat is wildfires. When the region has periods of drought, coupled with extreme heat, the incidence of wildfires can increase as the fauna, grass, and crops dry out they become a tinder box that is more susceptible to igniting

Development in Hazard Prone Areas

Extreme heat and cold affect people and livestock more than property. This hazard is not expected to cause concern in developing trends within the Region.

Johnson County

Table 3.58. Johnson County CPRI: Extreme Temperatures

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Extreme Temperatures	3	2	1	4	2.50	Moderate

Leavenworth County

Table 3.59. Leavenworth County CPRI: Extreme Temperatures

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Extreme Temperatures	3	2	1	3	2.40	Moderate

Wyandotte County

Table 3.60. Wyandotte County CPRI: Extreme Temperatures

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Extreme Temperatures	3	2	1	3	2.40	Moderate

Consequence (Impact) Analysis

Extremes of heat and cold environmental conditions can be detrimental to the health and comfort as human bodies attempt to maintain a core temperature of about 98.6 degrees F.

Extreme heat is the number one weather-related killer in the U.S. resulting in hundreds of fatalities each year. In fact, on average, extreme heat claims more lives each year than floods, lightning, tornadoes and hurricanes combined.

The hazard of extreme heat is when the body heats too quickly to cool itself safely, or when too much fluid or salt is lost through dehydration or sweating, body temperature rises and heat-related illness may develop.

The severity of heat disorders tends to increase with age. Conditions that cause heat cramps in a 17-year-old may result in heat exhaustion in someone 40 years old and in heat stroke in a person over 60.

Table 3.61 provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards for EMAP purposes.

Table 3.61. Consequence Analysis: Extreme Temperatures

Subject	Ranking	Impacts/Extreme Temperatures
Health and Safety of Persons in the Area of the Incident	Minimal - Severe	Depending on the duration of the event, Impact in the incidence area is expected to be severe for unprepared and unprotected persons. Impact will be minimal to moderate for prepared and protected persons.
Responders	Minimal to Severe	Impact could be severe if proper precautions are not taken, i.e. hydration in heat, clothing in extreme cold. With proper preparedness and protection the impact would be minimal.
Continuity of Operations	Minimal	Minimal expectation for utilization of the COOP.
Property, Facilities, and Infrastructure	Minimal to Sever	Impact to infrastructure could be minimal to severe depending on the temperature extremes.
Delivery of Services	Minimal	Impact on the delivery of services should be non-existent to minimal.
Environment	Severe	The impact to the environment could be severe. Extreme heat and extreme cold have the potential to seriously damage wildlife and plants, trees, crops, etc.
Economic Conditions	Minimal to Severe	Impacts to the economy will be dependent on how extreme the temperatures get, but only in the sense of whether people will venture out to spend money. Utility bills could shoot up causing more financial hardship and could put a strain on infrastructure and crops (minimal to severe).
Public Confidence in Jurisdiction’s Governance	Minimal to Moderate	Confidence will be dependent on how well utilities hold up as they are stretched to provide heat and cool air, depending on the extreme. Planning and response could be challenged (minimal to moderate).

3.2.9 Flood

Calculated Priority Risk Index	Planning Significance
3.55	High

Description

The two types of flooding that affect Region L are flash flooding and riverine flooding, which will be the focus of this section.

Flash Flooding

A flash flood is an event that occurs with little or no warning where water levels rise at an extremely fast rate. Flash flooding results from intense rainfall over a brief period, and can be associated with rapid snowmelt, ice jam release, frozen ground, saturated soil or impermeable surfaces

Flash Flood is caused by excess water usually from a storm. Flash floods occur whenever water enters into an area faster than it can be absorbed or drained. With no place to go, the water will find the lowest elevations–areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disperse the water flow.

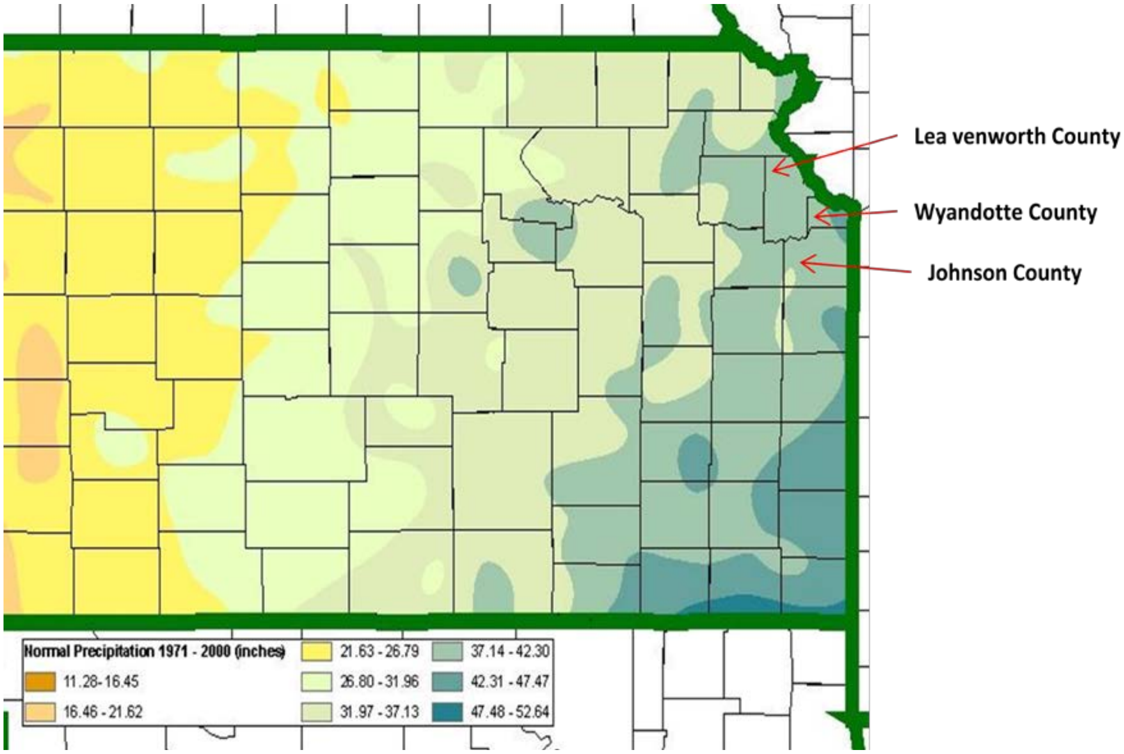
Flash flooding is an extremely dangerous form of flooding which can reach full peak in only a few minutes and allows little or no time for protective measures to be taken by those in its path. Flash flood waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding often results in higher loss of life, both human and animal, than slower developing river and stream flooding.

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

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

Flash flooding occurs in those locations of the planning area that are low-lying and/or do not have adequate drainage to carry away the amount of water that falls during intense rainfall events. Precipitation in the planning area, between 1971 and 2000, averaged 37.14 inches to 42.30 inches. The very tip of the Northeastern portion of Johnson County, and the eastern 1/3 of Wyandotte County averaged 42 – 47 inches. **Figure 3.21** shows the planning area as having greater precipitation amounts then the majority of the state.

Figure 3.21 Annual Precipitation Norms, 1971 – 2000.



Riverine Flooding

Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms "special flood hazard area" and "100-year flood" refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

Location

All of Region L is susceptible to flash flooding and riverine flooding. The surface waters of the planning area flow through 2 water basins: The Kansas Lower Republican and the Marais des Cygnes as shown in Figure **3.22 shows the Marais des Cygnes and Figure 3.23 shows the Kansas Lower Republican.**

Figure 3.22. Marais des Cygnes Basin

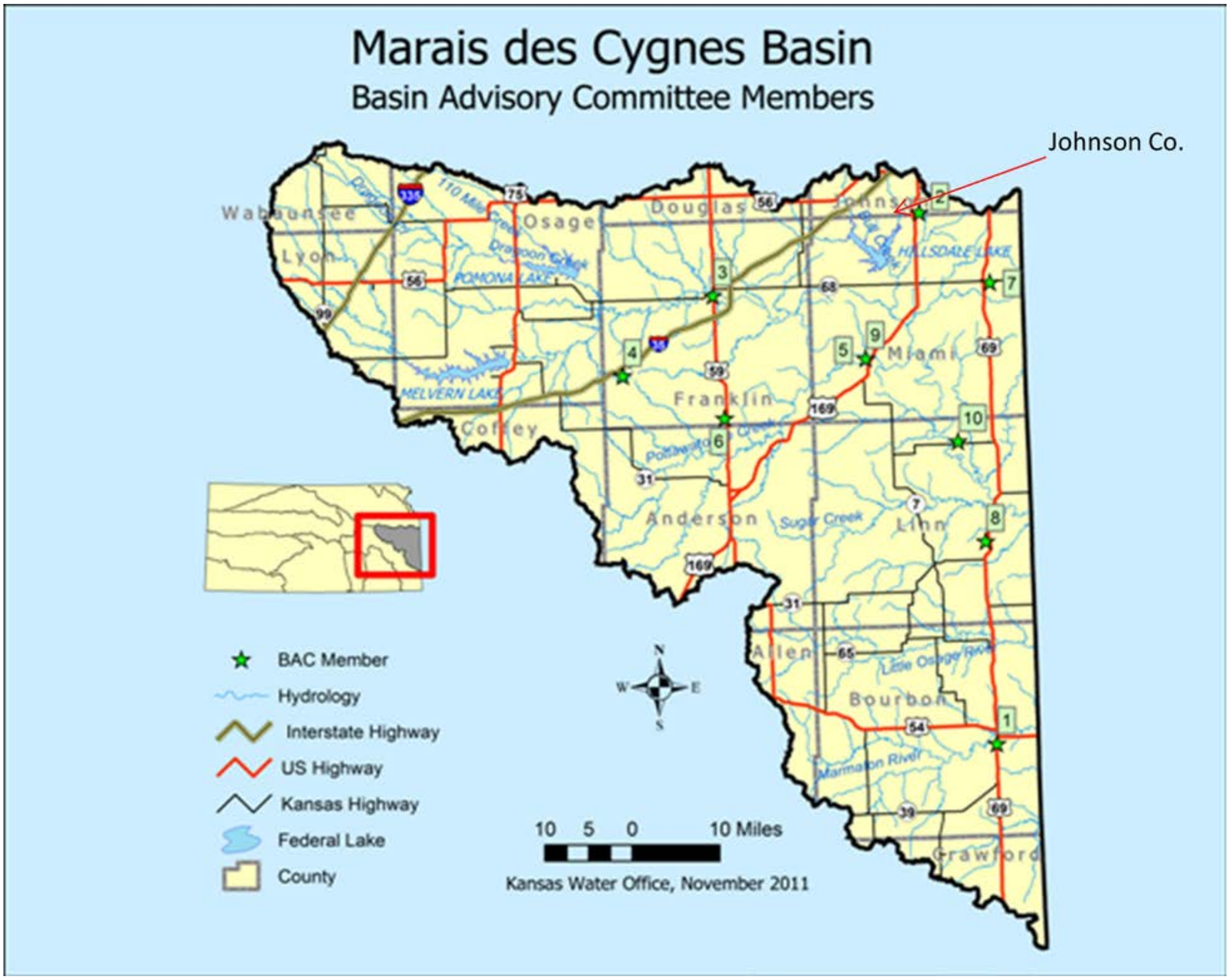
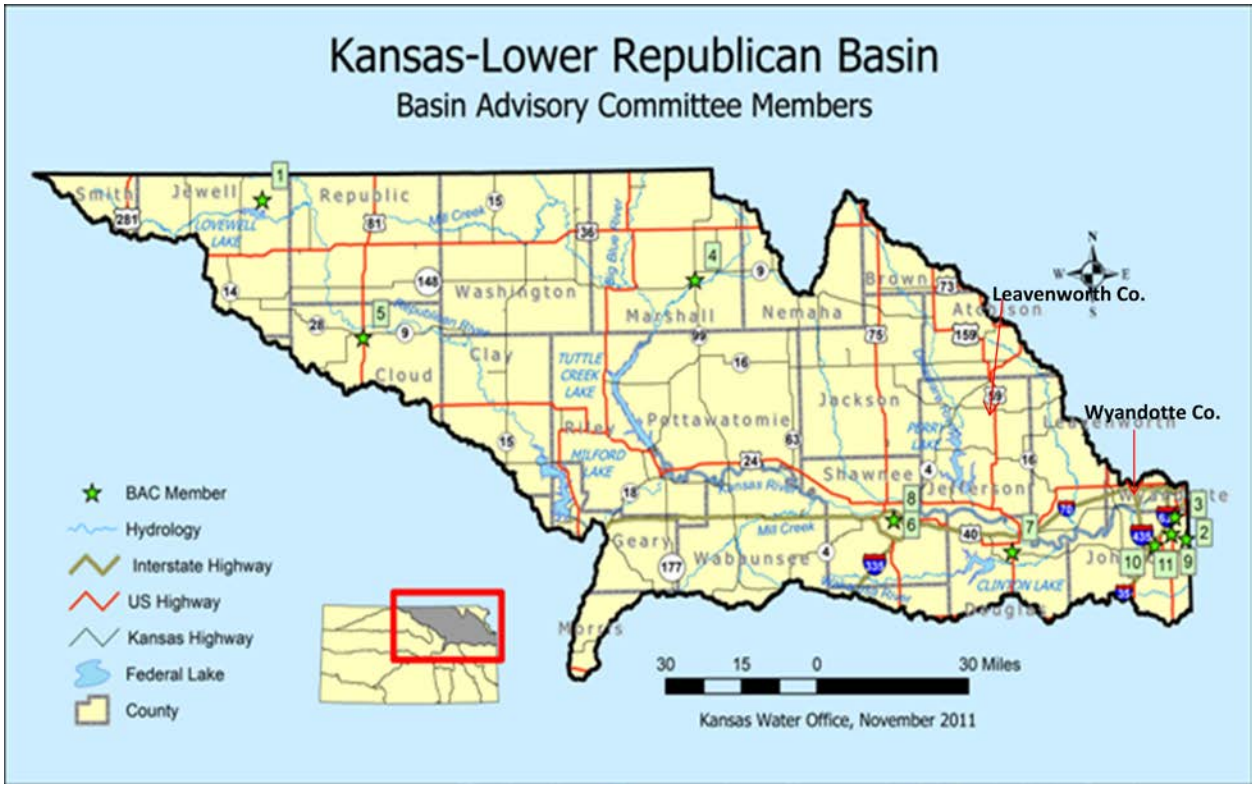


Figure 3.23. Kansas-Lower Republican Basin



Previous Occurrences

Major floods impacted Kansas in 1844, 1903, 1935, 1951, 1965, 1973, 1976, 1981, 1986, 1993, 1998, 2001, 2007, 2009, and most recently in 2011. Region L has been included in 16 of the past 34 Presidential Disaster Declarations that included flooding. Table 3.62 lists Disaster Declarations for flooding which included the counties that make up Region L. Summary tables of flood events in each county and excerpts of narratives describing some of those events follow.

Table 3.62. Disaster Declarations for Flooding that Have Included Region L

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
Presidential Declarations				
4035	09/23/2011 (6/1-8/1/2011)	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	$7,462,881
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	$117,565,269
1615	11/21/2005 (10/1-2/2005)	Severe Storms and Flooding	Atchison, Jackson, Jefferson, Leavenworth, Shawnee	$10,286,064
1579	2/8/2005 (1/4-6/2005)	Severe Winter Storm, Heavy Rains, and Flooding	Anderson, Atchison, Barber, Brown, Butler, Chase, Chautauqua, Clark, Coffey, Comanche, Cowley, Crawford, Douglas, Elk, Franklin, Greenwood, Harper, Harvey, Jackson, Jefferson, Kingman, Kiowa, Leavenworth, Lyon, Marion, McPherson, Morris, Osage, Pratt, Reno, Rice, Sedgwick, Shawnee, Sumner, Wabaunsee, Woodson, Wyandotte	$106,873,672
1562	09/30/2004 (8/27-30/2004)	Severe Storms, Flooding, and Tornadoes	Douglas, Wyandotte	$2,103,376
1535	8/3/2004 (6/12-7/25/2004)	Severe Storms, Flooding, and Tornadoes	Barton, Butler, Cherokee, Decatur, Ellis, Geary, Graham, Jewell, Labette, Lyon, Marion, Mitchell, Morris, Ness, Osborne, Pawnee, Phillips, Rooks, Rush, Russell, Shawnee, Sheridan, Smith, Thomas, Trego, Wabaunsee, Wallace, Woodson, Wyandotte	$12,845,892
1462	5/6/2003 (5/4-30/2003)	Severe Storms, Tornadoes, and Flooding	Allen, Anderson, Cherokee, Crawford, Douglas, Haskell, Labette, Leavenworth, Meade, Miami, Neosho, Osage, Seward, Woodson, Wyandotte	$988,056
1258	11/5/1998 (10/30-11/15/1998)	Severe Storms and Flooding	Butler, Chase, Coffey, Cowley, Douglas, Franklin, Greenwood, Harper, Harvey, Johnson, Leavenworth, Lyon, Marion, Neosho, Saline, Sedgwick, Sumner, Wilson, Woodson, Wyandotte	
1254	10/14/1998 (10/1-10/8/1998)	Severe Storms, Flooding, and Tornadoes	Bourbon, Cherokee, Douglas, Franklin, Jackson, Jefferson, Johnson, Leavenworth, Linn, Seward, Wabaunsee, Wyandotte	
1000	7/22/1993 (6/28-10/5/1993)	Flooding, Severe Storms	Atchison, Barton, Brown, Chase, Cherokee, Clay, Cloud, Crawford, Dickinson, Doniphan, Douglas, Edwards, Ellis, Ellsworth, Geary, Graham, Harvey, Hodgeman, Jackson, Jefferson, Jewell, Johnson, Lane, Leavenworth, Lincoln, Lyon, Marion, Marshall, McPherson, Mitchell, Morris, Nemaha, Ness, Osage, Osborne, Ottawa, Pawnee, Pottawatomie, Reno, Republic, Rice, Riley, Rooks, Rush, Russell, Saline, Sedgwick, Shawnee, Sheridan, Smith, Stafford,	$99,790,368

			Sumner, Thomas, Trego, Wabaunsee, Washington, Wyandotte	
663	6/28/1982	Severe Storms, Flooding	Jackson, Shawnee	$804,048
539	9/20/1977	Severe Storms, Flooding	Atchison, Brown, Doniphan, Jackson, Jefferson, Johnson, Leavenworth, Nemaha, Shawnee, Wyandotte	$4,041,566
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	$4,296,913
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	$1,954,624
267	7/15/1969	Tornadoes, Severe Storms, Flooding	Allen, Anderson, Bourbon, Crawford, Dickinson, Douglas, Ellsworth, Franklin, Johnson, Leavenworth, Linn, Lyon, McPherson, Miami, Morris, Neosho, Osage, Saline, Woodson, Wyandotte	$733,524
229	7/18/1967	Tornadoes, Severe Storms, Flooding	Anderson, Atchison, Chase, Cloud, Coffey, Crawford, Doniphan, Douglas, Finney, Franklin, Harper, Jackson, Jefferson, Kingman, Leavenworth, Linn, Lyon, Marion, Miami, Mitchell, Nemaha, Ness, Osage, Pottawatomie, Republic, Washington, Wabaunsee	$847,439
Emergency Declarations				
3324	6/25/2011	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	n/a

Table 3.63. NCDC Flood Events for Johnson County, KS for the period from 1/1/2000 to 12/31/2012

Location	Date	Event	Deaths	Injuries	Property Damages	Crop Damages
Johnson Co	03/04/2004	Flood	0	0	0.00K	0.00K
Johnson Co	05/19/2004	Flood	0	0	0.00K	0.00K
Johnson Co	07/24/2004	Flood	0	0	0.00K	0.00K
Johnson Co	08/27/2004	Flood	0	0	0.00K	0.00K
Johnson Co	06/04/2005	Flood	0	0	0.00K	0.00K
Merriam	06/03/2008	Flood	0	0	0.00K	0.00K

Merriam	06/03/2008	Flood	0	0	0.00K	0.00K
Merriam	06/03/2008	Flood	0	0	0.00K	0.00K
	Totals:	**8**	**0**	**0**	**0.00K**	**0.00K**

Source: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Table 3.64. NCDC Flash Flood Events for Johnson County, KS for the period from 1/1/2000 to 12/31/2012

Location	Date	Event	Deaths	Injuries	Property Damages	Crop Damages
OVERLAND PARK	06/20/2000	Flash Flood	0	0	0.00K	0.00K
OLATHE	06/01/2001	Flash Flood	0	0	5.00K	0.00K
LEAWOOD	06/01/2001	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	06/05/2001	Flash Flood	0	0	0.00K	0.00K
STILWELL	05/11/2002	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	06/22/2003	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	08/31/2003	Flash Flood	1	0	0.00K	0.00K
OVERLAND PARK	03/04/2004	Flash Flood	0	0	0.00K	0.00K
OLATHE	05/19/2004	Flash Flood	0	0	0.00K	0.00K
DE SOTO	07/06/2004	Flash Flood	0	0	0.00K	0.00K
GARDNER	07/16/2004	Flash Flood	0	0	0.00K	0.00K
STANLEY	08/23/2004	Flash Flood	0	0	0.00K	0.00K
STANLEY	08/24/2004	Flash Flood	0	0	0.00K	0.00K
MISSION	08/27/2004	Flash Flood	0	0	500.00K	0.00K
MISSION	08/27/2004	Flash Flood	0	0	0.00K	0.00K
SHAWNEE	08/28/2004	Flash Flood	0	0	0.00K	0.00K
GARDNER	06/04/2005	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	08/13/2005	Flash Flood	0	0	0.00K	0.00K
GARDNER	08/19/2005	Flash Flood	0	0	0.00K	0.00K
LENEXA	08/19/2005	Flash Flood	0	0	0.00K	0.00K
MISSION	08/20/2005	Flash Flood	0	0	0.00K	0.00K
GARDNER	07/11/2006	Flash Flood	0	0	0.00K	0.00K
GARDNER	07/11/2006	Flash Flood	0	0	0.00K	0.00K
SPRING HILL	07/11/2006	Flash Flood	0	0	0.00K	0.00K
GARDNER	08/27/2006	Flash Flood	0	0	0.00K	0.00K
SPRING HILL	08/27/2006	Flash Flood	0	0	0.00K	0.00K
PRAIRIE VLG	08/27/2006	Flash Flood	0	0	0.00K	0.00K
LENEXA	02/28/2007	Flash Flood	0	0	0.00K	0.00K
MISSION	02/28/2007	Flash Flood	0	0	0.00K	0.00K
MISSION	03/01/2007	Flash Flood	0	0	0.00K	0.00K
LENEXA	03/01/2007	Flash Flood	0	0	0.00K	0.00K
MISSION HILLS	04/25/2007	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	05/06/2007	Flash Flood	0	0	0.00K	0.00K
STANLEY	06/29/2007	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	06/29/2007	Flash Flood	0	0	0.00K	0.00K
GARDNER	06/30/2007	Flash Flood	0	0	0.00K	0.00K
LENEXA	07/09/2007	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	07/09/2007	Flash Flood	0	0	0.00K	0.00K
OVERLAND PARK	07/09/2007	Flash Flood	0	0	0.00K	0.00K
EDGERTON	06/02/2008	Flash Flood	0	0	0.00K	0.00K

WESTWOOD	06/03/2008	Flash Flood	0	0	0.00K	0.00K
OLATHE	06/03/2008	Flash Flood	0	0	0.00K	0.00K
LEAWOOD	07/30/2008	Flash Flood	0	0	0.00K	0.00K
FAIRWAY	06/24/2009	Flash Flood	0	0	0.00K	0.00K
WESTWOOD	08/17/2009	Flash Flood	0	0	0.00K	0.00K
LENEXA	06/08/2010	Flash Flood	0	0	0.00K	0.00K
STANLEY	06/08/2010	Flash Flood	0	0	0.00K	0.00K
LEAWOOD	06/08/2010	Flash Flood	0	0	0.00K	0.00K
LEAWOOD	06/12/2010	Flash Flood	0	0	0.00K	0.00K
MORSE	06/14/2010	Flash Flood	0	0	0.00K	0.00K
STILWELL HILLSIDE AR	06/16/2010	Flash Flood	0	0	0.00K	0.00K
STILWELL MISSION ARP	07/20/2010	Flash Flood	0	0	0.00K	0.00K
GARDNER ARPT	07/20/2010	Flash Flood	0	0	0.00K	0.00K
OLATHE	05/06/2012	Flash Flood	0	0	0.00K	0.00K
	Totals:	**54**	**1**	**0**	**505.00K**	**0.00K**

Source: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Table 3.65. NCDC Flood Events for Leavenworth County, KS for the period from 1/1/2000 to 12/31/2012

Location	Date	Event	Deaths	Injuries	Property Damages	Crop Damages
LEAVENWORTH Co.	6/24/2000	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	3/15/2001	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	5/06/2001	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	6/19/2001	Flood	0	0	2.010M	0.00K
LEAVENWORTH Co.	7/12/2001	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	7/19/2001	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	7/19/2001	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	9/17/2001	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	5/11/2002	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	5/19/2004	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	2/13/2005	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	5/13/2005	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	6/04/2005	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	6/06/2005	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	6/11/2005	Flood	0	0	0.00K	0.00K
LEAVENWORTH Co.	10/02/2005	Flood	0	0	2.800M	300.00K
EASTON	4/30/2006	Flood	0	0	0.00K	0.00K
LOWEMONT	5/07/2007	Flood	0	0	750.00K	100.00K
TONGANOXIE	5/07/2007	Flood	0	0	0.00K	0.00K

EASTON	10/18/2007	Flood	0	0	0.00K	0.00K
EASTON	12/11/2007	Flood	0	0	0.00K	0.00K
EASTON	3/03/2008	Flood	0	0	0.00K	0.00K
LENAPE	6/13/2010	Flood	0	0	0.00K	0.00K
Totals:	23		0	0	5.560M	400.00K

Source: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Table 3.66. NCDC Flash Flood Events for Leavenworth County, KS for the period from 1/1/2000 to 12/31/2012

Location	Date	Event	Deaths	Injuries	Property Damages	Crop Damages
Tonganoxie	06/01/2001	Flash Flood	0	0	0.00K	0.00K
Leavenworth	6/1/2001	Flash Flood	0	0	0.00K	0.00K
Leavenworth	6/1/2001	Flash Flood	0	0	0.00K	0.00K
Easton	6/19/2001	Flash Flood	0	0	0.00K	0.00K
Easton	6/20/2001	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	6/12/2003	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	6/12/2003	Flash Flood	0	0	0.00K	0.00K
Leavenworth	3/04/2004	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	7/06/2004	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	08/27/2004	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	08/27/2004	Flash Flood	0	0	0.00K	0.00K
Leavenworth	4/11/2005	Flash Flood	0	0	0.00K	0.00K
Leavenworth	5/11/2005	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	6/04/2005	Flash Flood	0	0	0.00K	0.00K
Leavenworth	6/04/2005	Flash Flood	0	0	0.00K	0.00K
Leavenworth	6/08/2005	Flash Flood	0	0	0.00K	0.00K
Jarbalo	06/12/2005	Flash Flood	0	0	0.00K	0.00K
Basehor	6/30/2005	Flash Flood	0	0	0.00K	0.00K
Lansing	6/30/2005	Flash Flood	0	0	0.00K	0.00K
Basehor	8/19/2005	Flash Flood	0	0	0.00K	0.00K
Easton	10/02/2005	Flash Flood	0	0	1.200M	0.00K
Leavenworth	10/02/2005	Flash Flood	0	0	1.000M	0.00K
Lenape	6/07/2007	Flash Flood	0	0	2.00K	0.00K
Tonganoxie	6/02/2008	Flash Flood	0	0	0.00K	0.00K
Linwood	6/03/2008	Flash Flood	0	0	0.00K	0.00K

Loring	6/05/2008	Flash Flood	0	0	0.00K	0.00K
Leavenworth	7/02/2008	Flash Flood	0	0	0.00K	0.00K
Leavenworth	7/02/2008	Flash Flood	0	0	0.00K	0.00K
Lansing	7/02/2008	Flash Flood	0	0	0.00K	0.00K
Lansing	9/12/2008	Flash Flood	0	0	0.00K	0.00K
Easton	9/13/2008	Flash Flood	0	0	0.00K	0.00K
Tonganoxie	4/25/2009	Flash Flood	0	0	0.00K	0.00K
Lansing	4/26/2009	Flash Flood	0	0	0.00K	0.00K
Reno	4/26/2009	Flash Flood	0	0	0.00K	0.00K
Reno	5/15/2009	Flash Flood	0	0	0.00K	0.00K
Leavenworth	8/17/2009	Flash Flood	0	0	0.00K	0.00K
Lansing	8/17/2009	Flash Flood	0	0	0.00K	0.00K
Leavenworth	8/17/2009	Flash Flood	0	0	0.00K	0.00K
Fairmount	7/11/2010	Flash Flood	0	0	0.50K	0.00K
Leavenworth	6.16.2919	Flash Flood	0	0	0.00K	0.00K
Lansing	7/16/2010	Flash Flood	0	0	0.00K	0.00K
Leavenworth	7.20/2010	Flash Flood	0	0	0.00K	0.00K
Leavenworth	7/20/2010	Flash Flood	0	0	0.00K	0.00K
Totals:	43		0	0	2.202M	0.00K

Source: NCDC. http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Table 3.67. NCDC Flood Events for Wyandotte County, KS for the period from 1/1/2000 to 12/31/2012

Location	Date	Event	Deaths	Injuries	Property Damages	Crop Damages
Wyandotte Co.	5/03/2001	Flood	0	0	0.00K	0.00K
Wyandotte Co.	6/20/2001	Flood	0	0	0.00K	0.00K
Wyandotte Co.	5/19/2004	Flood	0	0	0.00K	0.00K
Wyandotte Co.	8/27/2004	Flood	0	0	0.00K	0.00K
Kansas City	5/07/2007	Flood	0	0	0.00K	0.00K
Kansas Ctiy	5/08/2007	Flood	0	0	0.00K	0.00K
	Totals:	**6**	**0**	**0**	**0.00K**	**0.00K**

Source: NCDC. http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Table 3.68. NCDC Flash Flood Events for Wyandotte County, KS for the period from 1/1/2000 to 12/31/2012

Location	Date	Event	Deaths	Injuries	Property Damages	Crop Damages
Kansas City	4/03/2001	Flash Flood	0	0	0.00K	0.00K
Kansas City	4/14/2001	Flash Flood	0	0	0.00K	0.00K
Kansas City	6/05/2001	Flash Flood	0	0	0.00K	0.00K
Kansas City	5/19/2004	Flash Flood	0	0	0.00K	0.00K
Kansas City	5/19/2004	Flash Flood	0	0	0.00K	0.00K
Kansas City	7/06/2004	Flash Flood	0	0	0.00K	0.00K
Bonner Spgs	8/27/2004	Flash Flood	0	0	1.000M	0.00K
Kansas City	8/27/2004	Flash Flood	0	0	500.00K	0.00K
Kansas City	8/27/2004	Flash Flood	0	0	0.00K	0.00K
Kansas City	8/28/2004	Flash Flood	0	0	0.00K	0.00K
Kansas City	5/12/2005	Flash Flood	0	0	0.00K	0.00K
Kansas City	8/27/2006	Flash Flood	0	0	0.00K	0.00K
Kansas City	5/06/2007	Flash Flood	0	0	0.00K	0.00K
Bonner Spgs	6/07/2007	Flash Flood	0	0	0.00K	0.00K
Sunflower	10/17/2007	Flash Flood	0	0	0.00K	0.00K
Kansas City	7/02/2008	Flash Flood	0	0	0.00K	0.00K
Kansas City	7/02/2008	Flash Flood	0	0	30.00K	0.00K
Turner	7/27/2009	Flash Flood	0	0	00.0K	00.0K
Pomeroy	7/27/2009	Flash Flood	0	0	5.00K	0.00K
Muncie	8/17/2009	Flash Flood	0	0	0.00K	0.00K
Turner	7/11/2010	Flash Flood	0	0	0.00K	0.00K
	Totals:	**21**	**0**	**0**	**1.530M**	**0.00K**

Source: NCDC. http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Selected Event Narratives

FEMA-4035-DR: Flooding—September 23, 2011

Four counties in Northeast Kansas were declared for flooding that occurred from June 1 to August 1, 2011 along the Missouri River. These Counties included Atchison, Doniphan, Leavenworth, and Wyandotte. Damages as a result of this event were estimated to be nearly $1,211,416.62 and primarily involved damages to roads and bridges.

Record snowfall in the Rocky Mountains of Montana and Wyoming along with near record spring rainfall in central and eastern Montana triggered severe flooding within the Upper Missouri River Basin. According to the National Weather Service, in the second half of the month of May 2011, almost a year's worth of rain fell over the upper Missouri River Basin. This extremely heavy rainfall, in conjunction with an estimated 212 percent of normal snowpack in the Rocky Mountains, contributed to this flooding event.

All six major dams along the Missouri River released record amounts of water to prevent overflow and devastating consequences to towns and cities along the river from Montana to Missouri.

The Corps of Engineers reported that every non-federal levee from Rulo to Wolcott, Kansas in Wyandotte County on both sides of the river were either overtopped or breached. Included in the over toppings was Kansas Department of Corrections land below the Lansing Correctional Facility in Leavenworth County. The federal levee at Fort Leavenworth by Sherman Army Airfield was also breached. Water reached the previously evacuated hangars.

Figure 3.24. Missouri River Flooding 2011 – Leavenworth County

Figure 3.25. Missouri River Flooding 2011 showing Gauge at 29 ft.

Other Notable Flood Events

- **June 2001:** Storms dumped 5½ inches of rain on Easton in Leavenworth County. Stranger Creek overflowed and tore through houses, mobile homes, and fields and closed the Kansas Turnpike. Officials estimated 75 to 100 households in the town of about 360 residents were flooded. Twenty-six homes were destroyed, 21 received major damage, and 25 others had minor damage.

- **March 2004**: Heavy rains caused flooding on area streams and creeks. Indian Creek at Overland Park crested at 12.69 feet or 0.69 feet above flood stage. The Blue River at Stanley crested at 19.44 feet. 3.44 feet above flood stage.

- **May 2004**: Stranger Creek at Easton crested at 18.45 feet, or 1.45 feet above flood stage. The Blue River near Stanley crested at 20.12 feet, or 4.12 feet above flood stage.

- **May 2007**: A slow moving cold front combined with an upper level storm system, produced widespread flash flooding and large hail across the area from late on May 5th through May 6th 2007. The Kansas River at the 23rd Street Bridge crested at 40.96 feet, or 7.96 feet above flood stage in Wyandotte County.

- **June 2008:** Severe thunderstorms erupted across the area on June 3, 2008. There were reports of large hail and very heavy rains with flash flooding. An underpass was reported full of standing water, and several roads were washed out 3 miles west of Linwood. The planning area reported flooding in various jurisdictions.

- **June 2010:** A frontal boundary continued to meander around the region. Thunderstorms with very heavy rains, caused several reports of flash flooding across the area, in the late evening and early morning hours of, June 13th and 14th, 2010. Up to four inches of water was reported over 174th Street and Hemphill Road and up to two feet of water was reported on area roads in Johnson County.

Extent

The reported flooding events according to the NCDC database for the three counties that make up Region L are as follows:

- Within the last twelve years, Johnson County has experienced 8 floods and 54 flash floods. During the flood events, various rivers and creeks within Johnson County have crested at 0.22 to 4.12 feet above their respective flood stages. The following are the documented events for these crest:
    - **05/19/2004** Stranger Creek at Easton crested at 18.45 feet, or 1.45 feet above flood stage. The Blue River near Stanley crested at 20.12 feet, or 4.12 feet above flood stage.
    - **07/24/2004** Indian Creek in Overland Park crested at 12.22 feet, or 0.22 feet above flood stage.
- Between 2000 and 2012, Leavenworth County experienced 23 floods and 43 flash floods. The rivers and creeks within Leavenworth County crested during these flood events at .25 feet to 10.80 feet above the flood stage. Following are the events that detail these flood stages.
    - **02/14/2005** - The Stranger Creek near Easton crested at 17.25 feet, or 0.25 feet above flood stage.
    - **05/9/2007** - The Stranger Creek at Easton had its highest crest ever on May 7,2007. It crested at 27.80 feet, or 10.80 feet above flood stage. Several homes and businesses suffered damage.
- Wyandotte County experienced 6 floods and 21 flash flood events between the years 2000 and 2012. During the flood events, various rivers and creeks crested at .19 feet to 7.96 feet above flood stage. Following are the documented events for these crest:
    - **05/19/2004** - Turkey Creek at Southwest Blvd in Kansas City, Kansas crested at 61.19 feet, or 0.19 of a foot above flood stage.
    - **05/07/2007** to 05/11/2007 - A slow moving cold front combined with an upper level storm system, produced widespread flash flooding and large hail across the area from late on May 5th through May 6th 2007. The Kansas River at the 23rd Street Bridge crested at 40.96 feet, or 7.96 feet above flood stage.

Probability of Future Hazard Events

The planning area has been in 16 declared Presidential Disaster that includes flooding during the years 1969 – 2011. They have had a total of 155 incidences of flooding in the past 12 years, 2000 – 2012. This hazard has been deemed to be **"Highly Likely**" by the planning committee. The following details the probability for each county in Region L:

Table 3.69. Probability for Region L Using Data from 2000 - 2012

County	# of Flood Events	Probability (%) of Flood in a given Year	# of Flash Flood Events	Probability (%) of a Flash Flood in a Given Year
Johnson	8	66.6%	54	100%
Leavenworth	23	100%	43	100%
Wyandotte	6	50%	21	100%

Impact and Vulnerability

The vulnerability to flooding for Region L was determined using several sources:

- NCDC Storm Events Database
- USDA Risk Management Agency Crop Loss Statistics
- HAZUS MH 2.1 100-year Flood Scenario
- NCDC Storm Events Database

The NCDC Storm Events Database was the primary source of data to complete the vulnerability analysis of flash flood in the State; while the HAZUS MH 2.1 analysis was utilized to describe vulnerability to riverine flooding.

Flash flooding is not considered to be a "geographic" hazard. Due to the large number of variables that occur in rainfall amounts and intensity, it is not possible to predict all specific locations that are vulnerable to flash flooding. However, it is known that certain low-lying areas with poor drainage are more vulnerable than areas higher in elevation with good drainage. Additionally, historical statistics of areas that have been prone to flash flooding in the past can be utilized to determine potential vulnerability to future flash flooding.

The NCDC Storm Events Database is currently undergoing a revision. The online availability of historical events is limited to data from 10/1/2000 to 7/31/2012. Over 12 years of data is available in the online version, and flash flooding generally occurs annually in prone areas, the planning committee decided to use this more current data to analyze flash flooding events in Region L. For the period 2000 to 2012 there were 37 riverine flood events and 118 flash flood events. Historic riverine and flash flood events, fatalities, and injuries are included in the table below. Note that actual property damage is not included in this table due to the disparity of the reported figures and the difficulty of substantiating the monetary amounts.

Table 3.70. Summary of Reported Flood Events in the Planning Area, 2000 - 2012

County	# of Flood Events	Deaths	Injuries
Johnson	62	1	0
Leavenworth	66	0	0
Wyandotte	27	0	0
Total	**155**	**1**	**0**

USDA Risk Management Agency Crop Insurance Payments

Table 3.71 provides total crop insurance payments and annualized crop insurance payments for flood damage in Region L over the 10-year period from 2002 to 2011. The USDA does not differentiate damages from riverine flooding and flash flooding. These losses include combined losses for both types of flooding. The crop exposure value from the 2007 Census of Agriculture is provided to provide the basis for an annualized ratio of insurance payments to total value. Please note that this data only applies to insured crops. According to the *2011 Kansas Crop Insurance Profile Report* issued by the USDA Risk Management Agency 82 percent of Kansas' row crops were insured in 2011. The crop exposure values have not been adjusted in the table below:

Table 3.71. Flood-Related Crop Insurance Payments Analysis (2002-2011)

County	Crop Exposure Value (2007 Census of Agriculture)	Flood-Related Crop Insurance payments 2002-2011	Annualized Crop Insurance payments	Annualized Flood-Related Crop Insurance Payment Ratio
Mitigation Planning Region L				
Johnson	$29,472,000	$1,070,834	$107,083	0.36%
Leavenworth	$20,983,000	$3,290,635	$329,064	1.57%
Wyandotte	Not Reported	$0	$0	Not Reported
Total	**$50,455,000**	**$4,361,469**	**$436,147**	

Source: USDA Risk Management Agency; 2007 USDA Census of Agriculture; Note: Crop Exposure for Elk, Wichita & Wyandotte Counties was not published to avoid disclosure of individual operations.

HAZUS MH 2.1 100-year Food Scenario

The results of the HAZUS analysis were utilized to estimate potential losses for riverine flooding. The intent of this analysis was to enable the planning area to estimate where flood losses could occur and the degree of severity using a consistent methodology. The HAZUS model helps quantify risk along known flood-hazard corridors as well as lesser streams and rivers that have a drainage area of 10 square miles or more.

The HAZUS-MH analysis provides the number of buildings impacted, estimates of the building repair costs, as well as the associated loss of building contents and business inventory. This analysis is based on riverine flooding. Building damage can also cause additional losses to a community as a whole by restricting a building's ability to function properly. Income loss data accounts for losses such as 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-MH using a methodology based on the building damage estimates.

Among other factors, flood damage is related to the depth of flooding. HAZUS-MH takes into account flood depth when modeling damage (based on FEMA's depth-damage functions). The HAZUS-MH reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes in HAZUS-MH include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments 1-10 percent, 11-20 percent, etc., up to 50 percent. Buildings that sustain more than 50 percent damage are considered to be "substantially" damaged.

The displaced population is based on the inundation area. Individuals and households will be displaced from their homes even when the home has suffered little or no damage either because they were evacuated or there was no physical access to the property because of flooded roadways. Displaced people using shelters will most likely be individuals with lower incomes and those who do not have family or friends within the immediate area. HAZUS-MH does not model flood casualties.

According to the HAZUS MH2 2.1 one percent annual chance flood scenario results, there are 3,523 buildings in the one percent annual chance floodplain. Additionally, the planning area population vulnerable to displacement from the one percent annual chance flood scenario is 15,972. Table 3.72 provides the HAZUS results for the number of vulnerable buildings and population vulnerable to displacement for Region L.

Table 3.72. Vulnerable Buildings and Population, HAZUS One Percent Annual Chance Flood Scenario

County	Vulnerable Buildings	Population Vulnerable to Displacement
Mitigation Planning Region L		
Johnson	1,896	8,853
Leavenworth	97	1,541
Wyandotte	1,530	5,578
Total	**3,523**	**15,972**

Source: State Hazard Mitigation Plan, 2013

Table 3.73 that follows provides total direct building loss and income loss for each county in the region. Table 3.74 provides the HAZUS results for vulnerable populations and the population estimated to seek short term shelter as well as the numbers of damaged and substantially damaged buildings for each county.

Table 3.73. HAZUS MH 2.1 Flood Scenario Direct Building and Income Losses

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Loss	Structure and Contents Loss Ratio
Mitigation Planning Region L							
Johnson	$382,539,000	$428,080,000	$18,715,000	$829,334,000	$2,824,000	$832,158,000	0.59%
Leavenworth	$19,997,000	$19,661,000	$480,000	$40,138,000	$198,000	$40,336,000	0.25%
Wyandotte	$215,582,000	$366,298,000	$28,175,000	$610,055,000	$2,386,000	$612,441,000	1.79%
Total	**$618,118,000**	**$814,039,000**	**$47,370,000**	**$1,479,527,000**	**$5,408,000**	**$1,484,935,000**	

Source: State Hazard Mitigation Plan, HAZUSMH 2.1

Table 3.74. HAZUS MH 2.1 Flood Scenario Displaced Population and Number of Damaged/Substantially Damaged Buildings

County	Population Vulnerable to Displacement (# of persons)	Short Term Shelter Needs (# of persons)	Vulnerable Buildings	Damaged Buildings	Substantially Damaged Buildings
Mitigation Planning Region L					
Johnson	8,853	7,594	1,896	1,475	696
Leavenworth	1,541	702	97	21	0
Wyandotte	5,578	4,848	1,530	1,273	648
Total	**15,972**	**13,144**	**3,523**		**1,344**

Source: State Hazard Mitigation Plan, HAZUSMH 2.1

NFIP Participation and Repetitive Flood Losses Information on NFIP participation and flood loss claims were obtained from FEMA's Policy and Claim Statistics for Flood Insurance. This source provides losses from 1978 to August 2012. As of October 2012, Region L had a total of 1,571 insurance policies in force.
There are several limitations to this data, including:

- Only losses to participating NFIP communities are represented,
- Communities joined the NFIP at various times since 1978,
- The number of flood insurance policies in effect may not include all structures at risk to flooding, and
- Some of the historical loss areas have been mitigated with property buyouts.
- Some properties are under-insured. The flood insurance purchase requirement is for flood insurance in the amount of federally-backed mortgages, not the entire value of the structure. Additionally, contents coverage is not required.

Table 3.75. NFIP Status for Region L Jurisdictions

Community	CID	Curr Eff Map Date
Johnson County		
Desoto, City of	200161	08/03/09
Edgerton, City of	200162	08/03/09
Fairway, City of	205185	08/03/09
Gardner, City of	200164	08/03/09
Johnson County	200159	08/03/09
Lake Quivira, City of	200166	Suspended
Leawood, City of	200167	08/03/09
Lenexa, City of	200168	08/03/09
Merriam, City of	200169	08/03/09
Mission, City of	200170	08/03/09
Mission Hills, City of	200171	08/03/09
Mission Woods, City of	200172	08/03/09
Olathe, City of	200173	08/03/09
Overland Park, City of	200174	08/03/09
Prairie Village, City of	200175	08/03/09
Roeland Park, City of	200176	08/03/09
Shawnee, City of	200177	08/03/09
Spring Hill, City of	200178	08/03/09
Westwood, City of	200179	NFSHA
Westwood Hills, City of	200180	NFSHA
Leavenworth County		
Basehor, City of	200187	08/18/09
Easton, City of	200188	08/18/09
Lansing, City of	200189	08/18/09
Leavenworth County	200186	08/18/09
Leavenworth, City of	200190	08/18/09

Linwood, City of	200191	08/18/09
Tonganoxie, City of	200192	08/18/09
Wyandotte County		
Bonner Springs, City of	200361	09/02/11
Edwardsville, City of	200362	09/02/11
Kansas City, City of	200363	09/02/11
Wyandotte County	200562	09/02/11

The NFIP Policy and Loss statistics show a pattern of historical flood losses for the counties of Johnson, Leavenworth, and Wyandotte. The greatest losses have been in Wyandotte and Johnson Counties. **Table 3.76** provides summary data on NFIP policies and losses

Table 3.76. Summary of Policies, Insurance, and Closed Losses for Region L

County	Number of Policies in Force	Insurance in Force	Total Payments (1978 – 8/2012)
Johnson	1,005	$250,485,700	$8,651,619
Leavenworth	264	$53,334,200	$2,647,895
Wyandotte	302	$83,151,500	$9,955,138
Subtotal	**1,571**	**$386,971,400**	**$21,254,652**

Source: FEMA, http://bsa.nfipstat.fema.gov/reports/1040.htm#20

Table 3.77 show a breakdown of claims for local jurisdictions.

Table 3.77. Claims for Local Jurisdictions in Region L

Johnson County		
Jurisdiction	Total Losses	Total Payments
Desoto	1	.00
Edgerton	2	3142.55
Fairway	100	1,349,913.69
Johnson County	37	358,147.50
Leawood	80	1,034,552.28
Lenexa	17	53,342.46
Merriam	96	1,675,284.70
Mission Hills	56	1.336.277.00
Mission	69	332,542.10
Olathe	23	71,187.75
Overland Park	288	1,286,883.32
Prairie Village	111	552,074.57
Roeland park	40	145,364.37
Shawnee	61	429,871.38

Westwood Hills	2	5,973.27
Westwood	6	17,061.95
Leavenworth County		
Jurisdiction	Total Losses	Total Payments
Basehor	1	6,925.42
Easton	111	1,491,916.68
Lansing	5	17,523.34
County	29	324,118.50
Leavenworth	59	734,527.01
Linwood	1	.00
Tonganoxie	8	72,883.55
Wyandotte County		
Jurisdiction	Total Losses	Total Payments
Bonner Springs	61	570,858.48
Edwardsville	11	153,716.43
Kansas City	321	9,198,294.47
County	6	32,268.64

Source: FEMA, http://bsa.nfipstat.fema.gov/reports/1040.htm#20

Repetitive Loss Properties

A high priority in the planning area is the reduction in the number of repetitive loss structures. These structures strain the National Flood Insurance Fund on a national basis by increasing the NFIP's annual losses and the need for borrowing. More importantly, they drain resources needed to prepare for catastrophic events. The NFIP defines a repetitive loss property as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. At least two of the claims must be more than 10 days apart."

History of Repetitive Loss

Table 3.78 shows the number and location (by county and community) of repetitive loss and severe repetitive loss properties in the planning area. Johnson County has the most repetitive loss properties in the State of Kansas with 93.

Table 3.78. Kansas Repetitive Loss Properties (In Order by Number of Properties)

Community	# Rep Loss Properties	# Mitigated	Non-Mitigated Properties	Severe Repetitive Loss Residential Properties
Johnson County				
Johnson County Total	**93**	**27**	**66**	
Fairway	12	6	6	1
Johnson Co.	3	0	3	

Leawood	6	1	5	
Lenexa	3	2	1	
Merriam	16	9	7	
Mission Hills	8	0	8	2
Mission	6	3	3	
Olathe	1	1	0	
Overland Park	22	5	17	
Prairie Village	13	0	13	
Roeland Park	1	0	1	
Westwood	1	0	1	
Shawnee	4	3	1	
Wyandotte County				
Wyandotte County Total	**46**	**8**	**41**	
Edwardsville	2	0	2	
Kansas City	36	5	31	
Bonnie Springs	8	0	8	
Leavenworth County				
Leavenworth County Total	**25**	**14**	**10**	
Easton	16	12	4	
Leavenworth Co.	3	2	1	
Leavenworth City of	5	0	5	
Tonganoxie	1	1	0	

Source: KS State Hazard Mitigation Program

Severe Repetitive Loss

The Flood Insurance Reform Act of 2004 identified another category of repetitive loss, categorized as Severe Repetitive Loss (SRL). SRL properties are defined it as “a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amounts of such claims payments exceeding $20,000; or for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property. As of October 1, 2012, there are 3 validated insured residential properties in the planning area that meet the qualifications of SRL and the requirements to be considered for possible mitigation activities under FEMA’s SRL criteria. Table 3.79 provides additional information on losses associated with these 3 properties.

Table 3.79. Verified Residential Insured Severe Repetitive Loss Properties

Name	Community Name	Total Paid	Losses	SRL Status
Mitigation Planning Region L				
Johnson	Fairway, City Of	$74,824	5	V
Johnson	Mission Hills, City Of	$307,482	4	V
Johnson	Mission Hills, City Of	$343,821	4	V

Source: Flood Insurance Administration as of Oct 2, 2012. V – validated.

History of Severe Repetitive Loss

In addition to the verified residential, insured properties above, the NFIP tracks other categories of properties, including unverified properties, commercial properties, previously mitigated properties, and currently uninsured properties that meet the loss criteria.

The following table shows the communities with the repetitive loss properties.

Table 3.80. Kansas Severe Repetitive Loss Claims

County	Community Name	Total Paid	Losses	SRL Status
Mitigation Planning Region L				
Johnson	Fairway, City Of	$74,824	5	V*
Johnson	Johnson County	$125,677	5	VU
Johnson	Merriam, City Of	$171,306	8	VU
Johnson	Mission Hills, City Of	$307,482	4	V*
Johnson	Mission Hills, City Of	$343,821	4	V*
Johnson	Roeland Park, City Of	$97,503	15	VU
Johnson	Shawnee, City Of	$177,471	5	PN
Leavenworth	Easton, City Of	$77,843	2	MV
Wyandotte	Kansas City, City Of	$121,269	4	VNU
Wyandotte	Kansas City, City Of	$98,585	4	PNU
Wyandotte	Kansas City, City Of	$514,926	8	VN
Wyandotte	Kansas City, City Of	$147,317	4	VNU
Wyandotte	Kansas City, City Of	$599,430	10	PNU
Wyandotte	Kansas City, City Of	$1,288,116	8	PN
Wyandotte	Kansas City, City Of	$324,730	16	PN
Wyandotte	Kansas City, City Of	$829,891	7	PN
Wyandotte	Kansas City, City Of	$213,479	5	VNU
Wyandotte	Kansas City, City Of	$44,288	7	VU
Total		**$5,557,959**	**121**	

Source: Flood Insurance Administration (current as of October 2, 2012): **MV**-Mitigated Validated, **MVU**-Mitigated Validated Uninsured, **V**- Validated, **VU**-Validated Uninsured, **VN**-Validated Non Residential, **VNU**-Validated Nonresidential Uninsured, **P**-Pending, **PU**-Pending Uninsured, **PN**-Pending Non Residential **PNU**- Pending Nonresidential Uninsured

Mitigation of Severe Repetitive Loss

Of the 18 SRL properties in the planning area, only one has been mitigated The property located in Easton, Leavenworth County, was mitigated through ICC (Increased Cost of Compliance).

Mitigation of Repetitive Loss Properties

Region L has flooding as a known hazard, and has adopted the State of Kansas policy of mitigating repetitive loss properties as a priority use of mitigation funds. Of the 164 properties that meet the definition of repetitive loss in the planning area, 49 have been mitigated, leaving just 117 unmitigated repetitive loss properties. A summary is provided below of the mitigation methods utilized for the 49 mitigated properties.

- The majority of the properties that received mitigation funds were a part of the acquisition/demolition program
- Merriam, in Johnson County, provided their own funds to mitigate for repetitive properties through acquisition/demolition.

Community Rating System

For communities that participate in the NFIP, any development in the floodplain should be built according to its corresponding floodplain management ordinance. According to the State's minimum standards, the first floor elevations of residential property must be a minimum of one foot above the base flood elevation. For non-residential properties, the standard is to either elevate or flood proof to one foot above the base flood elevation. Additionally, the communities listed in Table 3.81 are part of the NFIPs Community Rating System (CRS) and are taking steps above and beyond the minimum requirements to qualify for reductions in flood insurance premiums. Additionally, the floodplain management practices for CRS communities are reviewed on a periodic cycle, typically every five years.

Table 3.81. Kansas Communities in the NFIP's Community Rating System (CRS)

Mitigation Planning Region	Community	County	CRS Entry Date	Current class	% Discount for SFHA	% Discount for Non-SFHA
L	Lansing, City of	Leavenworth	5/1/2011	8	10	5
L	Kansas City	Wyandotte	5/1/2013	7	20	10
L	Lenexa, City of	Johnson	10/1/2011	8	10	5
L	Olathe, City of	Johnson	10/1/1993	8	10	5
L	Overland Park, City of	Johnson	10/1/2009	8	10	5
L	Shawnee, City of	Johnson	10/1/1991	8	10	5

Source: State Hazard Mitigation Plan 2013

There are many different ways to earn CRS points in order to move up the coveted levels and reduce NFIP payment amounts. Following are a few of them: organize to prepare the plan; involve the Public; coordinate; assess the hazard; assess the problem; set goals; review possible activities; draft an action plan; adopt the plan; implement, evaluate, and revise. For a complete picture of how credits can be earned through these steps, the CRS Coordinator's Manual gives detailed instructions.

Summary

The vulnerability of Region L to flooding is high. Health and safety impacts of flooding can be devastating and can lead to the loss of life to floods. During the last 50 years fatalities have declined, yet economic losses (e.g., property, crop, and infrastructure) have risen (USGS 2006). This increase in losses can be attributed in part to encroachment of urban and agricultural development onto floodplains, which increases the potential for flood damage. Environmental and cultural resources are also susceptible to flooding. Prolonged flood conditions, such as experienced in 1993, 2007, and 2011 can kill wildlife, contaminate recreational areas, remove vegetation, saturate the ground for months and stress infrastructure such as roads. Region L continues to be proactive in their floodplain management as evidenced in their local plans, policies and ordinances.

Public health concerns that may result from flooding include the following:

- Drowning while driving. Almost half of the fatalities in 2010 during flood conditions were a result of drowning while attempting to drive through floodwaters. Only 18 inches of water is needed to lift a vehicle at which point the vehicle becomes buoyant and easily pushed by the flood waters.

- Contaminated drinking water due to waterborne diseases. Flooding can overwhelm drinking water infrastructure and wells, which reduces or prevents water purification. ½ of waterborne disease outbreaks in the U.S. occur in the aftermath of heavy rain.

- Sewage back-up in plumbing – flooding can cause sewage lines and septic tanks to overflow, resulting in sewage backing up into people's residences or other structures. Raw sewage is a health hazard that contains bacteria, viruses, and other disease causing germs. Gastrointestinal illnesses, skin infections, and rashes are a few of the common health concerns when sewage backs up into residences and other structures.

- Mold is another concern in the aftermath of flooding. Water intrusion anywhere in a structure can cause toxic mold to grow in ceilings, walls, and insulation. Breathing in mold can lead to symptoms that include sinus infection, congestion, coughing, breathing problems, skin and eye irritation. When individuals are immunocompromised, or have established lung issues such as asthma or COPD, mold can exacerbate the condition.

- Vector Control after a flood is critical in controlling waterborne pests such as mosquitoes which can cause arboviral diseases in humans. These pests flourish in wet and warm conditions.

Maintaining the floodplain in as natural a state as possible is key to mitigating for floods. The benefits of the floodplain are numerous. Natural floodplains provide many benefits for humans and natural systems. Each benefit contributes factors such as they naturally store and convey floodwaters, maintain water quality, recharge groundwater and naturally regulate flows into rivers and lakes. They support large and diverse populations of plants and animals, and provide historical, scientific, recreational, and economical benefits to communities. Wyandotte County Lake is a great example in Region L of a floodplain that contributes natural habitat for plants and animals as well as recreational use for the community. This is a country lake located at the northwest edge of Kansas City, Kansas. The 1,500 acres are positioned in a setting of hillside oak-hickory woodlands and lakeside sycamores. The 456 acre lake with marina was constructed in the 1930's by the Works Progress Administration.

Local Mitigation Concerns

- Flooding concerns for the planning area are not solely affected by the weather in Kansas. As seen during the 2011 Missouri River Floods, events up stream can have significant impacts on downstream communities. Montana had an unprecedented snowfall and precipitation amount during the winter of 2010-2011, which caused flooding in Region L. Levee breaches and over topping occurred frequently during this event, affecting Leavenworth and Wyandotte Counties.

- Flooding is a hazard that can also contribute to soil erosion, landslides and land subsidence. The impacts to transportation nodes, bridges, and industry along the rivers are also at risk during flooding events, which can affect lives and property.

- Flooding concerns along Stranger Creek running North to South through the central part of Leavenworth county which affects the cities of Eason and Linwood. Economic development in this area is hampered due to flooding concerns.

- Significant flood and erosion issues are present along Indian Creek in Olathe.

- An issue in Johnson County is the upstream development impact on downstream flooding. Historically, development does not account for downstream impact which creates flooding issues where before there were none.

- Flooding can contribute to contaminated waters, especially standing water that can cause public health concerns of infectious disease and bacterial illness. Cleanup of these waters will require diligence also so that the responders are not infected.

- Flooding issues on the Kansas River, in and around the DeSoto Bottoms can contaminate water wells that feed the Olathe Water production Center.

Development in the Hazard Area

Region L is the mostly densely populated area in Kansas, and is also the fastest growing. With that growth comes the need for more housing, businesses, health facilities, etc. Floodplain management practices must continue to be a priority to ensure that development is not occurring in areas at risk to flooding. All of the counties in Region L participate in the NFIP, so any development in the floodplain should be built according to its corresponding floodplain management ordinance. Additionally, the jurisdictions that participate in the NFIP and the Community Rating System (CRS) periodically review their floodplain management programs. The Department of Agriculture, Division of Water Resources also conducts Community Assistance Contacts (CAC) which offer assistance to the participating communities and assess the floodplain program. Community Assistance Visits (CAV), which is similar to full audits, are also conducted by the Division of Water Resources in order to ensure communities are in compliance with the floodplain management program.

In the jurisdictions *Land Use and Policy*, *Floodplain Management Ordinance*, and *Comprehensive Plans*, maintaining the integrity of the floodplain is front and center. All the jurisdictions are committed to mitigating for the flood hazard by keeping the floodplain areas devoid of development. In cases where existing development exist they have identified actions in Chapter 4 to educating the public, and when funds are available, providing acquisition/demolition projects in order to prevent further damage to property. By the very nature of its topographical/geographical make-up, Region L has a known flooding risk that they take seriously and actively mitigate for.

Table 3.82. Johnson County CPRI: Flood

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Flood	4	3	3	4	3.55	High

Table 3.83. Leavenworth County CPRI: Flood

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Flood	4	3	3	4	3.55	High

Table 3.84. Wyandotte County CPRI: Flood

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Flood	4	3	3	4	3.55	High

Figure 3.26. Planning Region L Hazus One Percent Annual Chance Floodplains

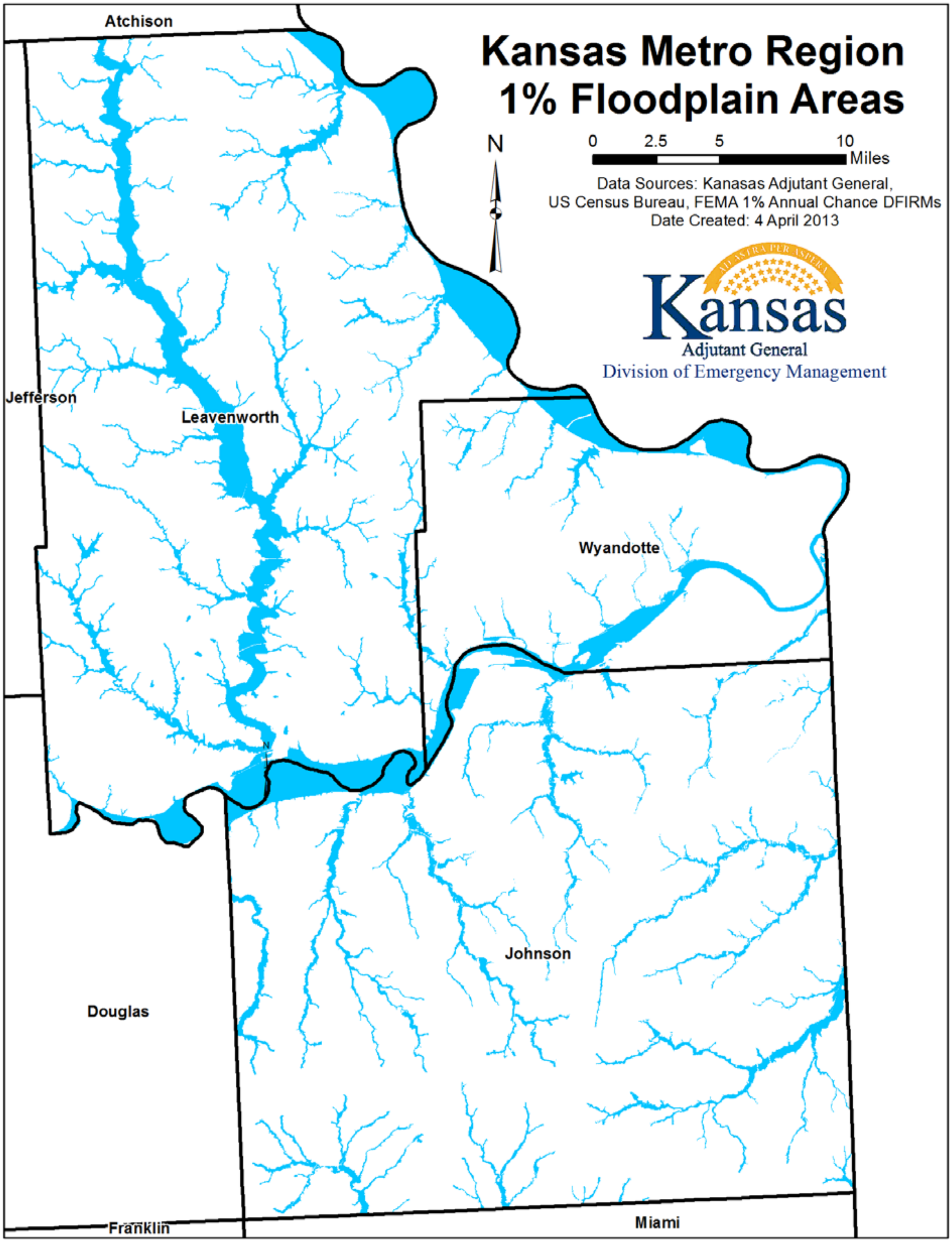
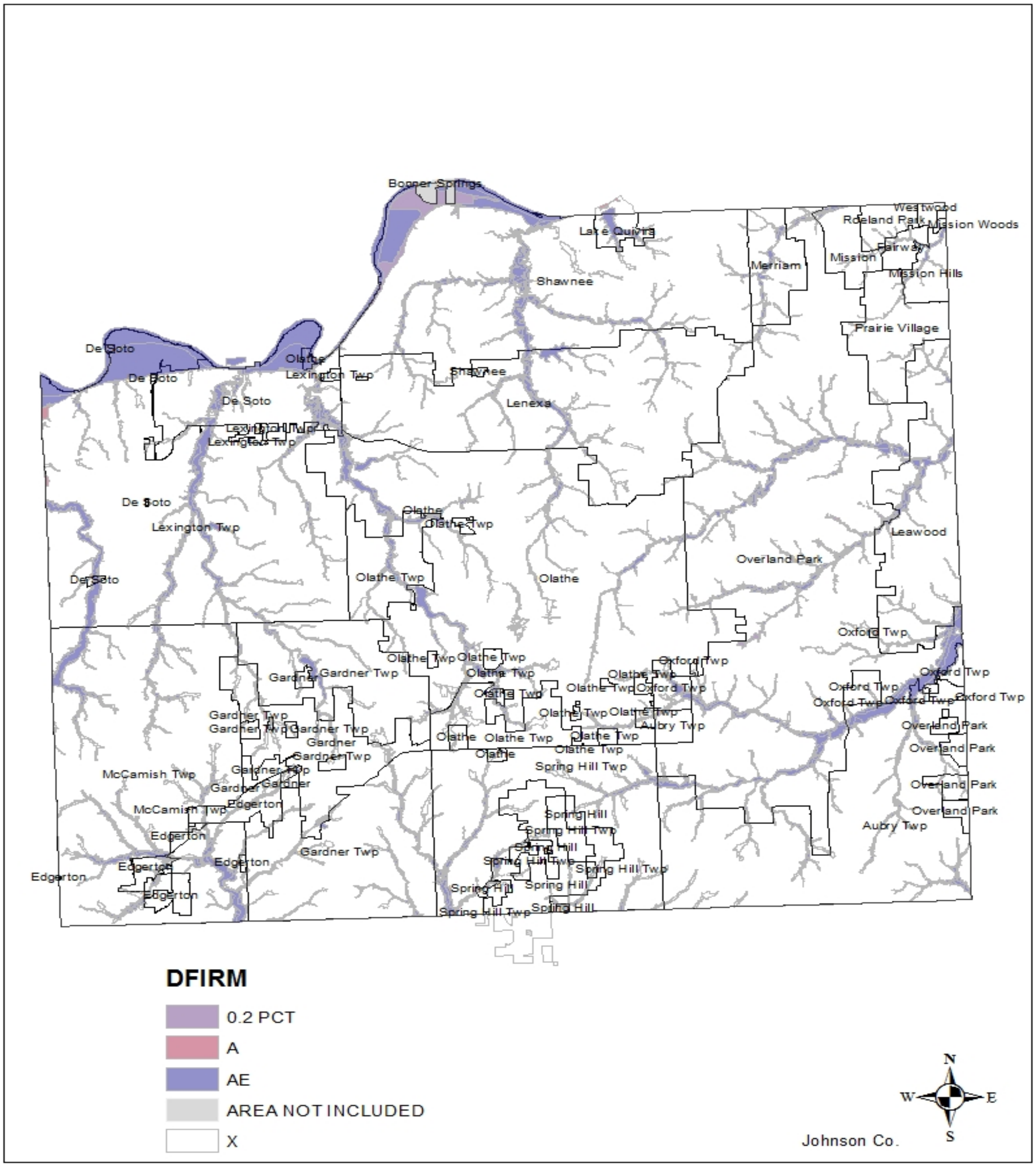


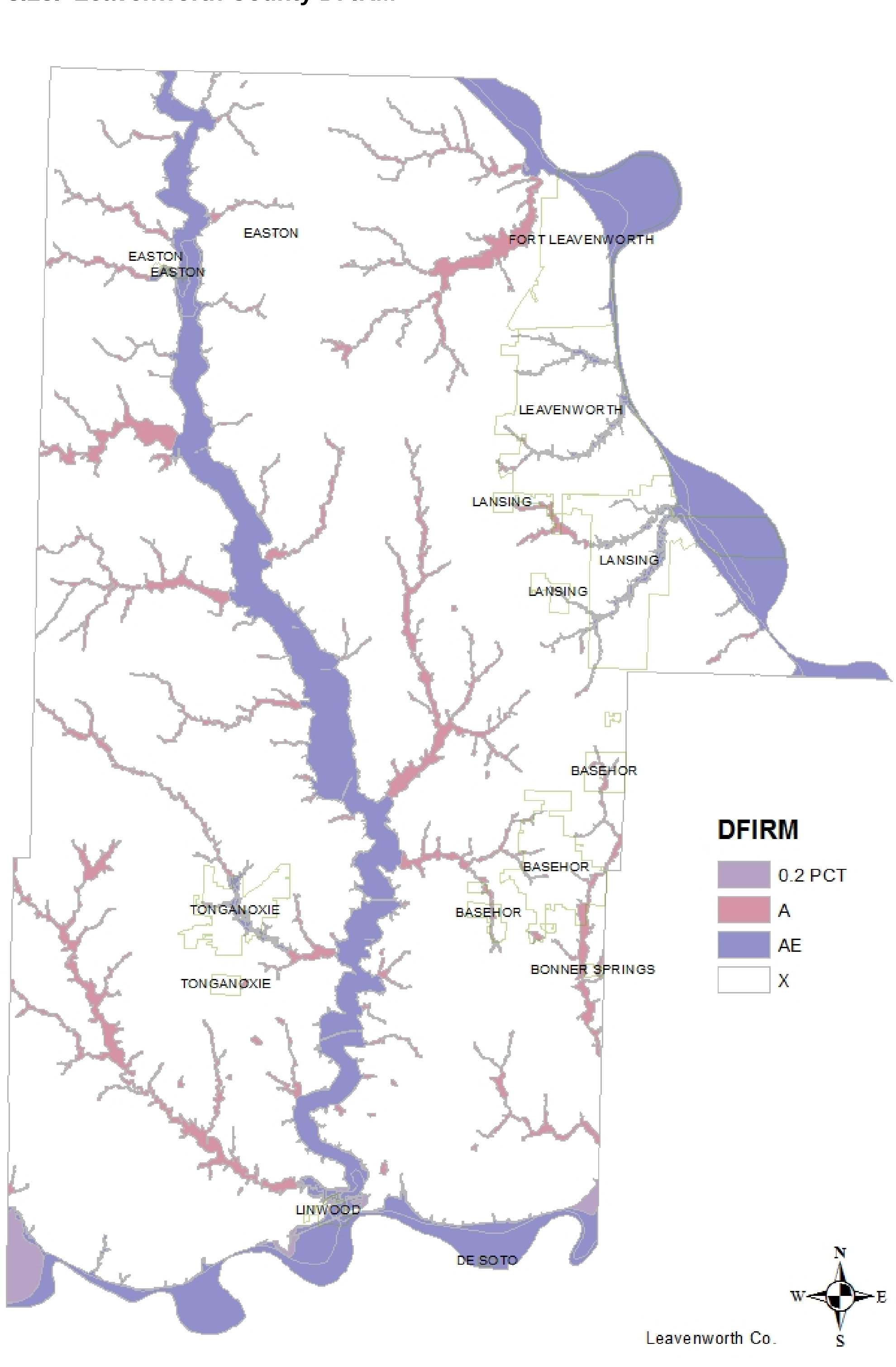
Figure 3.27, 3.28, and 3.29 show the DFIRM maps for Johnson, Leavenworth, and Wyandotte counties.

Figure 3.27. Johnson County DFIRM



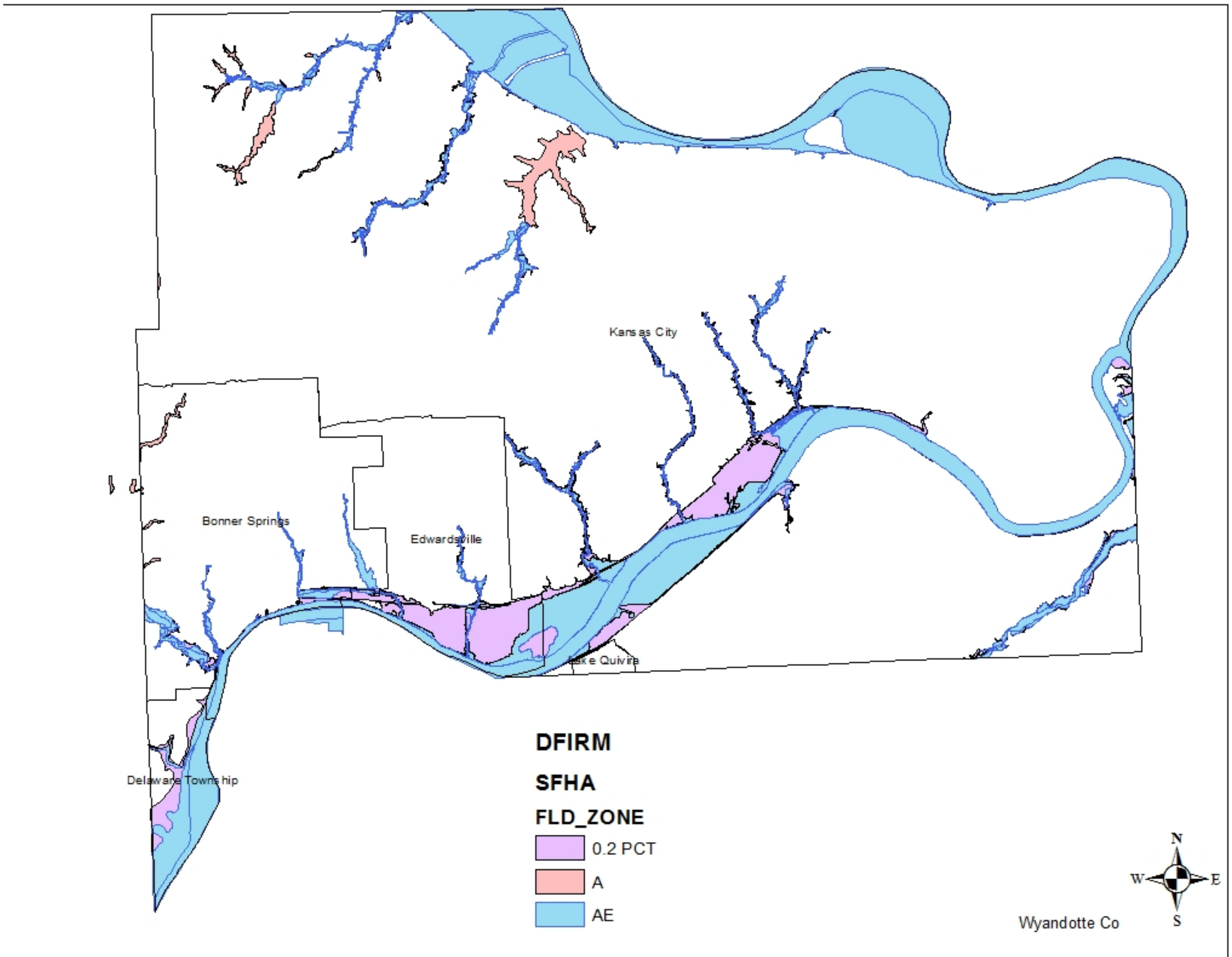
Note: 0 .2 % = up to the 500 year flood
A = Area subject to inundation by a 100-year flood.
AE = Areas subject to inundation by a 100-year flood as determined by detailed methods. Base Flood elevations are shown within these zones.

Figure 3.28. Leavenworth County DFIRM



Note: **0 .2 % = up to the 500 year flood**
A = Area subject to inundation by a 100-year flood.
AE = Areas subject to inundation by a 100-year flood as determined by detailed methods. Base Flood elevations are shown within these zones.

Figure 3.29. Wyandotte County DFIRM



Note: **0 .2 % = up to the 500 year flood**
A = Area subject to inundation by a 100-year flood.
AE = Areas subject to inundation by a 100-year flood as determined by detailed methods. Base Flood elevations are shown within these zones.

The following maps depict the special flood hazard areas for jurisdictions within the planning area.

Johnson County
Figure 3.30. DeSoto

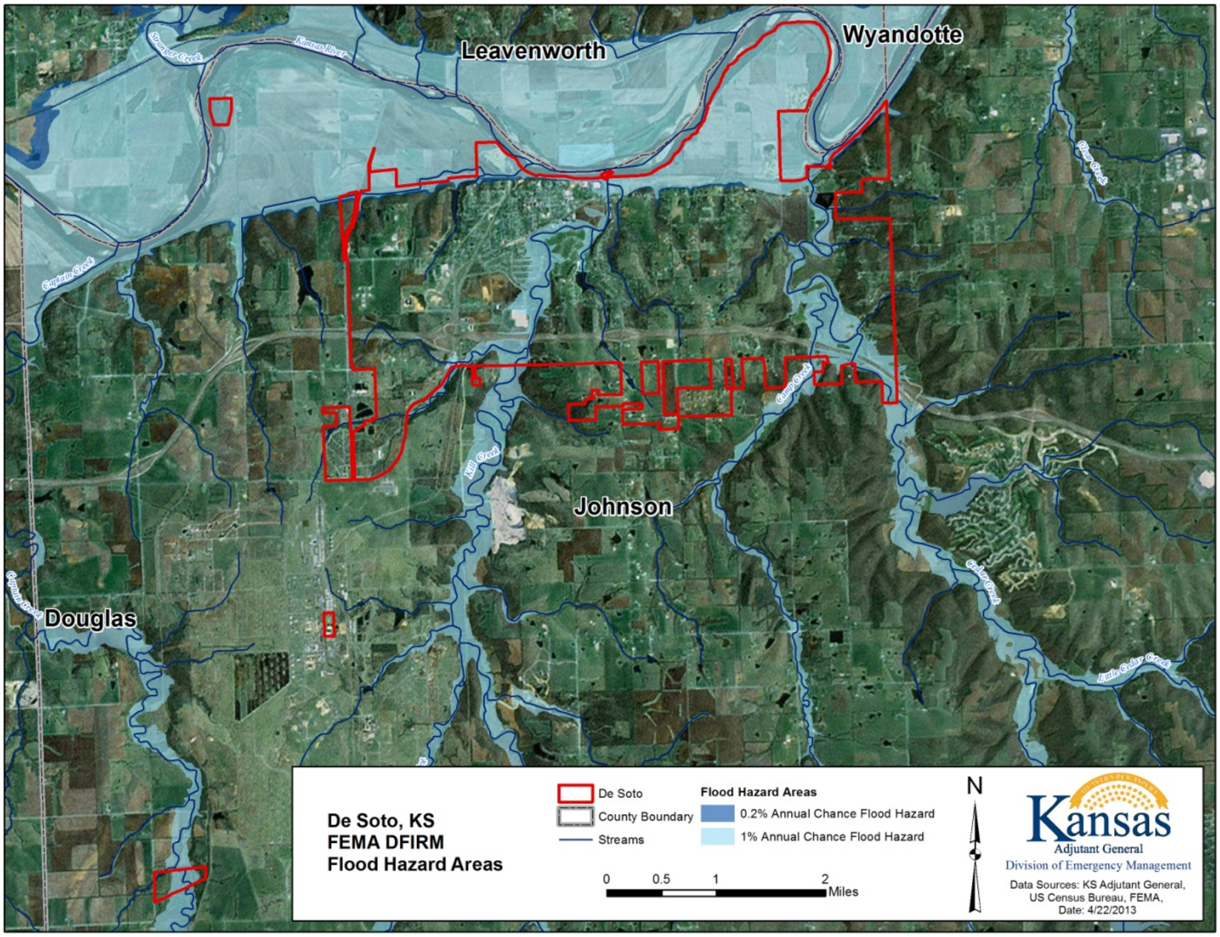


Figure 3.31. City of Merriam

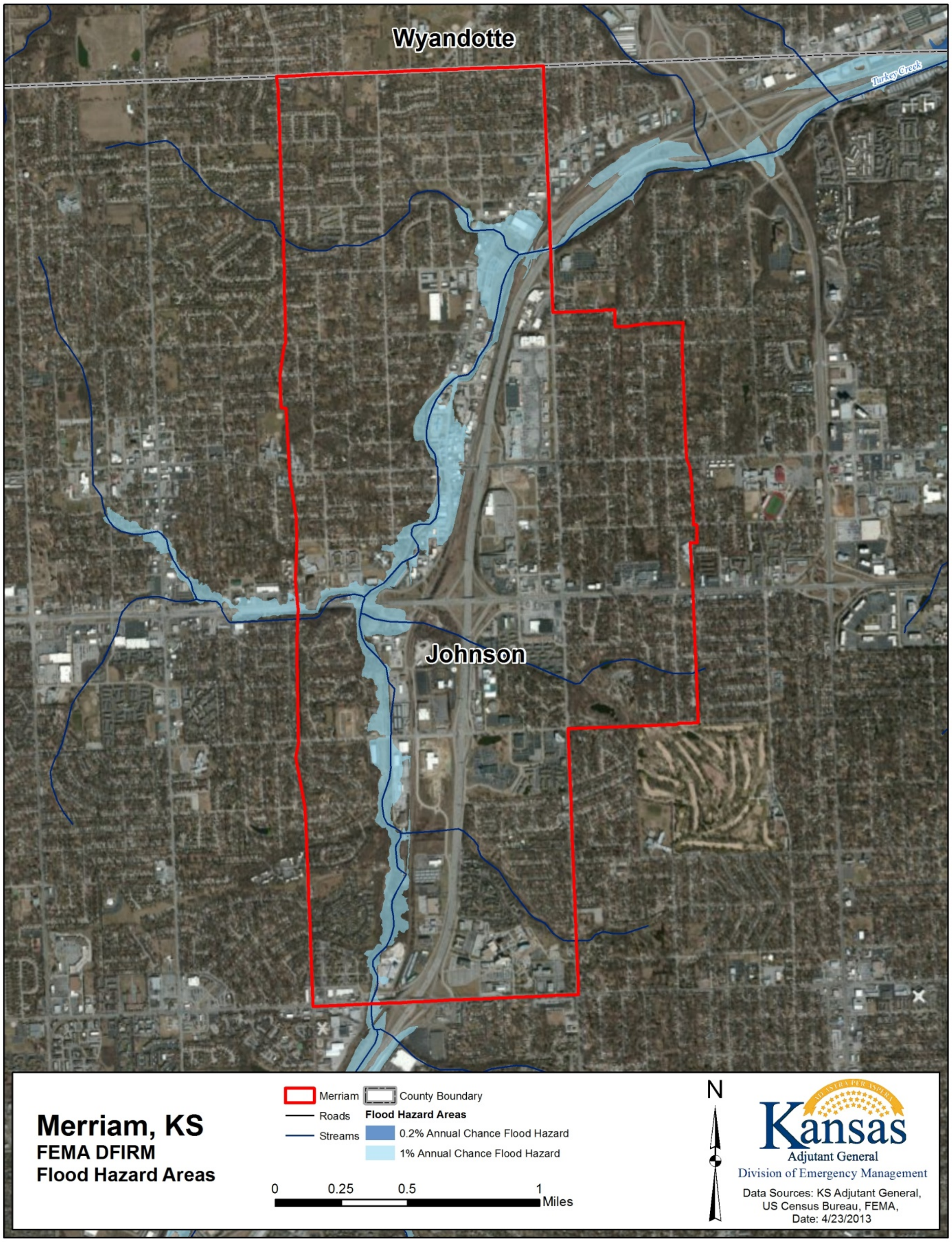


Figure 3.32. Cities of Mission, Mission Hills and Merriam

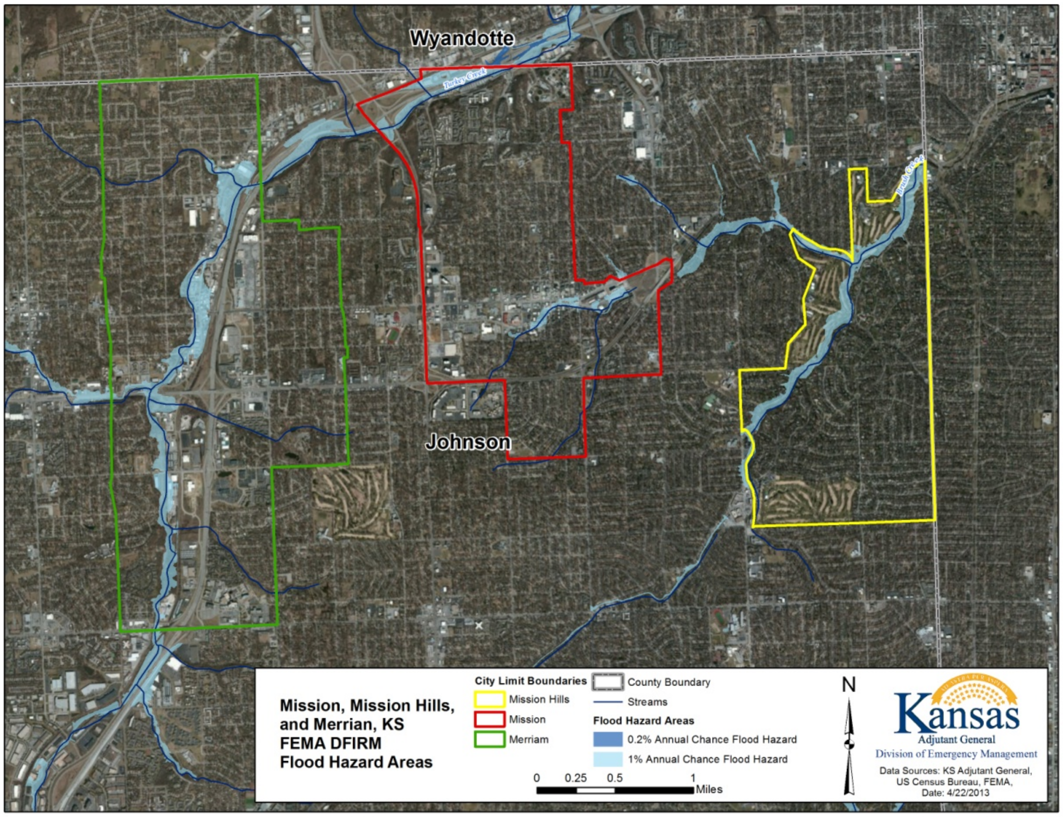


Figure 3.33. Mission Woods

Figure 3.34. City of Olathe

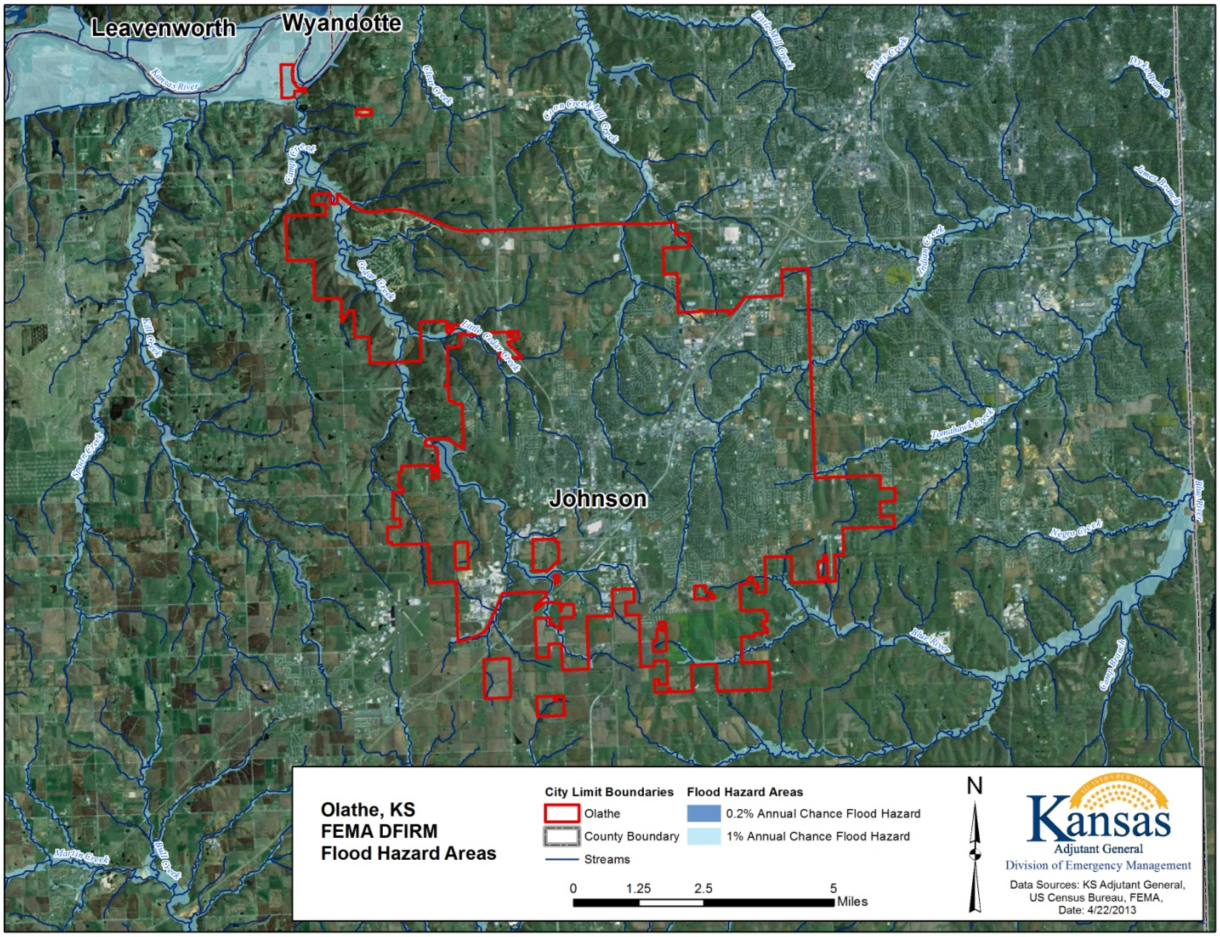


Figure 3.35. City of Overland Park

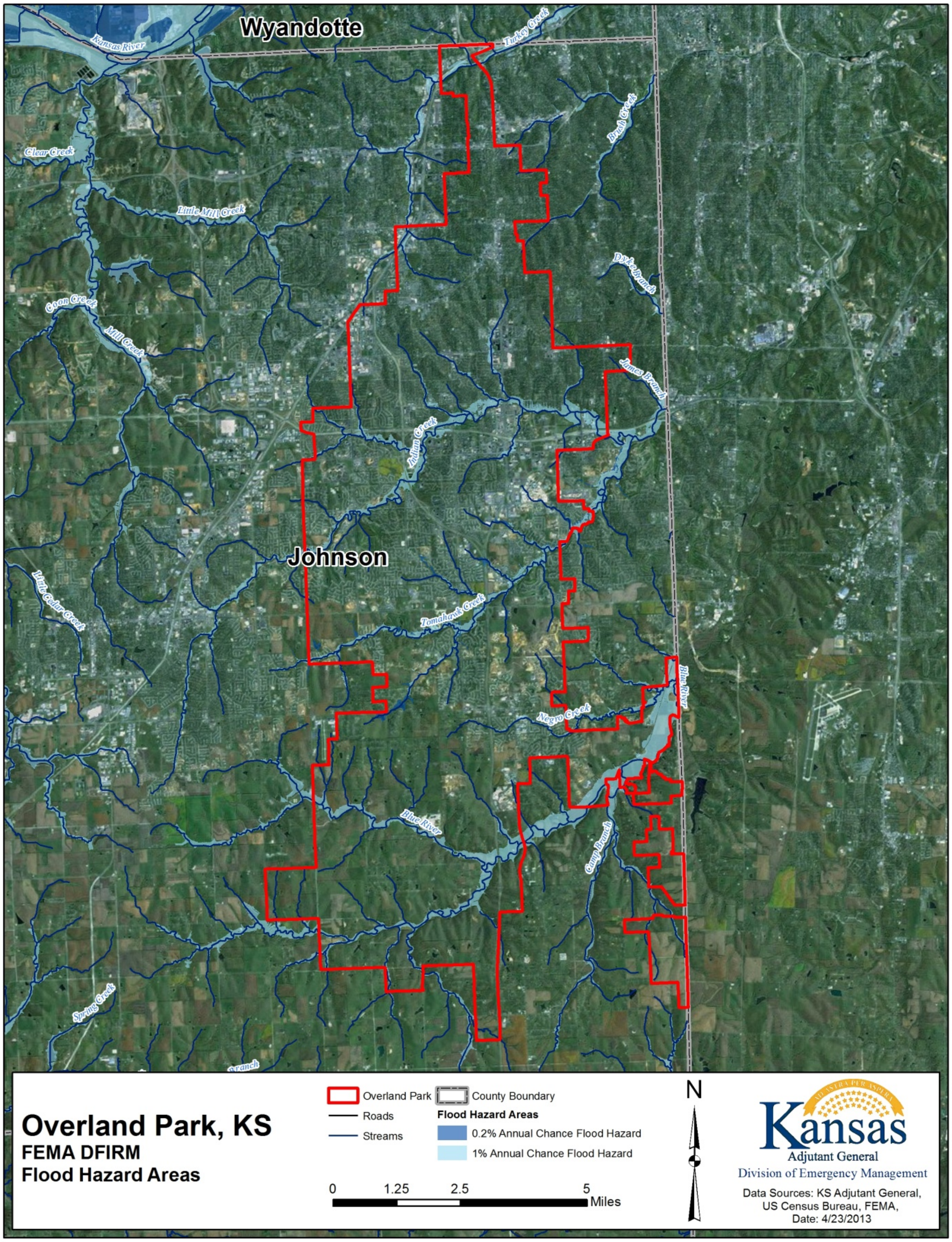


Figure 3.36. City of Prairie Village

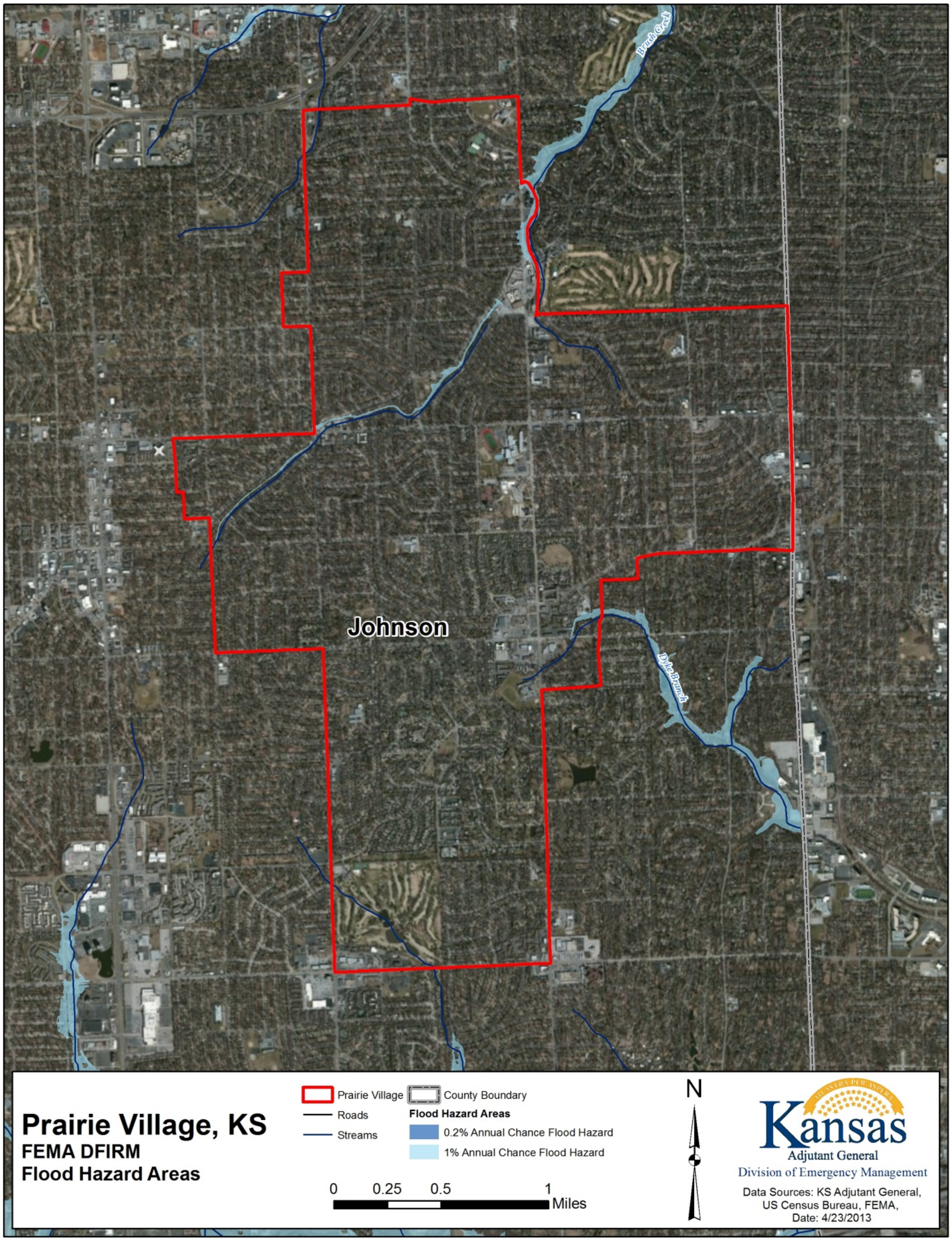


Figure 3.37. City of Shawnee

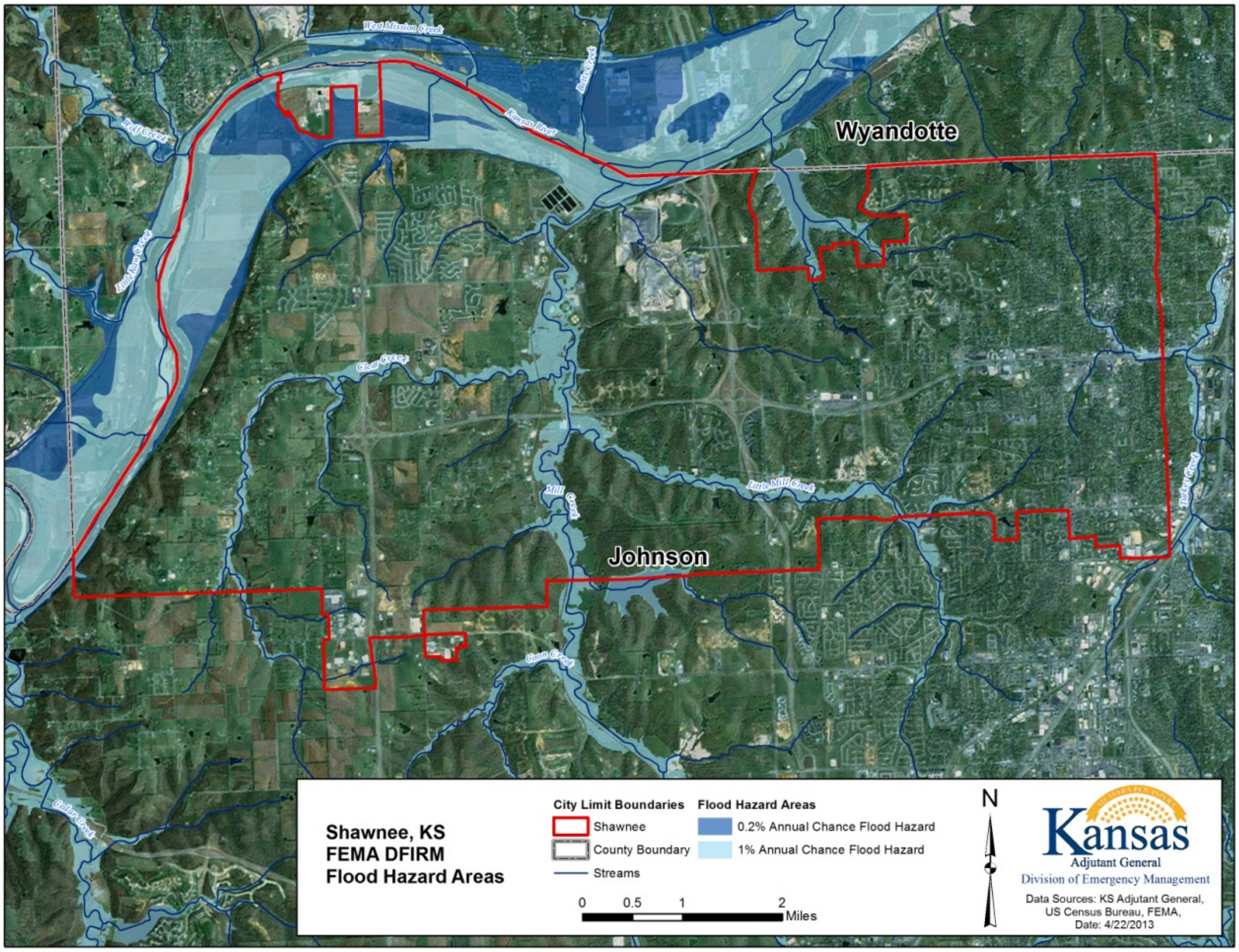


Figure 3.38. City of Westwood and Westwood Hills

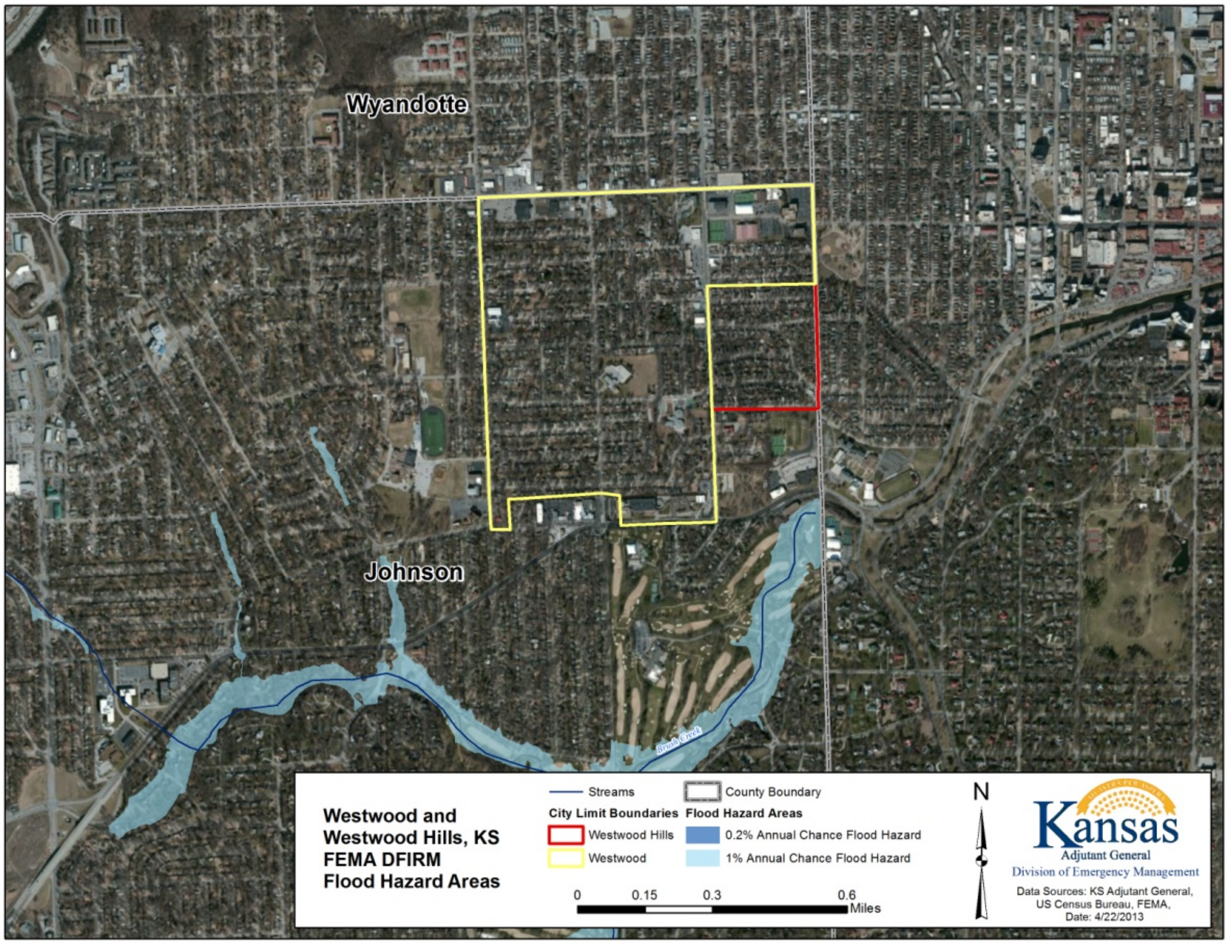


Figure 3.39. USD230

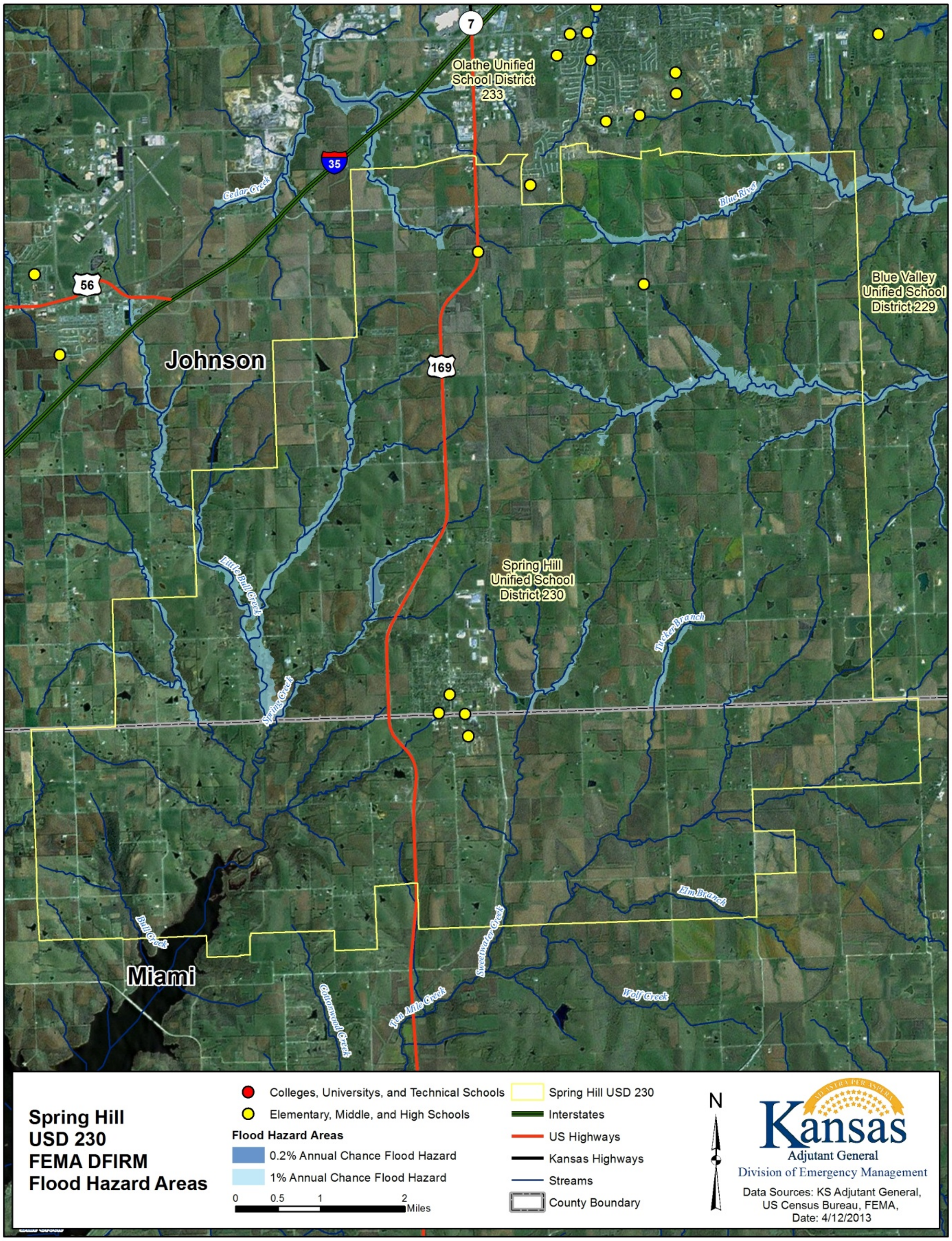


Figure 3.40. USD231

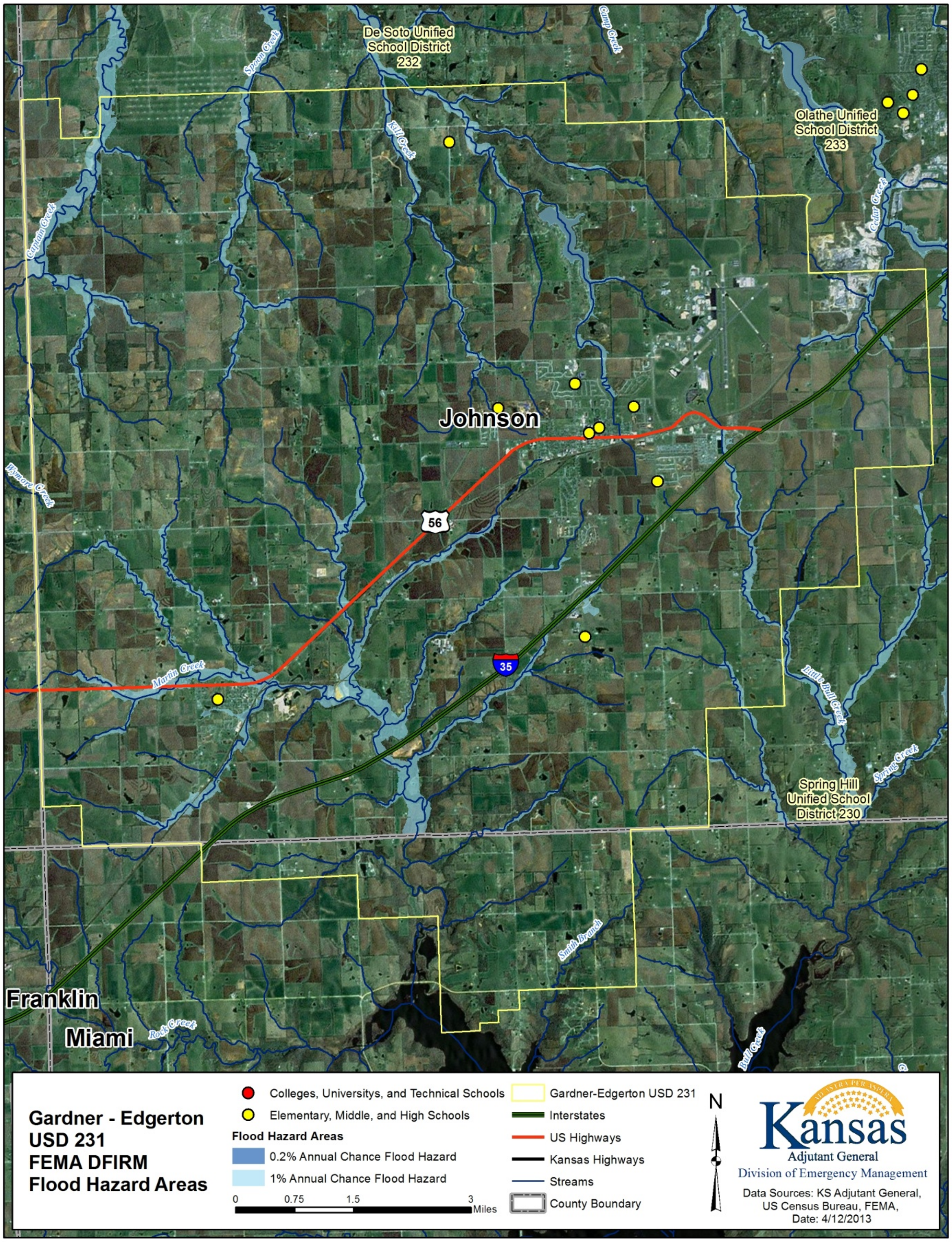


Figure 3.41. USD229

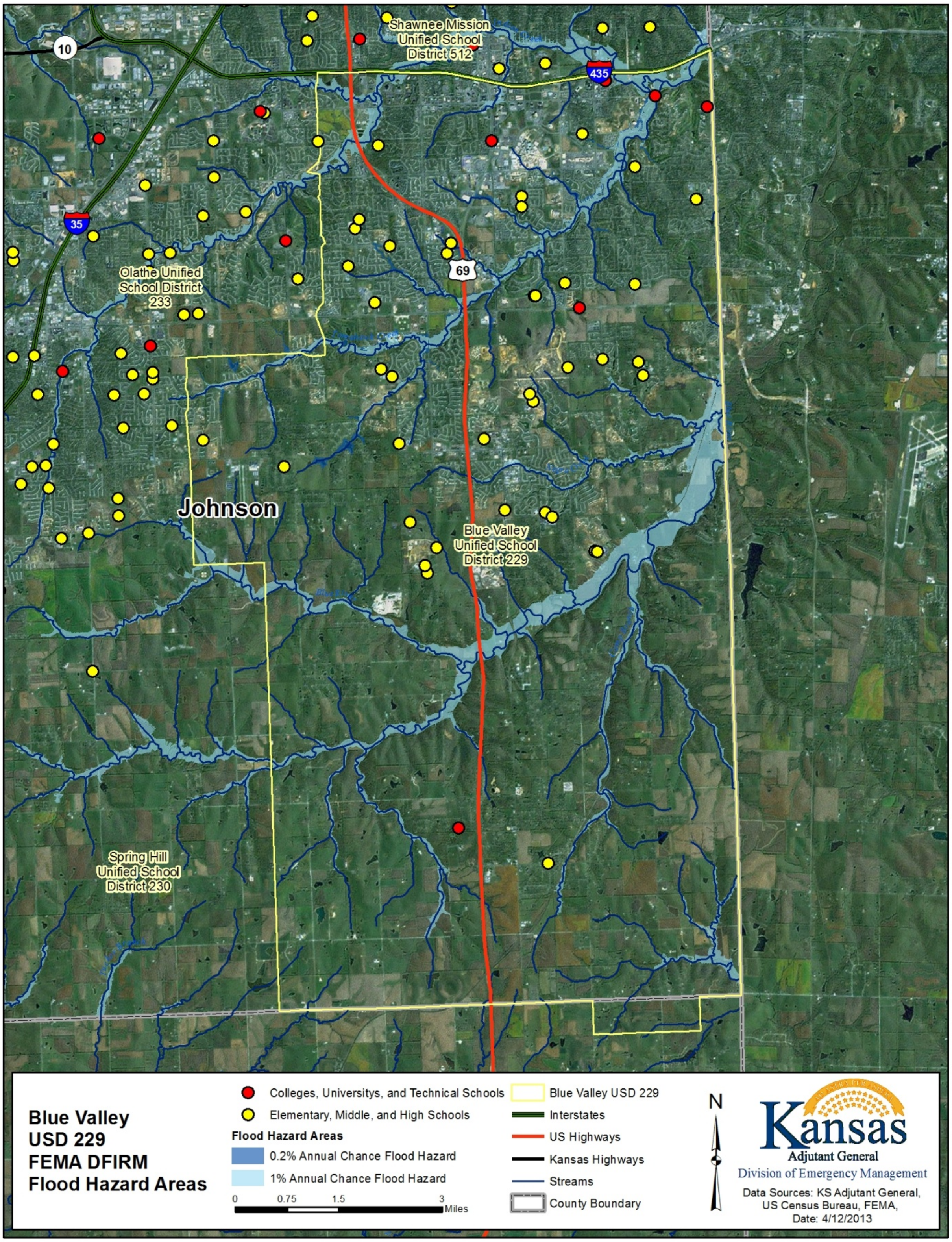


Figure 3.42. Johnson County Community College

Figure 3.43. University of Kansas, Edwards Campus

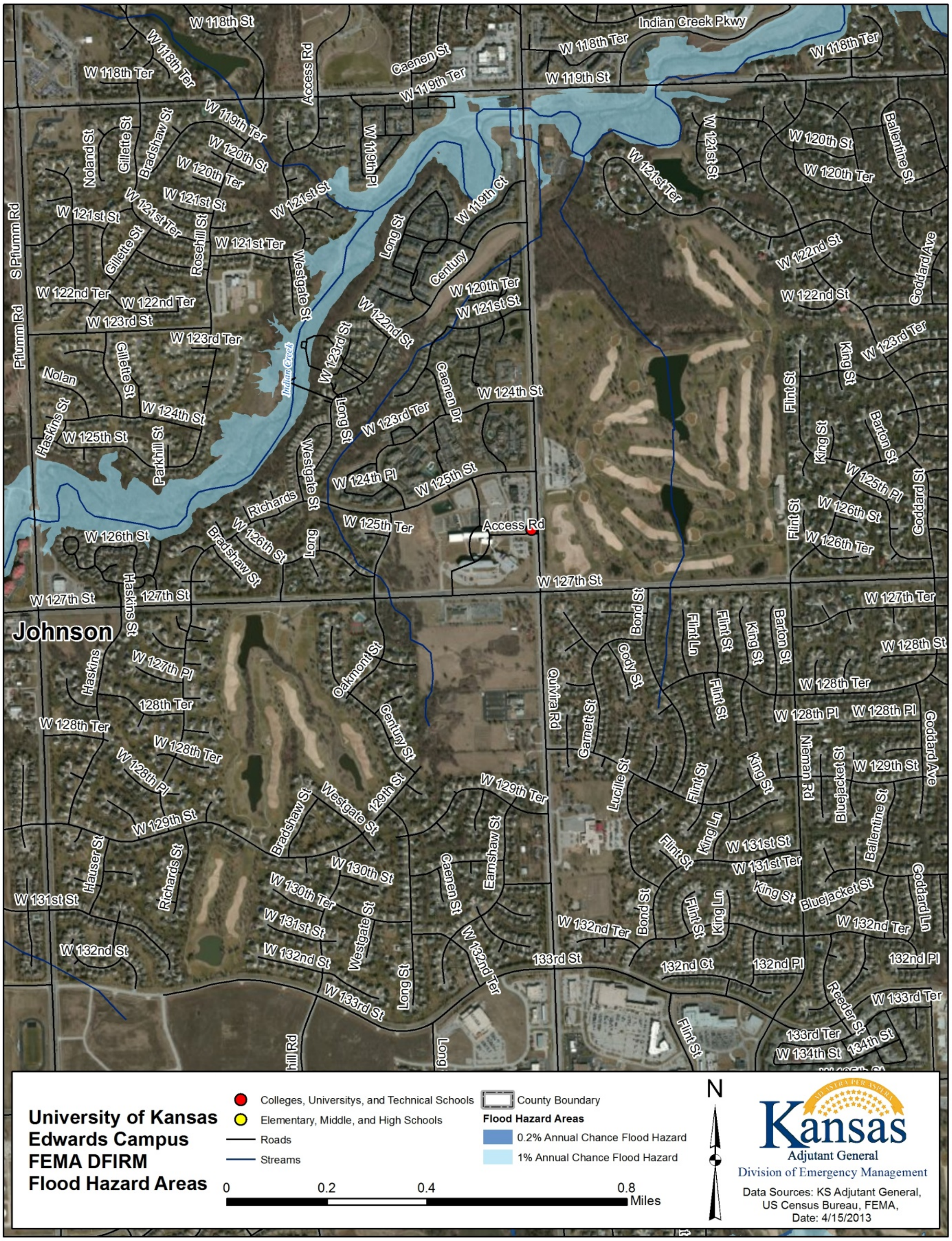
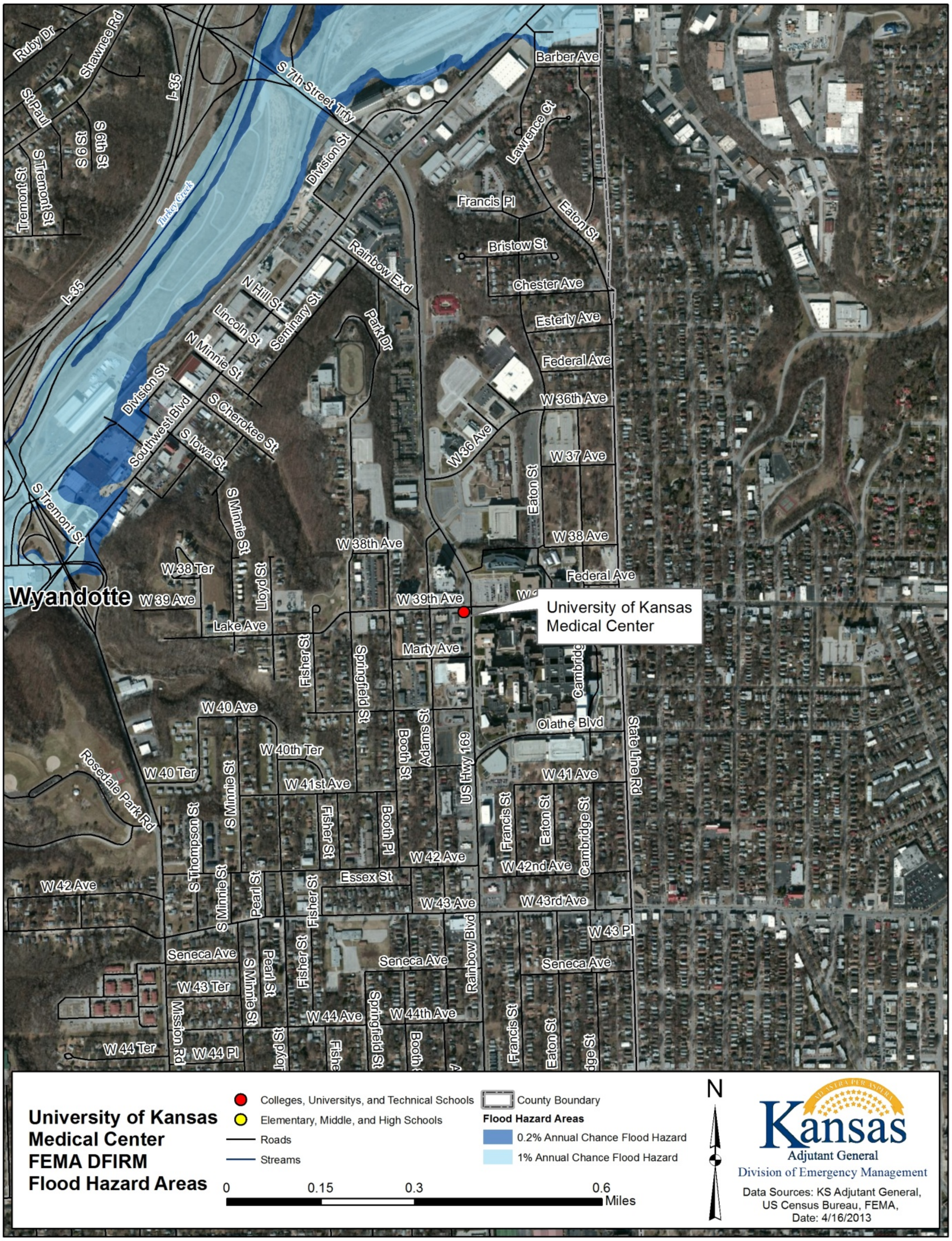


Figure 3.44. University of Kansas Medical Center



Leavenworth County:
Figure 3.45. City of Basehor

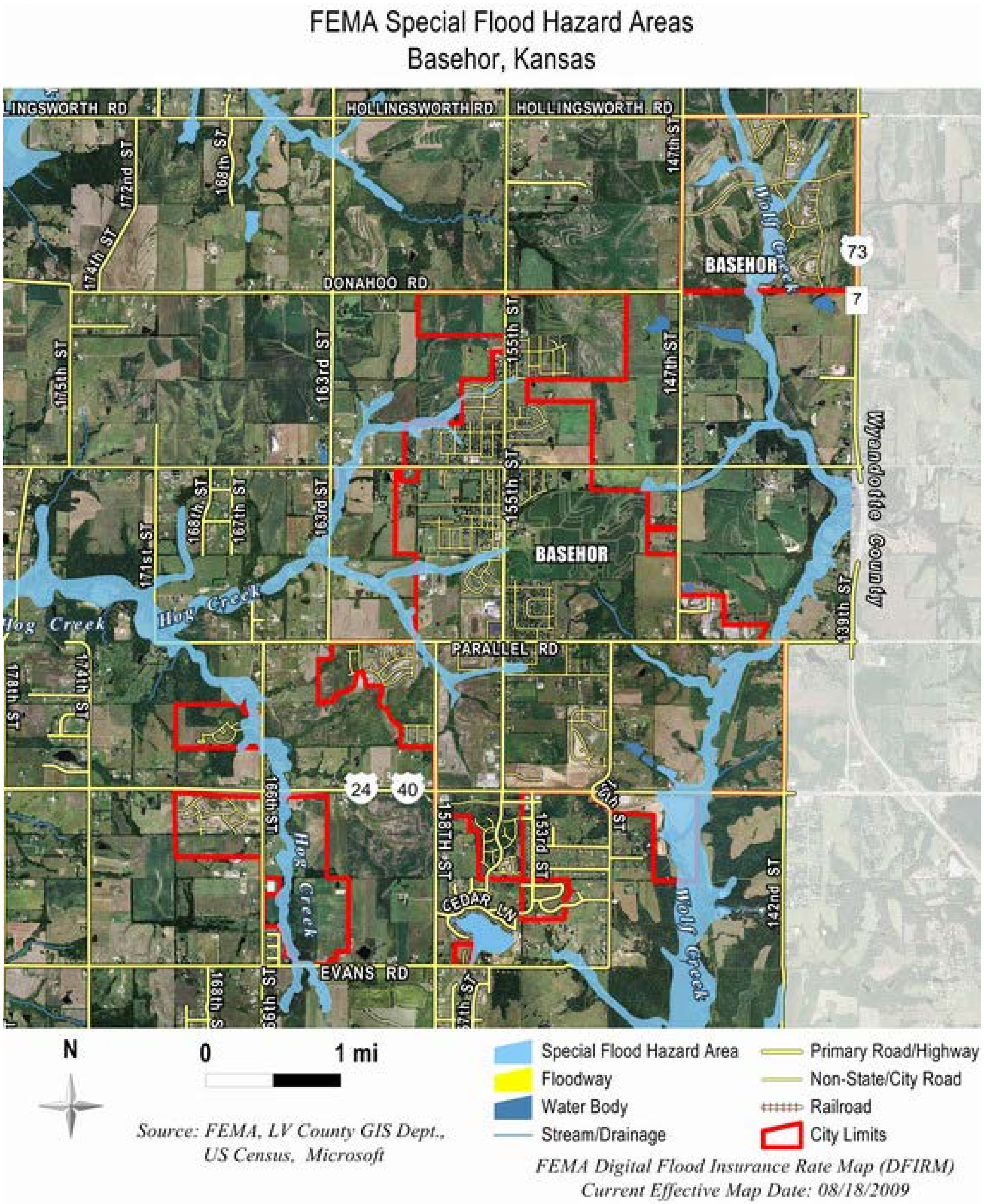


Figure 3.46. City of Easton

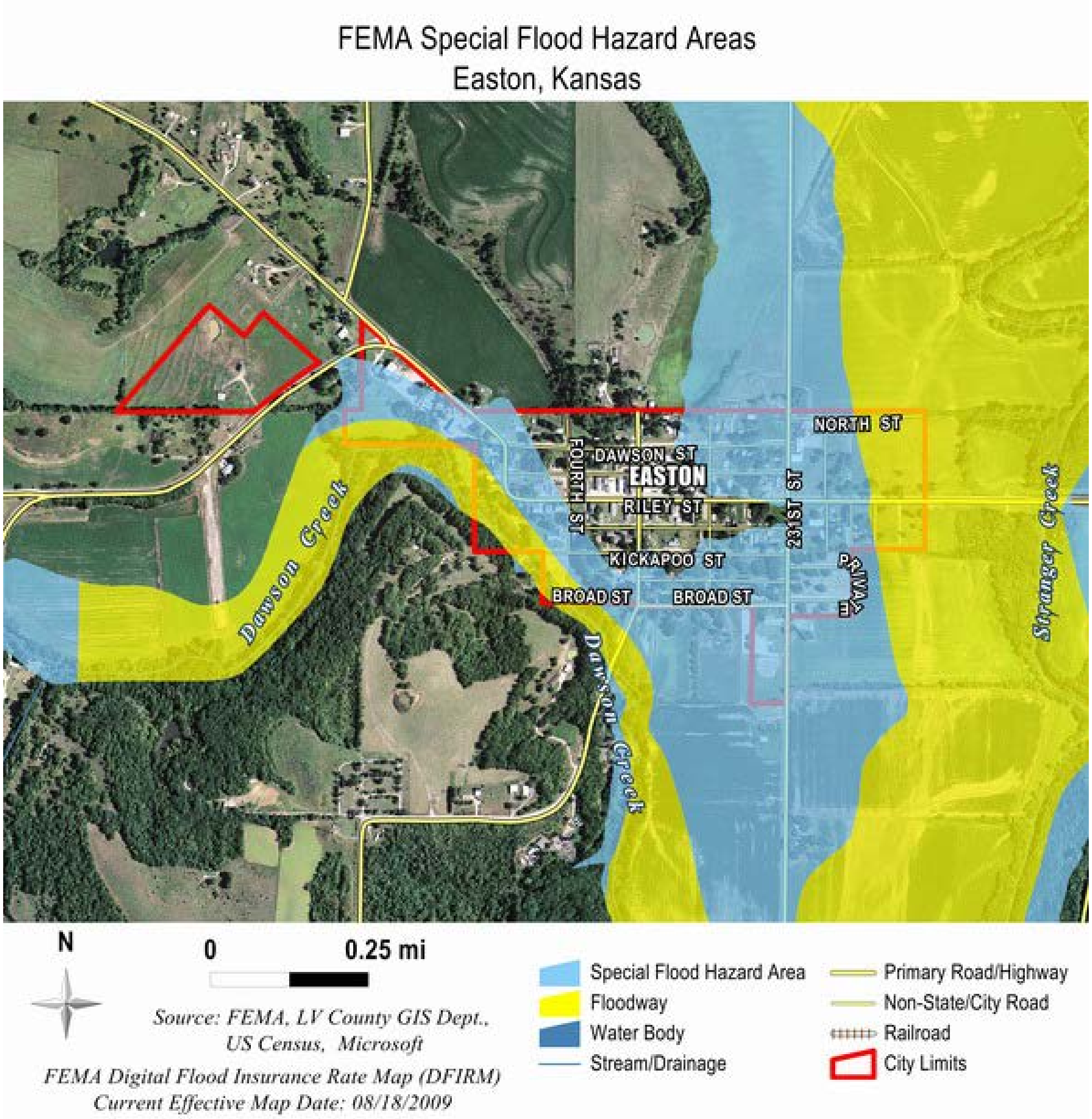


Figure 3.47. City of Lansing

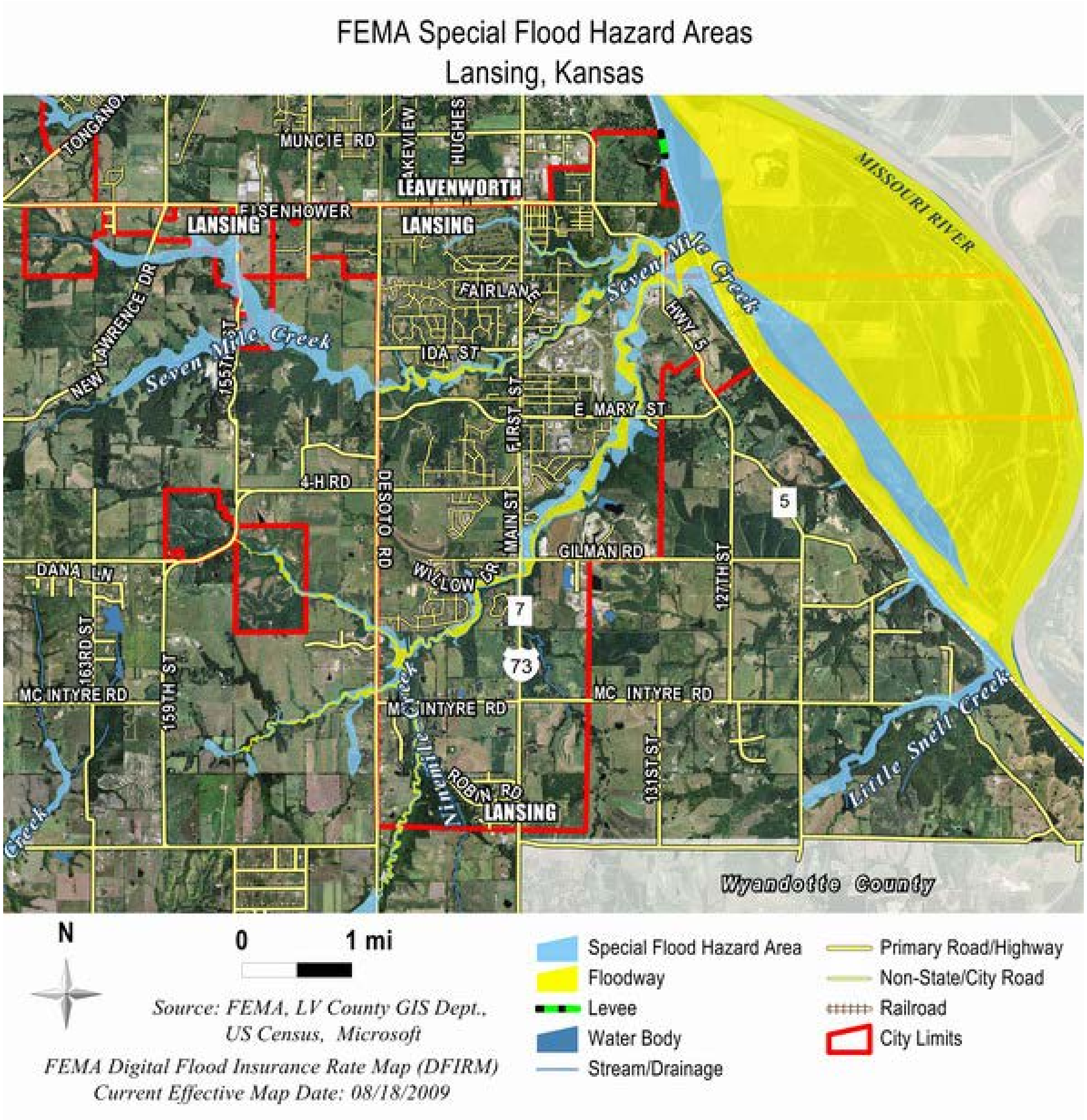


Figure 3.48. City of Leavenworth

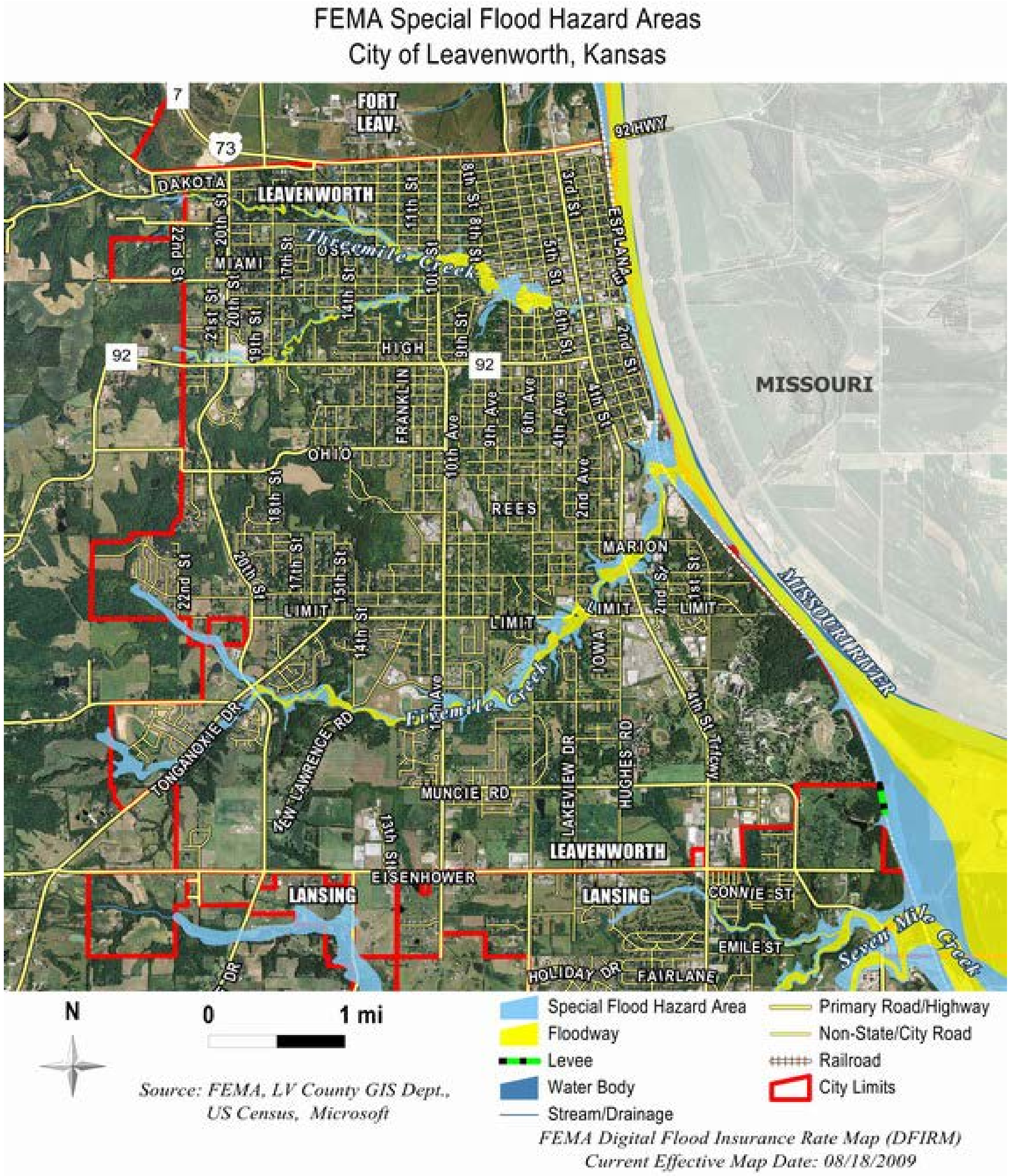


Figure 3.49. City of Tonganoxie

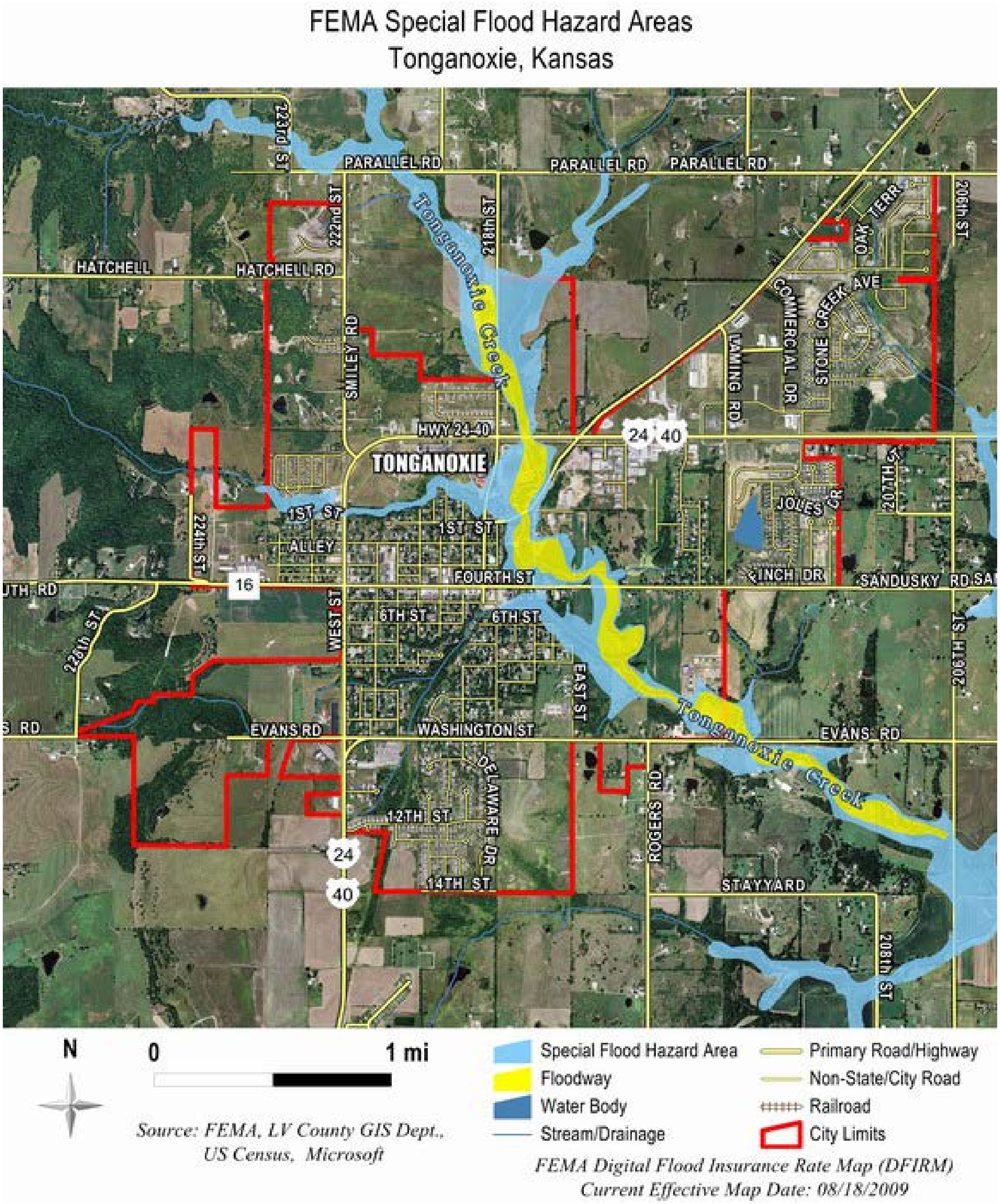


Figure 3.50. USD207 & USD453

Figure 3.51. University of Saint Mary

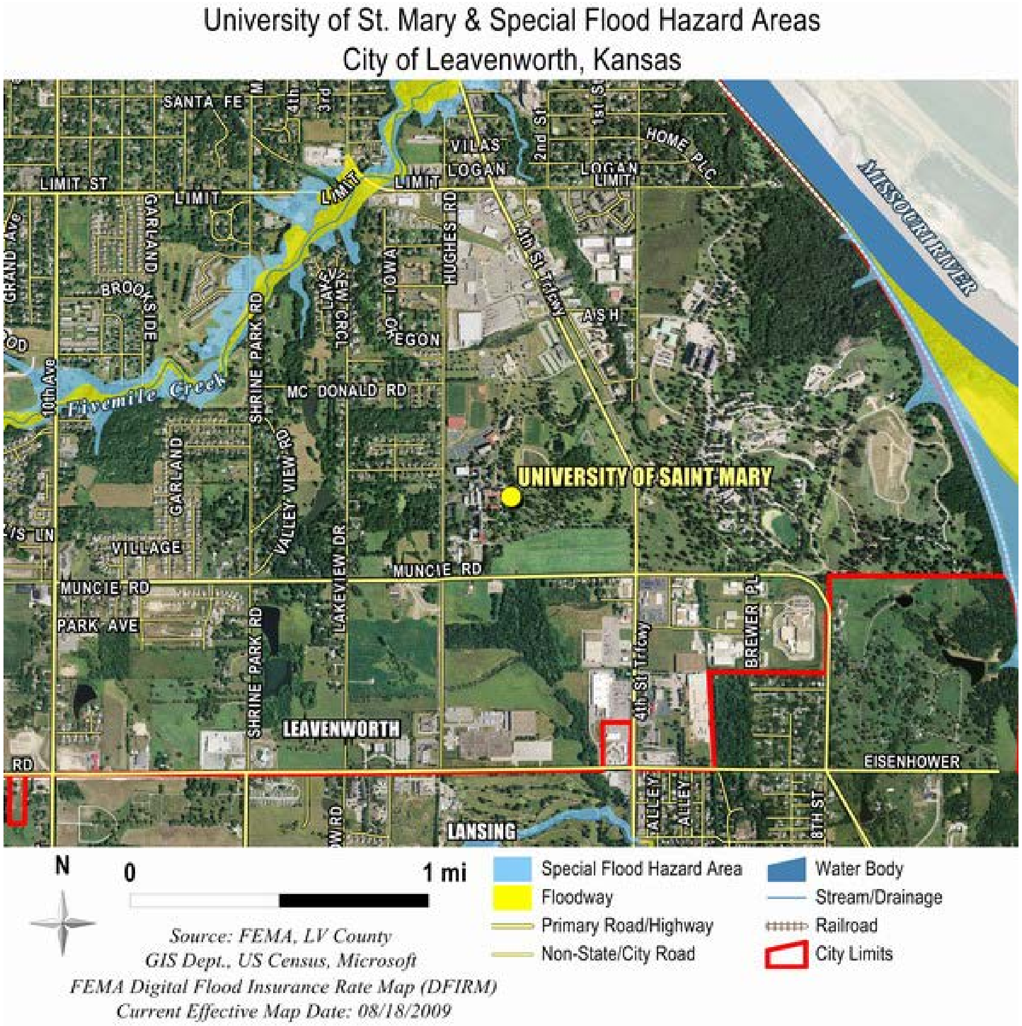


Figure 3.52. USD458

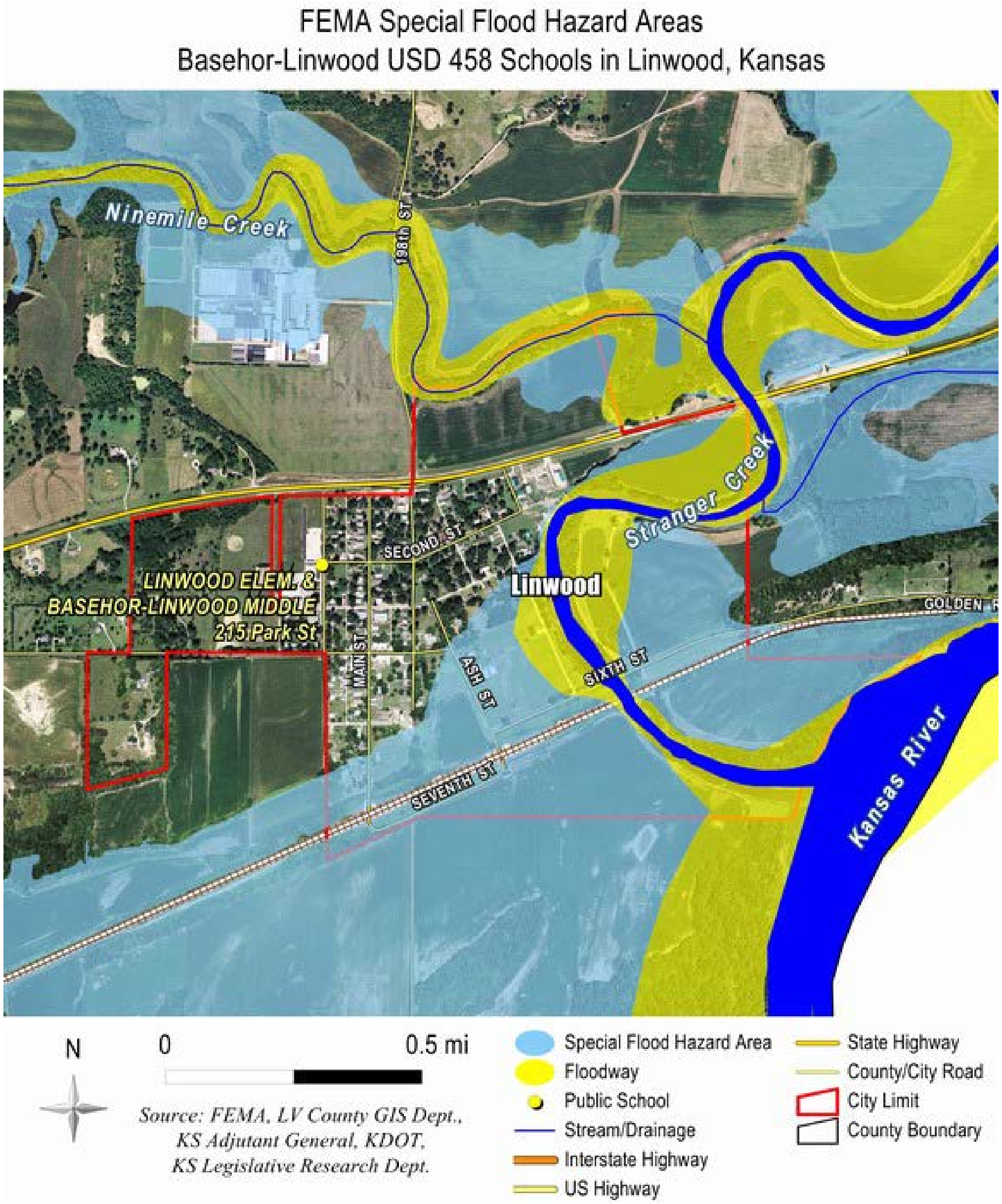


Figure 3.53. USD449

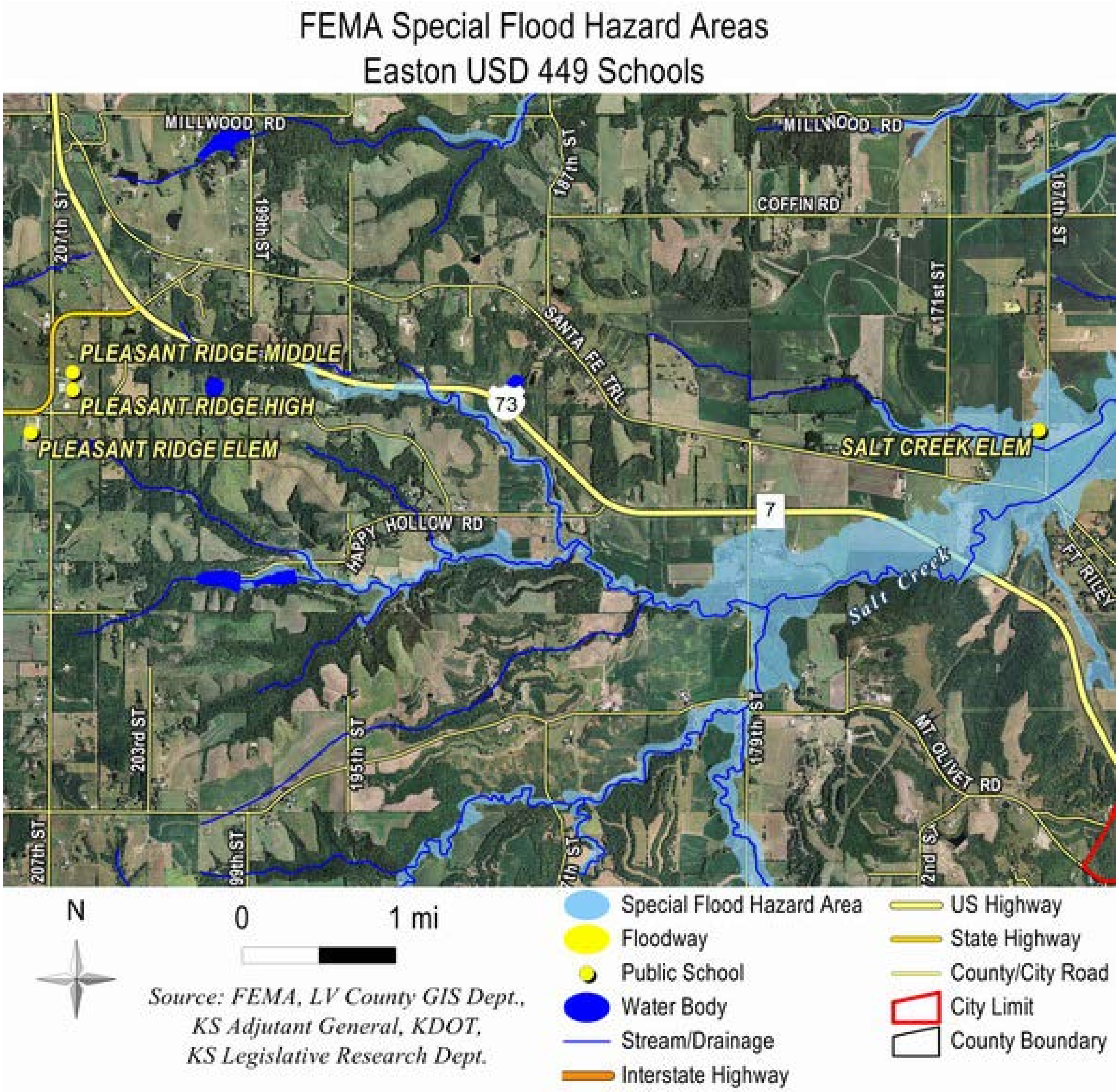


Figure 3.54. USD469

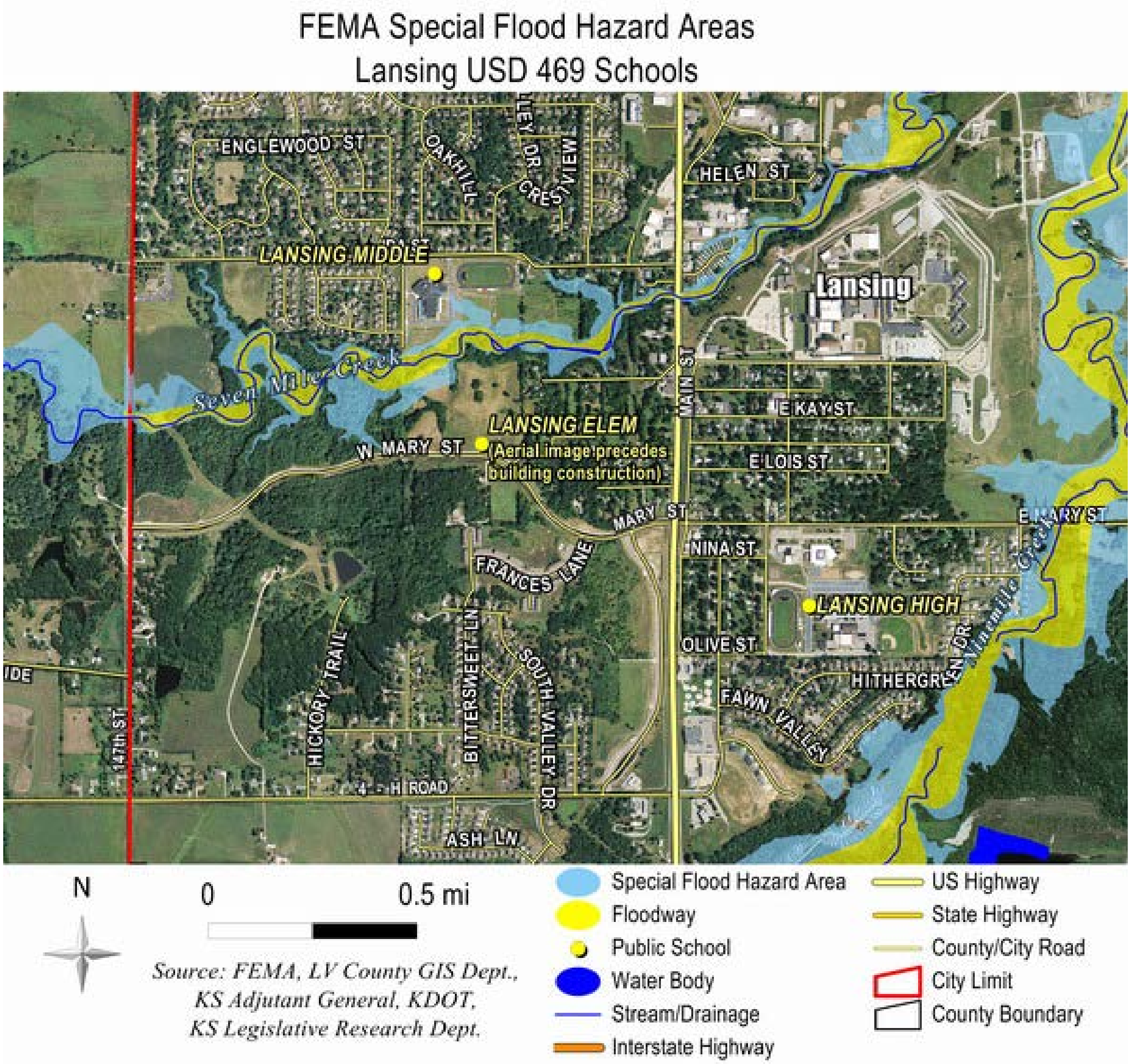


Figure 3.55. USD453

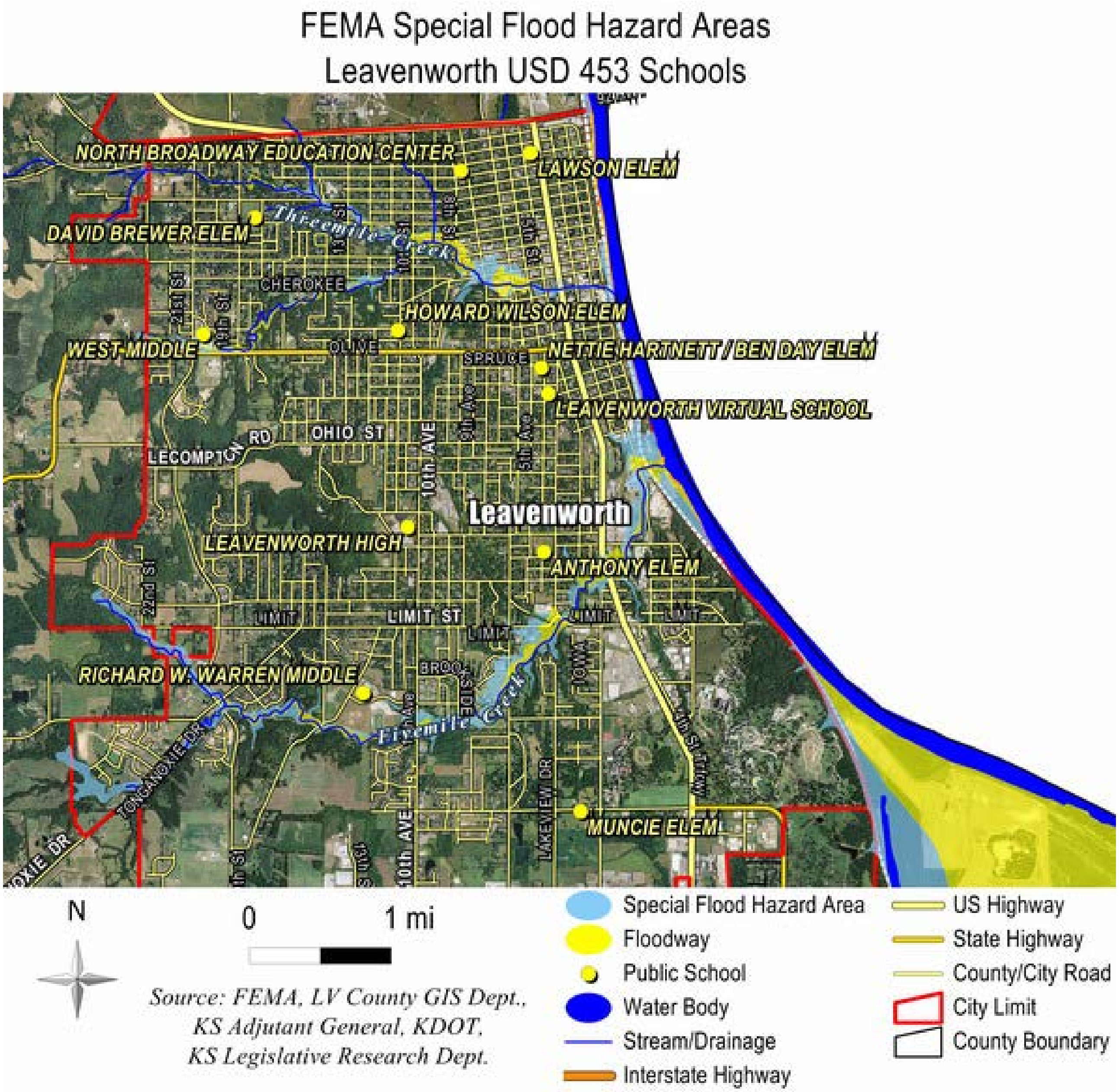


Figure 3.56. USD464

Figure 3.57. University of Saint Mary

Wyandotte County
Figure 3.58. City of Kansas City, KS

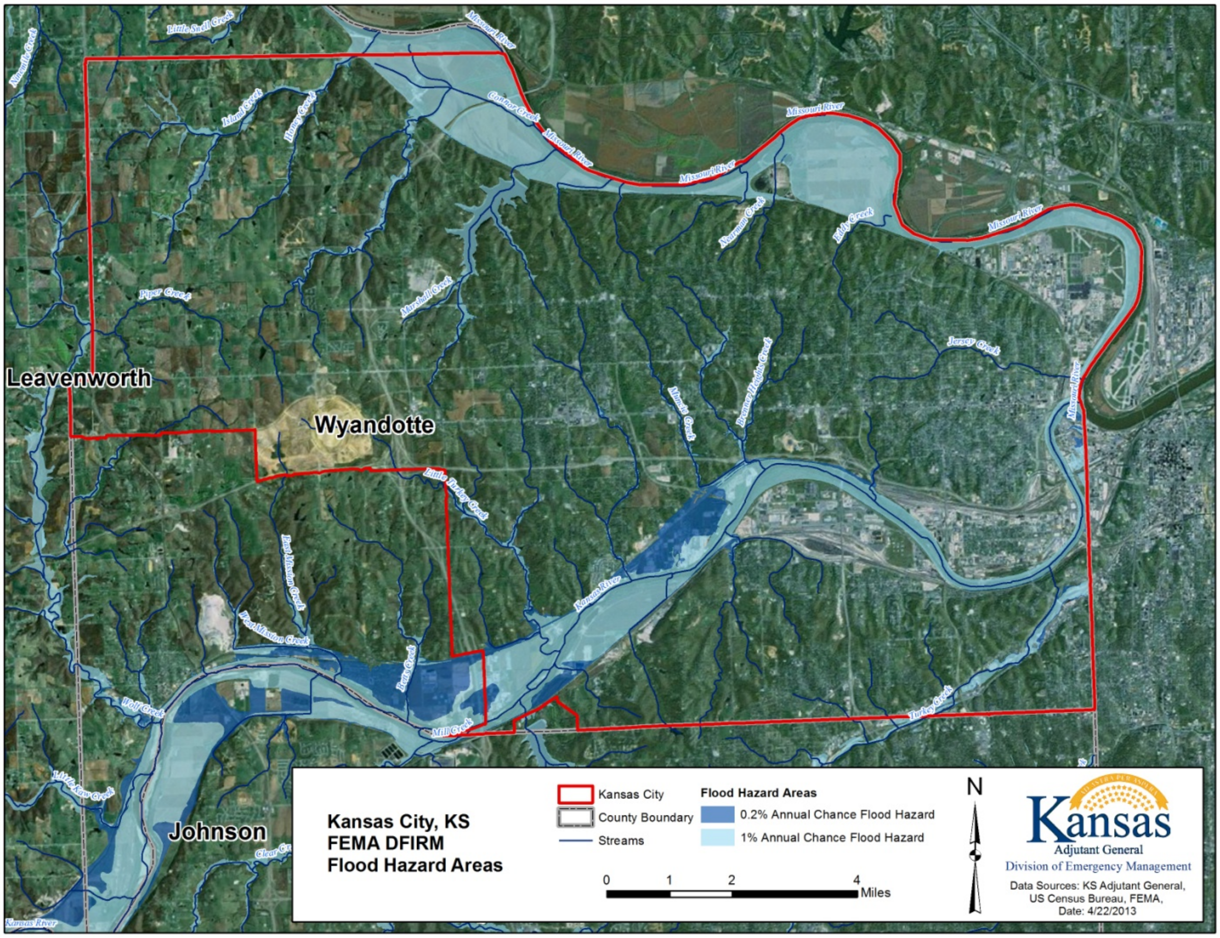


Figure 3.59. USD202

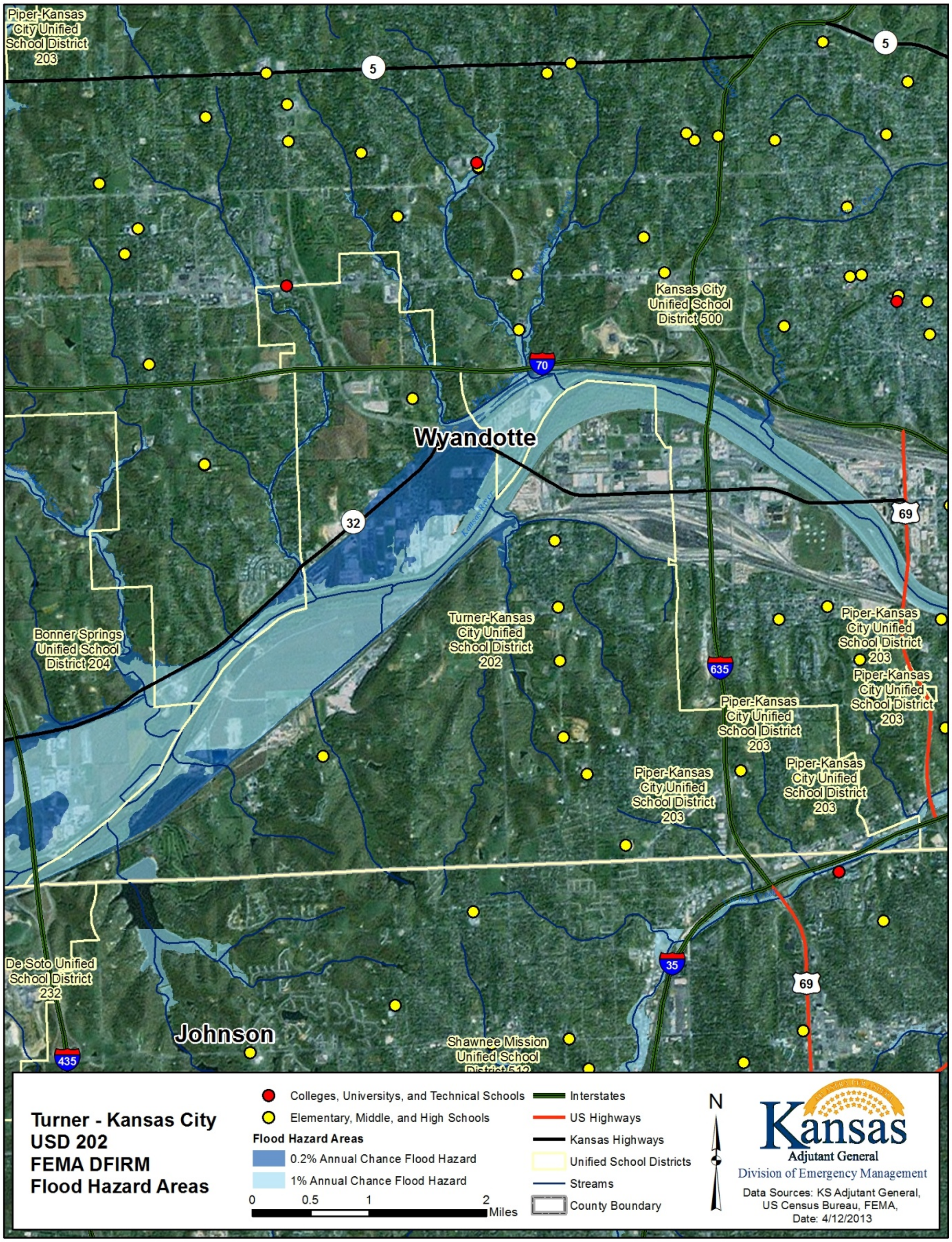


Figure 3.60. USD203

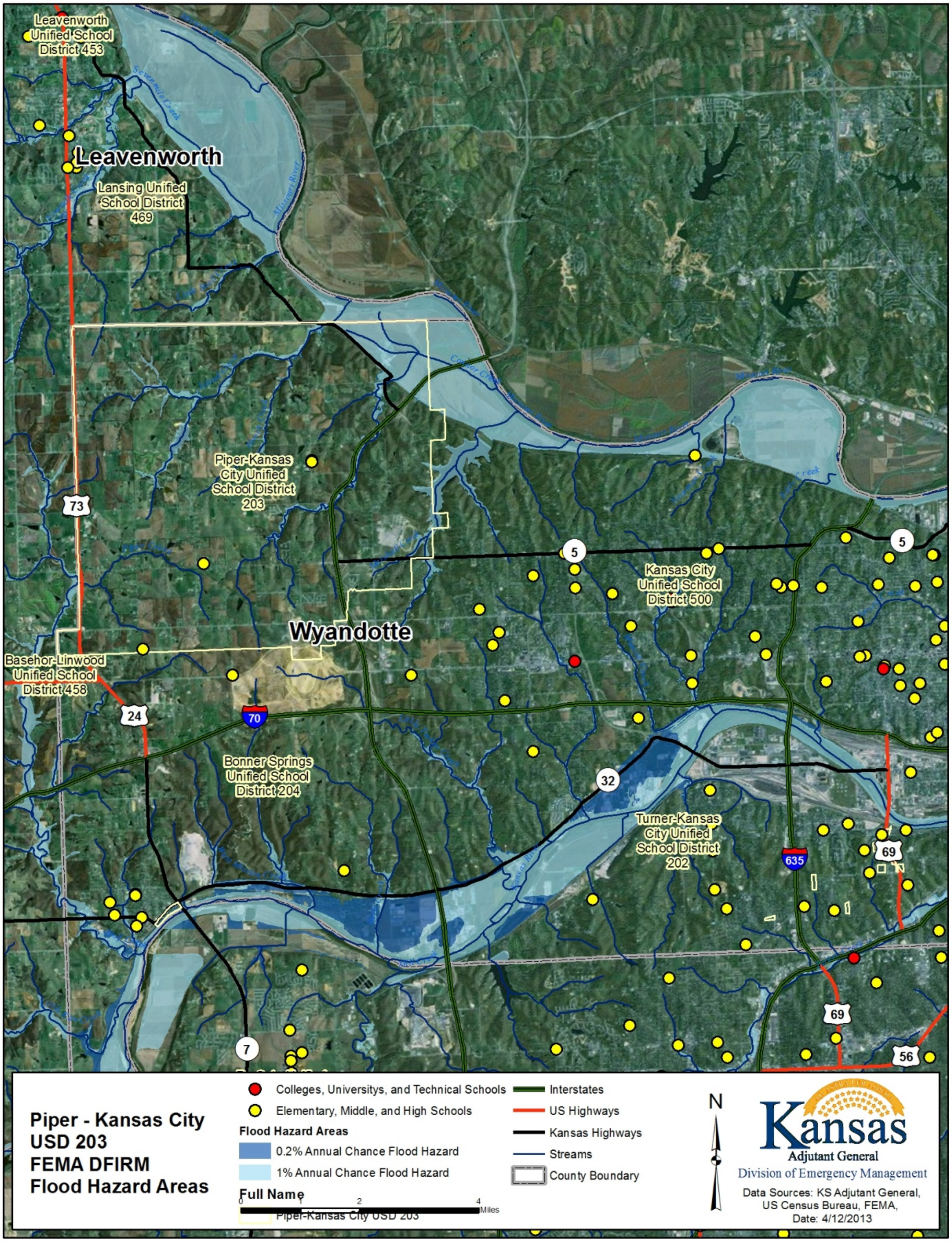


Figure 3.61. USD204

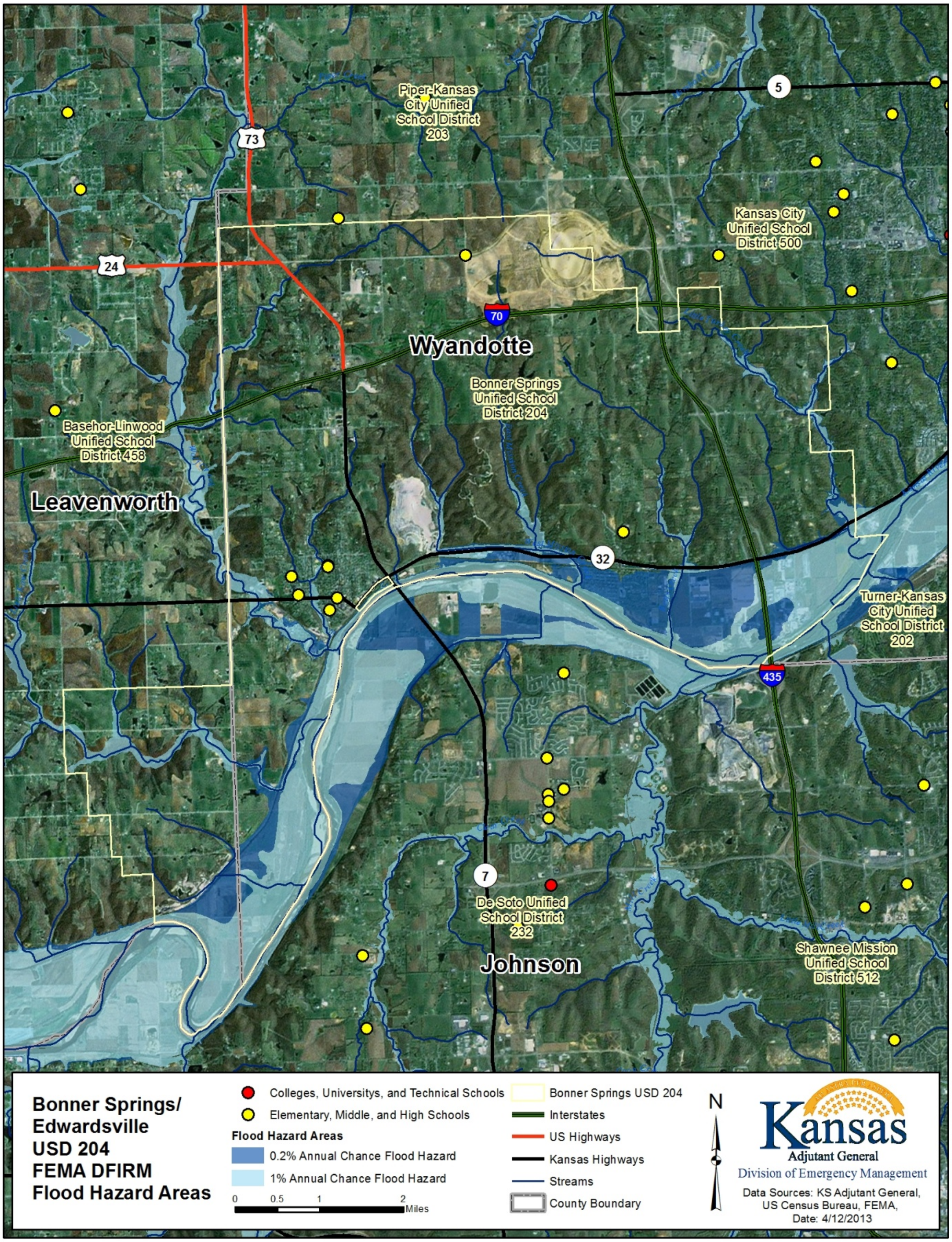


Figure 3.62. USD500

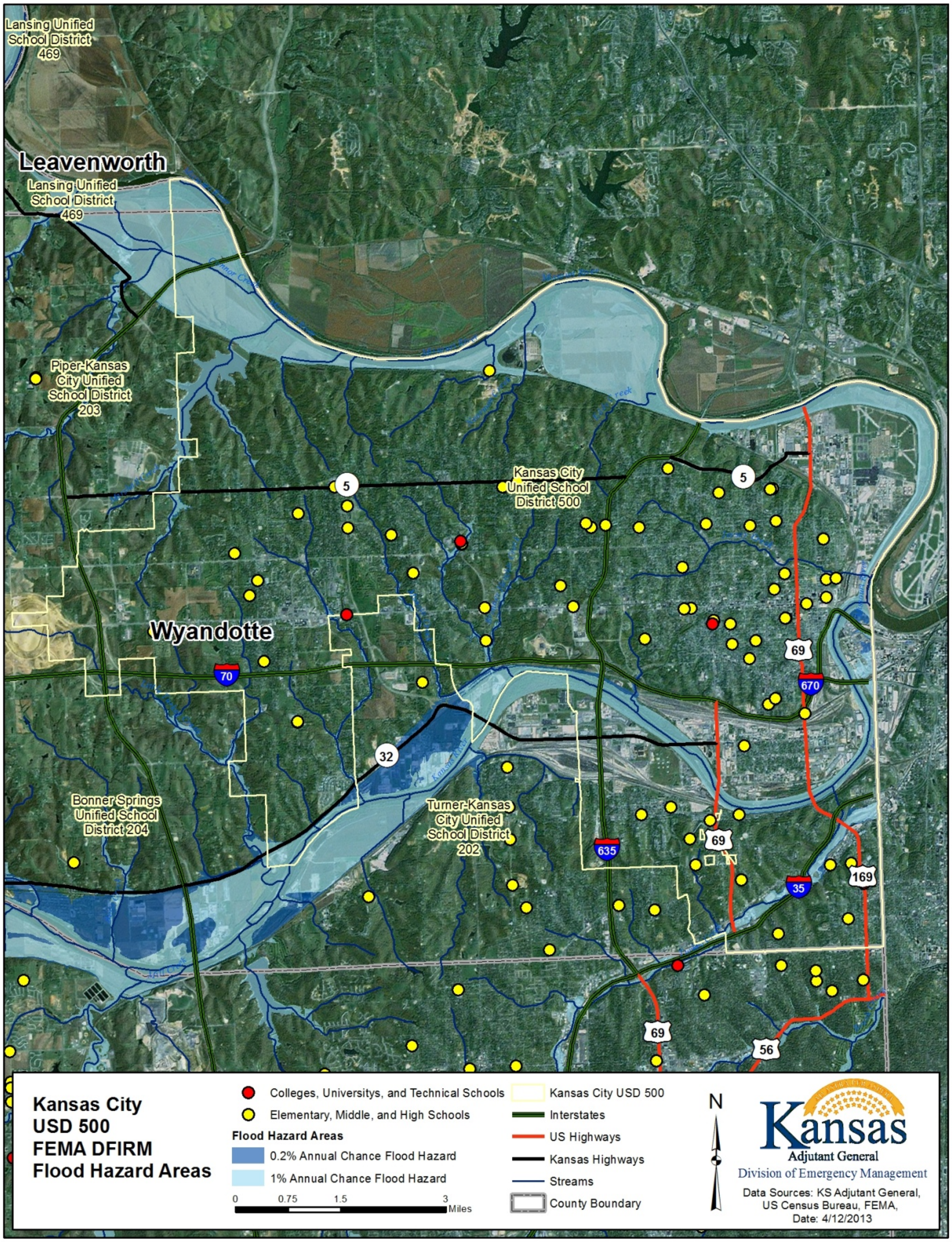


Figure 3.63. Kansas City Kansas Community College

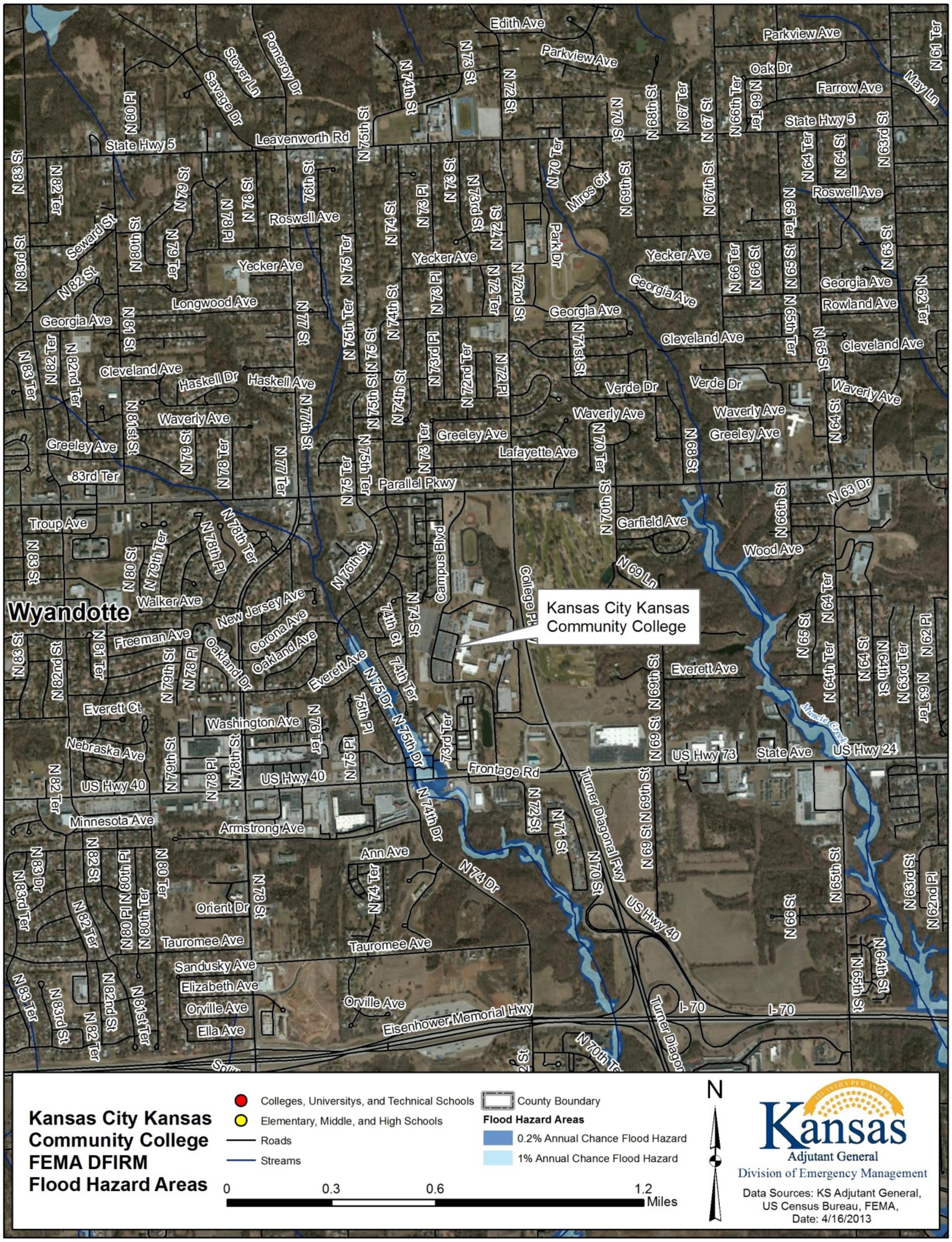


Figure 3.64. Kansas State School for the Blind

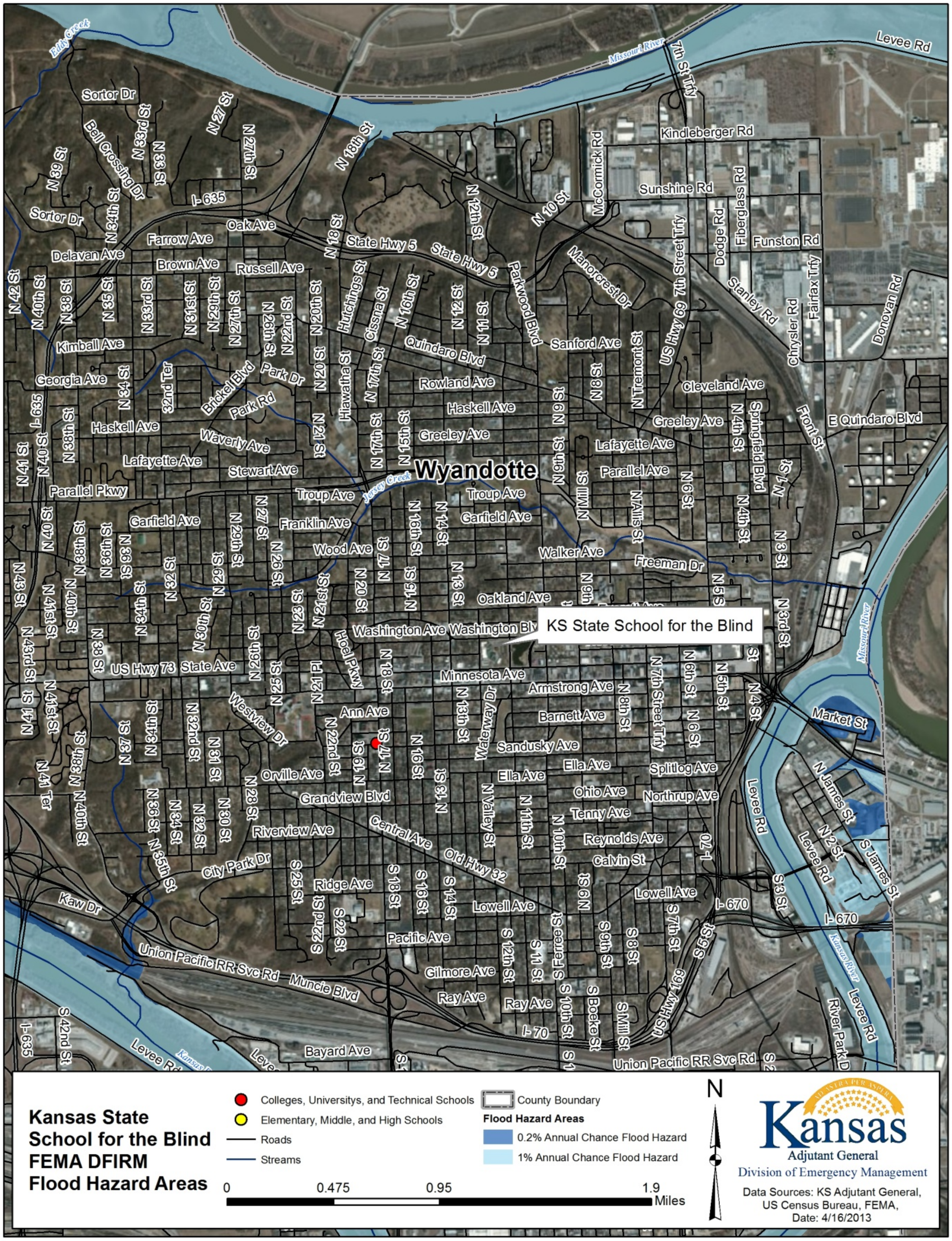
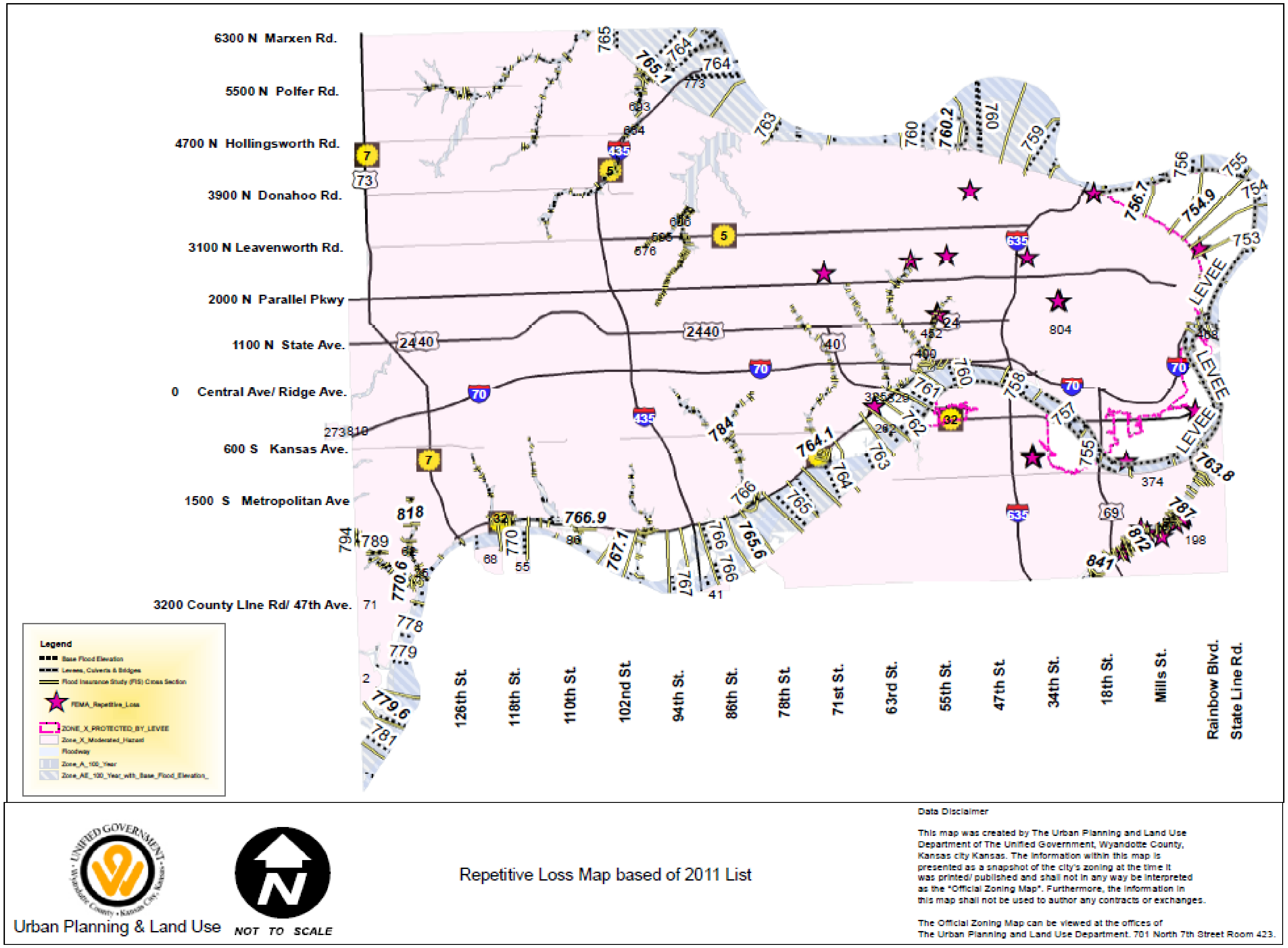


Figure 3.65 RL Properties – Wyandotte County



Consequence (Impact) Analysis

The information in **Table 3.85** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.85. EMAP Consequence Analysis: Flood

Subject	Ranking	Impacts/Flood
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe depending on the level of flood waters. Individuals further away from the incident area are at a lower risk of being affected. Casualties are dependent on warning time.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal to Severe	Temporary relocation may be necessary if inundation affects government facilities (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens to minimal to moderate.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to the flood waters (minimal to severe).
Environment	Severe	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the area flooded, depth of water, and the amount of time it takes for the water to recede (minimal to severe).
Public Confidence in Jurisdiction’s Governance	Minimal to Severe	Depending on the perception of whether the flood could have been prevented, warning time, and the time it takes for response and recovery will greatly impact the public’s confidence (minimal to severe).

3.2.10 Hailstorm

Calculated Priority Risk Index	Planning Significance
2.50	Moderate

Description

Hail is precipitation that is formed when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere causing them to freeze. The raindrops form into small frozen droplets and then continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen rain droplet can continue to grow and form hail. As long as the updraft forces can support or suspend the weight of the hailstone, hail can continue to grow. When the updraft can no longer support the hailstone, it will fall down to the earth. For example, a ¼" diameter or pea sized hail requires updrafts of 24 mph, while a 2 ¾" diameter or baseball sized hail requires an updraft of 81 mph.

Hailstorms can cause damage to property, crops and the environment and kill and injure livestock. Because of the agricultural footprint in the planning area, crop damage and livestock losses due to hail are of concern. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are other concerns most commonly damaged by hail. Hail has been known to cause injury to humans, occasionally fatal injury.

Based on information provided by the Tornado and Storm Research Organization, **Table 3.86** below describes typical damage impacts of the various sizes of hail.

Table 3.86. Tornado and Storm Research Organization Hailstorm Intensity Scale

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

Location

Hail can happen anywhere within Region L. The planning area consists of agricultural and urban landscapes, each being vulnerable in their own way. The agricultural areas of the planning area are vulnerable in terms of crops and livestock, directly affecting farmer's economic outlook. The urban areas are vulnerable in terms of people, infrastructure, and buildings.

Between the years 2000 and 2012, the hail events in Region L have been considerable. The following table shows the events by county for the period 2000-2012.

Table 3.87. Hail Events by County in Region L

County	Event (#)
Johnson	247
Leavenworth	188
Wyandotte	63
Total	**498**

Source: National Climatic Database

Previous Occurrences

Due to the large number of hail events in the planning area since the last plan updates, the following occurrences are a sample taken from the past few years that reflect the extent of hail occurrences in Region L.

- **Jun 2009** - Severe thunderstorms produced several reports of large hail. This was during the evening hours of June 9, 2009, as a cold front pushed through the area. Several cities in the planning area reported up to 1.75 inch in diameter hail.

- **April 2010** - Severe thunderstorms brought large hail and damaging winds to the area, during the morning hours of April 30, 2010 in Leavenworth and Wyandotte Counties. Hail was reported at some locations as **1.50** inches in diameter.

- **Sep 2010** - A warm and unstable air mass was located over the region, during the afternoon and evening hours of September 18, 2010. A cold front moved southeast across the Leavenworth area in the afternoon and evening hours. There were numerous reports of hail up to **1.75 inches** in diameter.

- **Aug 2011** - The storms formed along a boundary of very warm temperatures in the Southern Plains, and cooler temperatures in the Mid-Missouri River valley. A developing cluster of storms over east central Kansas rapidly transitioned into a wind producing MCS, as it approached and crossed the Kansas City metro. However, ahead of this complex, a very strong storm dropped south out of Nebraska, and produced extreme hail up to the size of **4.5 inches** in the cities of Easton and Leavenworth. This storm however decreased in intensity as it entered Kansas City, setting the stage for the strong wind producing MCS in east central Kansas to become the main threat. Measured wind speeds between 60 and 80 mph, raced through extreme eastern Kansas, causing additional tree and power line damage leading to power outages.

- **May 2012** - A cold front moved southeast across the area, during the afternoon through evening hours, of May 6, 2012. The front produced scattered thunderstorms, with a|few becoming severe. There were numerous reports in Johnson County of hail up to **1 inch**, along with two reported tornadoes.
- **Aug 2012** - A cold front brought severe thunderstorms to portions of extreme eastern Kansas, during the late afternoon and evening hours of August 8, 2012. Hail was reported as up to **1 inch** in diameter

Extent

Hail is a common occurrence across the planning area, specifically in the spring and summer months. The severity of the incidence is tied to the size of the hail, and the location of the event. The planning committee has determined that the magnitude of this hazard is negligible. Injuries and/or injuries could be treated with first aid.

Probability of Future Events

According to the National Climatic Data Center Storm Events, there were 498 hail events in the planning area between the years 2000 and 2012 (12 years). Based on this information, the probability of at least one hail event in any given year in Region L is **"Highly Likely".**

Impact and Vulnerability

Severe thunderstorms and associated hail events will continue to cause damage to anything and everything exposed to the weather elements. To determine potential financial loss estimates to hail in Region L, the available historical loss data was annualized. In the case of frequently occurring weather-related hazards such as hail, annualized historical loss data is considered to be the best resource for determining future potential losses. The planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (2006 – 2012) and the USDA Risk Management Agency insured crop loss payments (2002 – 2011) since agriculture plays such as important role in the various sectors of Region Ls economy. According to this data, in the past 12 years there have been 498 hail events in the Region, with an average of 41.5 events per year. Because this data was based on each county's data, one hail event could be included three times; one for each county. Loss estimates are difficult to provide because so much of it is private insurance and not available for this plan. However, Region L saw annualized property damages between 2006 and 2012 at $265,357, and crop insurance paid for the same time period at $6,633 for the planning area.

All 3 counties in the planning area are vulnerable to hailstorms. The statistical analysis method was used to refine and assess the relative vulnerability of each of these counties to hail. Ratings were assigned to pertinent factors that were examined at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized insured crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

The following are the data sources for the rating factors: Social Vulnerability Index for the counties from the Hazards and Vulnerability Research Institute at the University of South Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010), USDA's Census of Agriculture (2007) and USDA Risk Management Agency (2002 – 2011). Please note that the data on crop losses only applies to insured crops. According to the *2011 Kansas Crop Insurance Profile Report* issued by the USDA Risk Management Agency 82 percent of Kansas' row crops were insured in 2011.

It was determined that since hail is a common occurrence in the region, that using historical events and property damages from 2006 forward provides adequate events to describe the hail hazard in Kansas.

Table 3.88 provides the data obtained for each of the factors by county. **Table 3.89** that follows provides the ranges that were used to determine the resulting ratings.

Table 3.88. Vulnerability of Kansas Counties Factor Amounts for Hail

County	So VI Rating (1-5)	Prior Events 2006 – 2012	Property Damages	Annualized Property Damages	Total Building Exposure ($1000)	Population Denstiy	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Hail	Annualized Crop Insurance paid
Johnson	1	132	$1,020,000	$145,714	$43,871,468	1,149.60	$29,472,000	$28,592	$2,859
Leavenworth	1	107	$362,000	$51,714	$4,877,783	164.7	$20,983,000	$37,737	$3,774
Wyandotte	3	29	$475,500	$67,929	$12,066,666	1,039.00	$0	$0	$0
Total		268	$1,857,500	$265,357	$60,815,917		$50,455,000	$66,329	$6,633

Note: The Census of Agriculture did not publish crop exposure inWyandotte County to avoid disclosure of individual operations. The following are the 1 – 10 ranges for the hail vulnerability factor ratings. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.89. Ranges for Hail Vulnerability Factor Ratings

Ratings	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss
1		18 - 55	0 - $10,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	0 - $100,000
2	1	56 - 90	$10,001 - $50,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$100,001 - $300,000
3		91 - 125	$50,001 - $100,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$300,000 - $500,000
4	2	126 - 160	$100,001 - $300,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$500,001 - $700,000
5		161 - 195	$300,001 - $500,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$700,001 - $900,000
6	3	196 - 230	$500,001 - $700,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$900,001 - $1,100,000
7		231 - 265	$700,001 - $900,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$1,100,001 - $1,300,000
8	4	266 - 300	$900,001 - $1,100,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$1,300,001 - $1,700,000
9		301 - 335	$1,000,001 - $4,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$1,700,001 - $2,100,000
10	5	336 - 370	$4,000,000 - $32,012,357	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$2,100,000 - $2,300,000

Source: State Hazard Mitigation Plan. * Population density is the number of people per square mile.

Table 3.90 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and **Table 3.91** provides the seven rating values assigned that were considered in determining overall vulnerability to hail.

Table 3.90. Ranges for Overall Hail Vulnerability

Ranges	Low	Medium-Low	Medium	Medium-High	High
	9 - 14	15 - 21	22 - 28	29 – 35	36 - 41

Source: State Hazard Mitigation Plan

Table 3.91. Vulnerability of Kansas Counties to Hail

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Hail Vulnerability
Mitigation Planning Region L									
Johnson	2	4	4	10	10	2	1	33	Medium-High
Leavenworth	2	3	3	2	2	2	1	15	Medium-Low
Wyandotte	6	1	3	3	10	1	1	25	Medium

Source: State Hazard Mitigation Plan 2013

Johnson County ranks 5th in the State of Kansas for vulnerability to Hail. Leavenworth and Wyandotte did not make the top 10, however this does not negate the risk of this hazard that they face as a normal occurrence.

Severe thunderstorms and the associated hail events will continue to cause damage to anything and everything exposed to the weather elements, including people, crops, livestock, and structures.

Summary

The entire planning area is susceptible to hail, to include agricultural land, livestock, people, and property. Mitigating for hail is difficult because there is no way to predict with 100% accuracy on when or where it will happen.

Local Mitigation Concerns

- According to the Census of Agriculture, the planning area has 327,163 acres that is used for agricultural purposes. It is this agricultural footprint that has the potential to have an economic impact from hail damages sustained during a hail event. All the counties within the Region are susceptible to this hazard, which is difficult to mitigate for when large areas of land are affected.
- Region L has the highest incidence of growth in the state of Kansas. While buildings and people are relatively safe from hail events, the potential is there for injuries or death related to this hazard, normally dependent on where an individual is when an event occurs and the intensity of the event itself. Driving the transportation nodes, or playing golf can be dangerous pastimes if an individual is caught unaware during an event with 4.5 inch diameter hail, as seen on the previous occurrence of August 2011 . Infrastructure and buildings can also see damage with large hail.

Development in Hazard Prone Areas

The increased level of new development is not as significant to hail damage as the agricultural losses. The economic result due to hail damage can reverberate throughout the local communities. Counties in the planning area that have the most farmland acreage will bear a larger loss than the counties that are mainly industrialized and business leaning. In the more urbanized counties such as Johnson and Wyandotte the impact is no less severe, just different. Nurseries, residential landscaping, and inner city landscaping improvements can take a heavy toll due to hail.

Johnson County

Table 3.92. Johnson County CPRI: Hail

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Hail	4	1	2	1	2.50	Moderate

Leavenworth County

Table 3.93. Leavenworth County CPRI: Hail

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Hail	4	1	2	1	2.50	Moderate

Wyandotte County

Table 3.94. Wyandotte County CPRI: Hail

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Hail	4	1	2	1	2.50	Moderate

Consequence (Impact) Analysis

The information in **Table 3.95** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.95. Consequence Analysis, Hail

Subject	Ranking	Impacts/Hailstorm
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas depending on whether individuals are caught outside during the event and size of hail.
Responders	Minimal	Impact to responders is expected to be non-existent to minimal.
Continuity of Operations	Minimal to Moderate	Temporary relocation may be necessary if government facilities experience damage (minimal to moderate).
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be severe to facilities and infrastructure in the incident area. Utility lines, roads, residential and business properties will be most affected.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained (minimal to severe).
Environment	Severe	Impact could be severe for the immediate impacted area, depending on the size of the event. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Local economy and finances may be adversely affected, depending on damages sustained (minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal to Moderate	Response and recovery will be in question if not timely and effective. Warning systems in place and the timeliness of those warnings could be questioned (minimal to moderate).

3.2.11. Hazardous Materials

Calculated Priority Risk Index	Planning Significance
2.90	Moderate

Description

Hazardous materials and waste are a concern for Region L because a sudden accidental or intentional release (see Section 3.3.17 Terrorism/Agri-terrorism) of such materials can be dangerous to human health and safety, to property, and to the quality of the environment. Such releases may come from both fixed sources, such as a manufacturing or storage facility, or from a transportation source, such as a truck or pipeline. Accidental releases may be due to equipment failure, human error, or a natural or manmade hazard event.

Generally, with a fixed facility, the hazards are pre-identified, and the facility is required by law to prepare a risk management plan and provide a copy to the local emergency planning committee (LEPC) and local fire departments.

Agricultural facilities throughout the planning area are likely to have dangerous materials present that could pose a threat to surrounding populations in the event of an emergency or disaster. Facilities that store or use chemicals considered unusually dangerous to human safety are required by Section 112R of the Clear Air Act Amendments to assess the potential impacts of an accidental release of the chemical at their facility and to prepare risk management plans (RMP). Of particular interest to the Region and all of Kansas is that ammonia is one of the covered hazardous materials. Numerous Kansas ammonia storage and distribution facilities have filed an RMP with the U.S. Environmental Protection Agency (EPA). A database with information about Kansas facilities that have RMPs is available through the EPA at www.rtknet.org/rmp/KS.php .

Location

The primary agency responsible for hazardous materials within the State of Kansas is the Kansas Department of Health and Environment, Division of Environment http://www.kdheks.gov/environment/index.html . The Kansas Response Plan, Emergency Support Function #10 – Oil and Hazardous Materials is another resource for response information. (The Kansas Response Plan is not added as an appendix to this mitigation plan for security reasons.)

Hazardous materials pose a threat to communities in all areas of the Region. Localities where hazardous materials are fabricated processed and stored as well as those where hazardous waste is treated, stored and disposed of are most at risk for hazardous materials incidents. Additionally, localities along transportation corridors that carry these materials to their final destinations are at risk.

The planning committee considers the risk level from hazardous materials accidents to be moderate due to expanded development and industrialization of the Kansas City Metropolitan area. Generally, it is the developed areas or environmental resources in the immediate vicinity of facilities or transportation routes that would be at risk.

Fixed Facility Locations

In 2011, there were 373 facilities housing hazardous chemicals in the planning area, identified by the Community Right to Know Act. The breakdown by counties can be seen in **Table 3.96**.

Table 3.96. Number of Facilities Housing Hazardous Chemicals by County, 2011.

County	Number of Facilities
Johnson	205
Leavenworth	29
Wyandotte	139
Total	373

Source: State Hazard Mitigation Plan

Table 3.97 shows the U.S. Environmental Protection Agency Superfund sites in Region L. A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, which may affect local ecosystems and/or people. Two sites are currently on the Superfund National Priority list for the planning area. The proposed date and final date are the National Priority Listing history information.

Table 3.97. Superfund National Priorities List Sites in Kansas

National Priority	City	County	Proposed Date	Final Date
Chemical	Olathe	Johnson	1/18/1994	5/31/1994
Doepke Disposal		Johnson	12/30/1982	9/8/1993

Source: U.S. Environmental Protection Agency, http://www.epa.gov/region7/cleanup/index.htm

Pipelines

According to the U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration's Pipeline Safety Stakeholder Communications, Region L's gas transmission line and hazardous liquid line mileage are seen in **Table 3.98.** All mileages are for 2010 and are approximate as some data sources may not have contained a complete record of pipeline mileage.

Table 3.98. Gas Transmission Line and Hazardous Liquid Line Mileage by Mitigation Planning Region and County.

County	Gas Miles	Liquid Miles	Percent of Total
Mitigation Planning Region L			
Johnson	232	120	1.40%
Leavenworth	106	134	0.90%
Wyandotte	66	155	0.80%
Subtotal	404	409	

Source: U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration
http://primis.phmsa.dot.gov/comm/reports/safety/KS_detail1.html?nocache=3112#_OuterPanel_tab_6

Figure 3.66 shows the locations of the Region's gas and petroleum lines. **Figure 3.67** reflects the transportation Routes in the Region.

Figure 3.66 Region L's Gas Transmission and Petroleum Lines

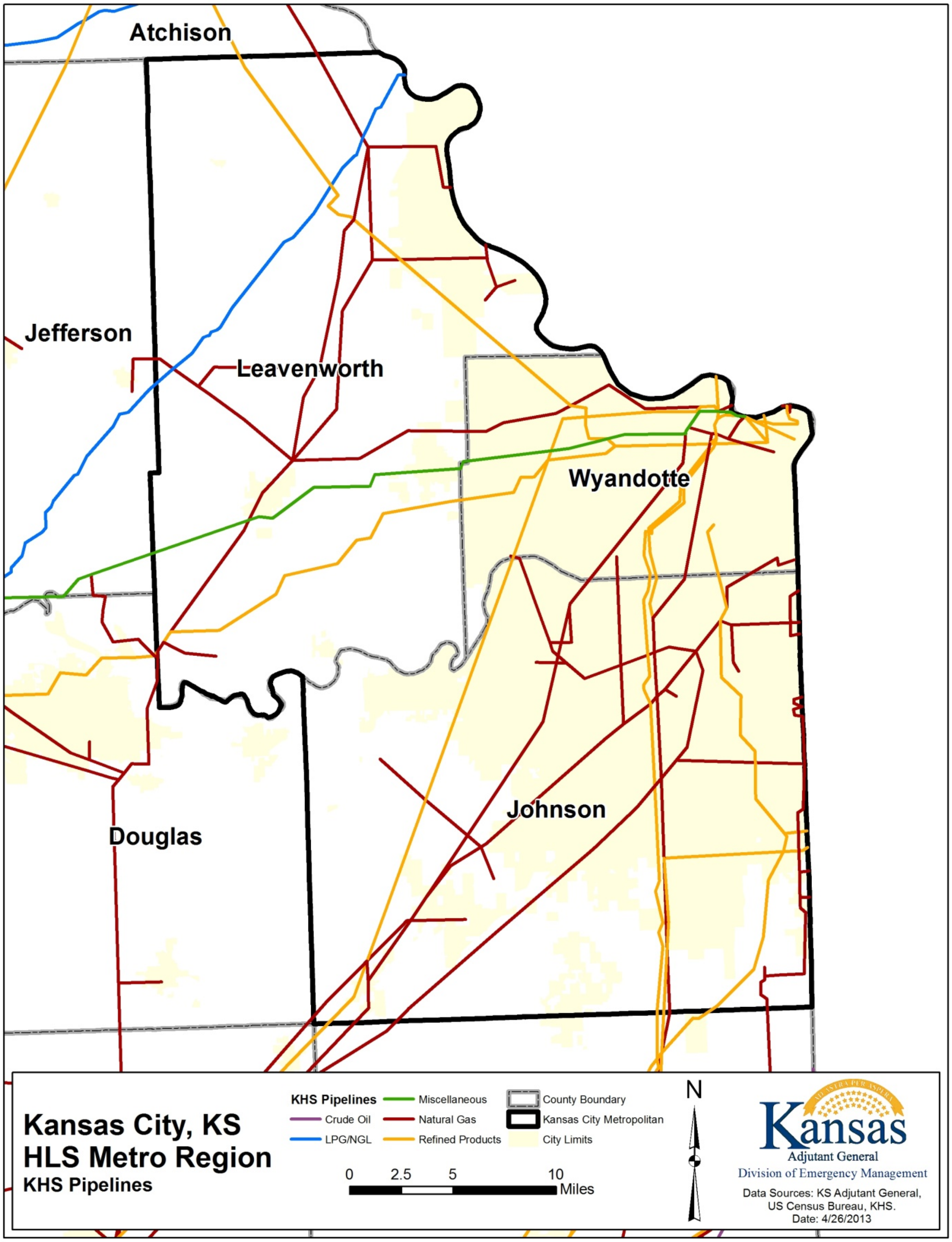
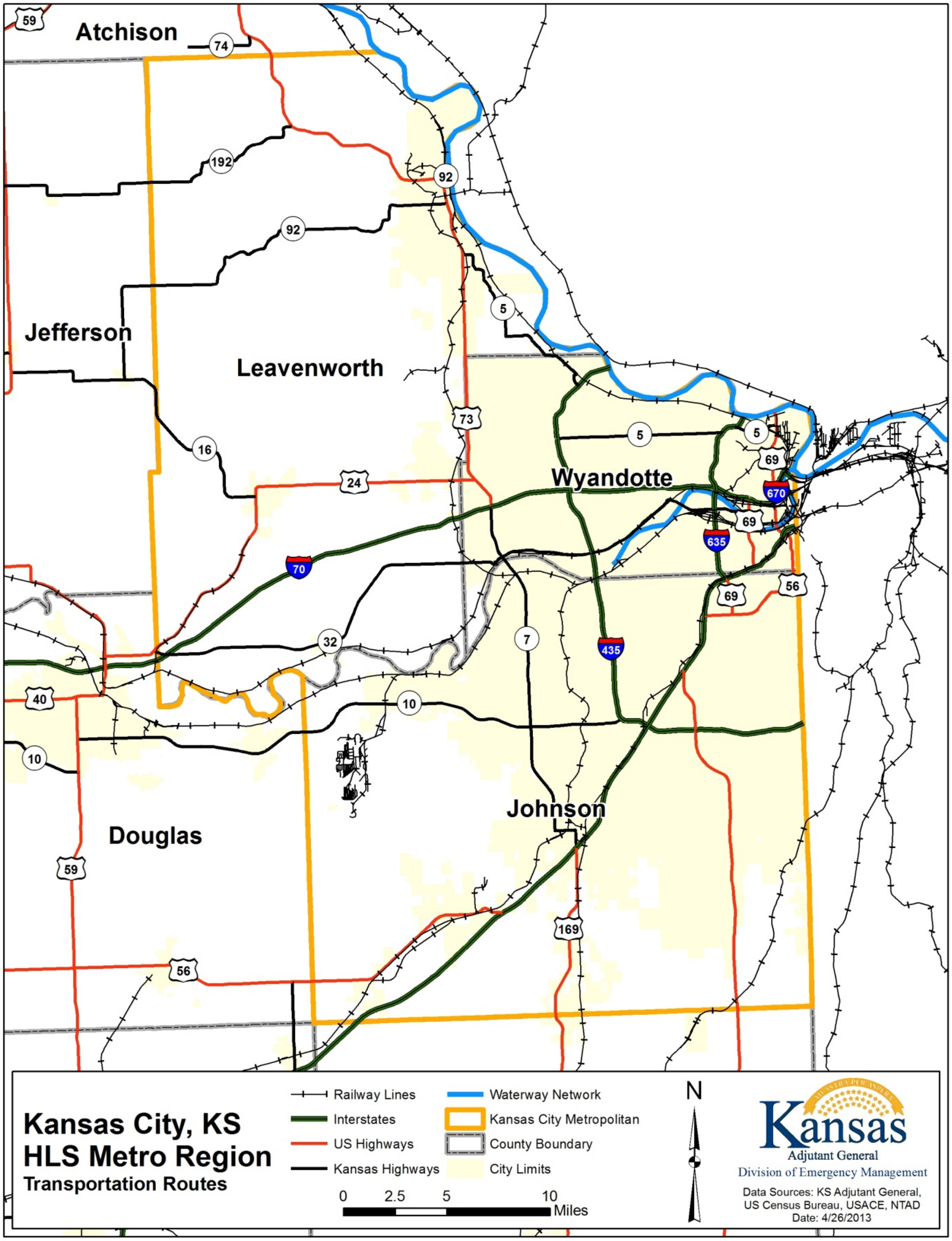


Figure 3.67 Region L's Transportation Routes



Previous Occurrences

When viewed statewide, hazardous materials accidents are frequent events. Annualized statistics from the Kansas Division of Emergency Management, Technological Hazards Section in **Table 3.99** indicates the number of Region L incidents at the primary locations of fixed facility, motor carrier, pipeline and rail during the 10-year period of 2003-2012. The largest number of incidents occurred at fixed facilities in Wyandotte County, and by motor carrier for Johnson and Leavenworth Counties during this timeframe.

The spiller is responsible to report to all the appropriate agencies depending on the material and volume spilled. To satisfy the requirement of Kansas Regulation K.A.R. 28-48 all spills that impact the soils or waters must be reported to the KDHE or in the case that it originates from an oil or gas production leases, be reported to the Kansas Corporation Commission.

If the release is not contained, or threatens the health or safety of the local population, the Local Emergency Planning Committee (LEPC) within the county of the release, must be notified first by dialing 911. Hazardous materials spills and air releases that meet federal reportable quantities and oil and petroleum spills over 110 gallons must also be reported to KDEM

Table 3.99. Primary Locations of Hazardous Materials Incidents, 2003-2012

Johnson County

Year	Fixed Facility	Motor Carrier	Pipeline	Rail	OTHER
2003	8	15	6	1	0
2004	3	7	0	0	2
2005	2	2	0	0	1
2006	3	0	0	0	0
2007	3	0	1	0	1
2008	1	2	0	0	2
2009	4	5	0	0	3
2010	5	5	0	1	0
2011	0	1	0	1	2
2012	0	6	1	0	2
Total	**29**	**43**	**8**	**3**	**13**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Leavenworth County

Year	Fixed Facility	Motor Carrier	Pipeline	Rail	OTHER
2003	0	1	0	0	0
2004	0	1	0	0	0
2005	1	1	0	1	0
2006	1	0	0	0	0
2007	1	3	0	0	1
2008	1	7	1	0	1
2009	3	5	1	0	3
2010	2	5	1	0	2
2011	0	3	0	0	0
2012	0	4	0	0	0
Total	**9**	**30**	**3**	**4**	**7**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Wyandotte County

Year	Fixed Facility	Motor Carrier	Pipeline	Rail	OTHER
2003	21	4	0	6	0
2004	9	3	2	11	3
2005	9	2	2	6	2
2006	15	1	0	7	2
2007	5	1	0	2	0
2008	6	1	0	3	0
2009	18	2	0	7	0
2010	11	2	0	8	4
2011	5	1	0	3	1
2012	8	2	1	8	4
Total	**107**	**19**	**5**	**61**	**16**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Table 3.100 shows that the major cause of hazardous material incidents in Region L, broken out by County, was due to spills for incidents from 2003-2012. Note that the total number of causes may be greater than the total number of spills. Each release can have multiple causes.

Table 3.100. Causes of Hazardous Materials Incidents in Region L, by County., 2003-2012

Johnson County

Year	Explosion	Fire	Spill	Equipment Failure	Operator Error	Natural	Dumping	Other
2003	1	3	17	6	4	0	0	0
2004	0	0	3	7	2	0	0	1
2005	0	0	2	3	2	0	0	1
2006	0	0	2	2	0	0	0	1
2007	0	0	1	3	1	0	0	1
2008	0	1	4	0	1	0	0	1
2009	0	1	6	3	2	1	0	2
2010	0	0	7	4	1	0	0	4
2011	0	0	4	1	0	0	0	1
2012	0	1	6	2	1	0	0	1
Total	**1**	**6**	**52**	**31**	**14**	**1**	**0**	**13**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Leavenworth County

Year	Explosion	Fire	Spill	Equipment Failure	Operator Error	Natural	Dumping	Other
2003	0	0	1	1	0	0	0	0
2004	0	0	0	0	0	0	0	1
2005	0	1	2	1	1	0	1	0
2006	0	1	0	0	0	0	0	0
2007	0	0	2	1	2	0	0	2
2008	0	0	5	2	4	0	0	5
2009	0	1	3	2	3	0	4	1
2010	1	1	5	3	1	0	0	4
2011	0	0	0	0	0	0	0	3
2012	0	0	3	0	1	0	0	2
Total	**1**	**4**	**21**	**10**	**12**	**0**	**5**	**18**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Wyandotte County

Year	Explosion	Fire	Spill	Equipment Failure	Operator Error	Natural	Dumping	Other
2003	0	0	15	12	1	2	0	2
2004	0	0	12	6	5	0	1	12
2005	0	1	3	9	3	0	0	5
2006	0	0	10	7	4	0	0	9
2007	0	0	2	5	0	0	0	1
2008	0	0	4	2	1	0	0	7
2009	0	0	8	15	0	1	0	10
2010	0	0	18	9	0	0	0	4
2011	0	0	7	4	0	0	0	1
2012	0	1	18	4	3	0	0	4
Total	**0**	**2**	**97**	**73**	**17**	**3**	**1**	**55**

Source: Kansas Division of Emergency Management, Technological Hazards Section

U.S. Department of Transportation's Pipeline & Hazardous Materials Safety Administration

Reports from the U.S. Department of Transportation's Pipeline & Hazardous Materials Safety Administration's provides detail and incident history for the pipeline systems in the planning area between 2001 and 2012. Significant incidents are those incidents reported by pipeline operators with any of the following conditions met: 1) fatality or injury requiring in-patient hospitalization; 2) $50,000 or more in total costs, measured in 1984 dollars; 3) highly volatile liquid releases of five barrels or more or other liquid releases of 50 barrels or more; 4) liquid releases resulting in an unintentional fire or explosion. According to these reports, there were 147 pipeline incidents that caused four fatalities, 24 injuries and $69.5 million in damages over the 12 year period (2001-2012). **Table 3.101** gives the incident details by county for the Region

Table 3.101. Details of Kansas Pipeline Incidents by Mitigation Planning Region and County, 2001-2012

County	Total Natural Gas Transmission Incidents	Total Natural Gas Distribution Incidents	Total Hazardous Liquid Incidents	Total Fatalities	Total Injuries	Total Damage	Gross Barrels Lost	Total Barrels Recovered
Mitigation Planning Region L								
Johnson	3	1	1	0	0	$1,897,704	258	196
Leavenworth	1	0	0	0	1	$80,160	0	0
Wyandotte	2	0	7	1	3	$14,724,798	6,800	5,089
Total	**6**	**1**	**8**	**1**	**4**	**$16,702,662**	**7,058**	**5,285**

Source: U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration, http://primis.phmsa.dot.gov/comm/reports/safety/IncDetSt_st_KS_flt_sig.html?nocache=999#_all

Notes: The costs shown are in 2011 dollars. For years 2002 and later, property damage is estimated as the sum of all public and private costs reported in the 30-day incident report. For years prior to 2002, accident report forms did not include a breakdown of public and private costs so property damage for these years is reported total property damage field in the report.

Notable Hazardous Materials Incidents

- 15 Feb 2010 a fuel tanker spill near the 18th expressway & Kansas in Kansas City, Kansas. 800 gallong of gasoline flowed into the storm sewer in Wyandotte County.
- 16 Feb 2010 an oil lease spill of 4000 gallons of crude oil in a rural area threatening waterways in Leavenworth County.
- 15 Jul 2012 a fuel tanker truck wrecked in a ditch near I-435 and State Line, Overland Park. 2000 gallons of diesel fuel spilled causing road closures.

Extent

The extent of a Hazardous Material incident would depend greatly on the type of Hazardous Material, the location, and the amount of material that is released. Due to the variables of this hazard, the planning committee has determined that this hazard would be negligible. The event would not result in injuries or illness that could not be treated by first aid.

Probability

The release of hazardous materials, whether through accidental spills, human error, or other etiology is not in and of itself uncommon in the planning area. Minor occurrences happen fairly frequently. Precautions, laws, regulations, and checklist are all utilized to avoid this hazard, however they continue to happen. During the last three full years, 2010 – 2012, there were 357 hazardous incidents in the planning area. This results in a 100% chance of this hazard occurring in any given year. The planning committee has assigned this hazard a probability of **"Highly Likely**."

Impact and Vulnerability

Table 3.102 lists the number of hazardous materials incidents, injuries, fatalities and people evacuated from the public and facilities by county in the Region over the 10-year period of 2003-2012. There were a total of 357 incidents reported to KDEM

Table 3.102. Reported Number of Hazardous Materials incidents, Injuries, Fatalities and People Evacuated by County, 2003-2012

Incident County	Incidents	Injuries	Fatalities	People Evacuated
Mitigation Planning Region L				
Johnson	96	4	0	81
Leavenworth	53	49	3	152
Wyandotte	208	6	0	87
Total	**357**	**59**	**3**	**320**

Source: Kansas Division of Emergency Management, Technological Hazards Section

The impact of this type of disaster will likely be localized to the immediate area surrounding the incident. The initial concern will be for people and then the environment. If contamination occurs, the spiller is responsible for the cleanup actions and will work close with local responders, KDHE, KCC, KDEM, and EPA to ensure that cleanup is done safely and in accordance with federal and state laws.

As mentioned, it is difficult to determine the potential losses to existing development because of the variable nature of a hazardous materials spill. For example, a spill of a toxic airborne chemical in a populated area could have great potential for loss of life and by contrast, the spill of a very small amount of a chemical in a rural agricultural area would be much less costly and possible limited to remediation of soil.

For discussion purposes, the materials needed for a spill at a fixed facility at an easily remediated area are listed below in **Table 3.103.** The costs for the cleanup are estimated from the current State of Kansas Unified HazMat Response Program statewide contract # 35167.

Table 3.103 Potential Cost Estimate for HAZ-MAT Spill Remediation

Classification	Rates Per Hour/Unit	Number of Hours/Units	Total Cost
Project Manager	$90.00	24	$2,160
Health & Safety Supervisor	$86.00	24	$2,064
Environmental Tech	$50.00	12	$600
Foreman	$55.00	24	$1,320
Equipment Operator	$56.50	24	$1,356
Laborer	$45.00	24	$1,080
Truck, 4 wheel drive	$680/wk	1	$680
Backhoe, Case 416B	$320.00/day	2	$640
Forklift, 3 ton all terrain	$160.00/day	2	$320
Skimmer	$250.00/day	2	$500
Pump, 4”	$80.00/day	3	$240
Drums, chemical, 17H or 17E	$90.00	25	$2,250
Drums, 95 gallon	$295.00	25	$7,375
Vermiculite per bag	$15.00	6	$90
Acid Suits	$70.00/each	6	$420
Gloves	$4.00/pair	30	$120
Total			**$21,215**

Source: State of Kansas Unified HazMat Response Program statewide contract # 35167.

According to the Kansas Division of Emergency Management, Technological Hazards Section there are 7 facilities subject to the Risk Management Plan requirements in the planning area as of December 2012. The top ranked facilities for Region L are listed in **Table 3.104** and are ranked based on population affected according to the Risk Management Plan’s Worst Case Scenario. Statewide, Wyandotte has the 2nd most worst case scenario facilities, following Sedgwick County who is first with 7. Information concerning these facilities is limited in this plan because of security and liability issues.

Table 3.104. Top Ranked Worst Case Scenario Facilities in Kansas, 2012

Mitigation Planning Region	County	Type of Facility
L	Wyandotte	Chemical Production and Processing
L	Wyandotte	Specialty Gas
L	Wyandotte	Water Treatment
L	Wyandotte	Refrigerated Warehouse
L	Johnson	Refrigerated Warehouse & Distribution
L	Johnson	Food Manufacturing
L	Leavenworth	Water Treatment

Source: State Hazard Mitigation Plan

Special populations are particularly vulnerable because of the inherent potential difficulties involved in the evacuation should the necessity arise. **Table 3.105** shows the number of special population facilities in each county that is located within ½ mile of a chemical facility.

Table 3.105. Number of Special Population Facilities Within ½ Mile of a Chemical Facility

County	Health Facilities	Colleges	Educational Facilities	Aging Facilities	Child Care	Correctional Institutions
Mitigation Planning Region L						
Johnson	4	14	53	37	340	5
Leavenworth	1	1	12	2	31	2
Wyandotte	2	2	33	3	102	5
Total	7	17	98	42	473	12

Source: State Hazard Mitigation Plan

Summary

Region L is vulnerable to a Hazardous Material Incident due to its large industrial base in Kansas City area of Wyandotte County, its farmland footprint in Leavenworth County, and the major transportation nodes that run through the planning area. Pipelines, railroads, highways, chemical plants and use of those chemicals are all issues that make Region L vulnerable. The initial concern during an incident is for the large amount of people that live in this Region, then the environment.

Local Mitigation Concerns

- As mentioned in the vulnerability overview, the transportation nodes are a susceptible to a hazardous material incident. Whether due to transportation trucks carrying freight that is classified as hazardous material, railroad cars carrying potentially dangerous loads, or the waterways that have barges carrying freight subject to an incident. All are concerns that require a proactive approach.

- Wyandotte County is 2nd on the top 10 worst case scenario facilities list for the State of Kansas., with four facilities that have the potential to create a major hazardous incident. Added to this is their high industrial footprint that requires the use and storage of hazardous materials.

- Gas and Petroleum pipelines are numerous within the Region, transporting highly flammable and toxic products throughout the area and state. A release, or fire, at any of these locations could be catastrophic to the lives and property of individuals that live or travel near to any of these areas. Individuals downwind could suffer repercussions also.

- Millions of gallons of gas is stored underground in this Region. This storage is located under the Central West portion of the county from West of the county shop – south of Spring Dale, East of McLouth.

- With the KU Cancer Center moving into Northeast Johnson County, and the Bio-Hazard Facility being built in Manhattan, KS, the interstate highway systems which run through Region L could be at an increased risk of a hazardous material spill, sometimes of unknown etiology.

Development in Hazard prone Areas

As the infrastructure and population of Region L increases, along with the number and type of hazardous chemicals stored and transported through the area, the amount of potential losses will increase.

Johnson County

Table 3.106. Johnson County CPRI: Hazardous Materials

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Hazardous Materials	4	1	4	2	2.90	Moderate

Leavenworth County

Table 3.107. Leavenworth County CPRI: Hazardous Materials

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Hazardous Materials	4	1	4	2	2.90	Moderate

Wyandotte County

Table 3.108. Wyandotte County CPRI: Hazardous Materials

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Hazardous Materials	4	1	4	2	2.90	Moderate

Consequence (Impact) Analysis

This hazard could have a significant impact on the public health, the environment, private property and the economy. The impact of this type of disaster will likely be localized to the immediate area surrounding the incident. The initial concern will be for people, then the environment. If contamination occurs, the spiller is responsible for the cleanup actions and will work closely with the KDHE, KDEM, KCC, EPA and the local jurisdiction to ensure that cleanup is done safely and in accordance with federal and state laws.

The information in provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.109. EMAP Consequences Analysis: Hazardous Materials

Subject	Ranking	Impacts/Hazardous Materials
Health and Safety of Persons in the Area of the Incident	Severe	Localized impact will be severe within the plume/spill area, depending on the type of chemical/material released. As distance is increased from the plume area, the impact will become minimal to moderate.
Responders	Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a minimal to moderate impact.
Continuity of Operations	Minimal to Severe	Temporary relocation could be necessary if government facilities are in close proximity to the incident area. This temporary relocation could become significant depending on clean-up (minimal to severe).
Property, Facilities, and Infrastructure	Minimal – Severe	Impact is expected to be minimal for actual structural properties, facilities, and infrastructure. Unless it is accompanied by an igniting device in which case it could be severe.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the plume/spill area (minimal to severe).
Environment	Severe	Localized impact within the plume/spill area could be severe to native plants, wildlife and natural habitats. Clean up and remediation will be required.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected depending on whether agriculture is affected, what type of material is released, is the company a major employer, etc.
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Impact will be dependent on whether or not the release could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes.

3.2.12 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.

The development of sinkhole and subsidence areas can be grouped into three major categories:

1. Natural dissolution of soluble minerals, causing the development of sinkholes,
2. Extraction of minerals by either solution mining or shaft mining which leaves a void space where subsidence can occur, and
3. Downward drainage of fresh water, via a drill hole or unplugged oil or gas well which penetrates a soluble mineral formation and has an outlet for the solution cavity water to be disposed.

Major materials or minerals present in Kansas that are associated with subsidence and sinkhole development include: salt, limestone and dolomite, gypsum, coal, lead and zinc.

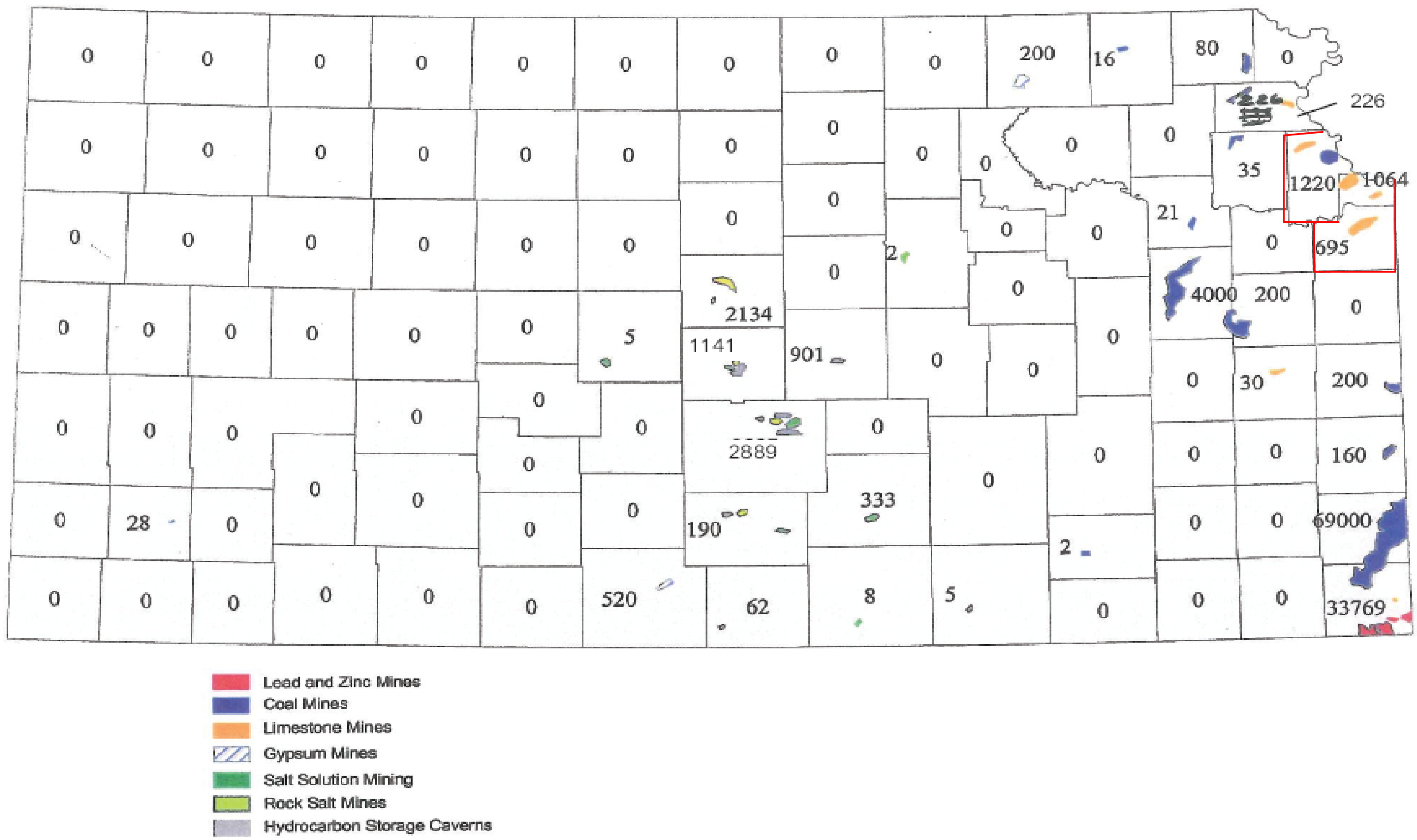
Underground limestone mines have contributed to a subsidence problem in the Kansas City metropolitan area, on the Missouri side.

Location

The planning area does have some areas of concern for this hazard, although it is not a wide spread hazard.

The Kansas Department of Health and Environment in 2006 prepared a report on “Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas.” The report inventoried subsurface void space from oil and gas exploration and production, natural sources, shaft mining, and solution mining. Because some areas were corrected the revised total void space inventory for all sources in the state is 119,136 acres. The distribution of total acres and major cause of void spaces are shown for Leavenworth, Wyandotte, and Johnson Counties in **Figure 3.68.** Notable to this region are the limestone mines in all the counties, and the coal mines in Leavenworth County. These void spaces could be susceptible to collapse resulting in land subsidence and sinkholes in the area. Additional information from this report is discussed in the Extent Section below.

Figure 3.68. Total Subsurface Void Space by County (in acres)

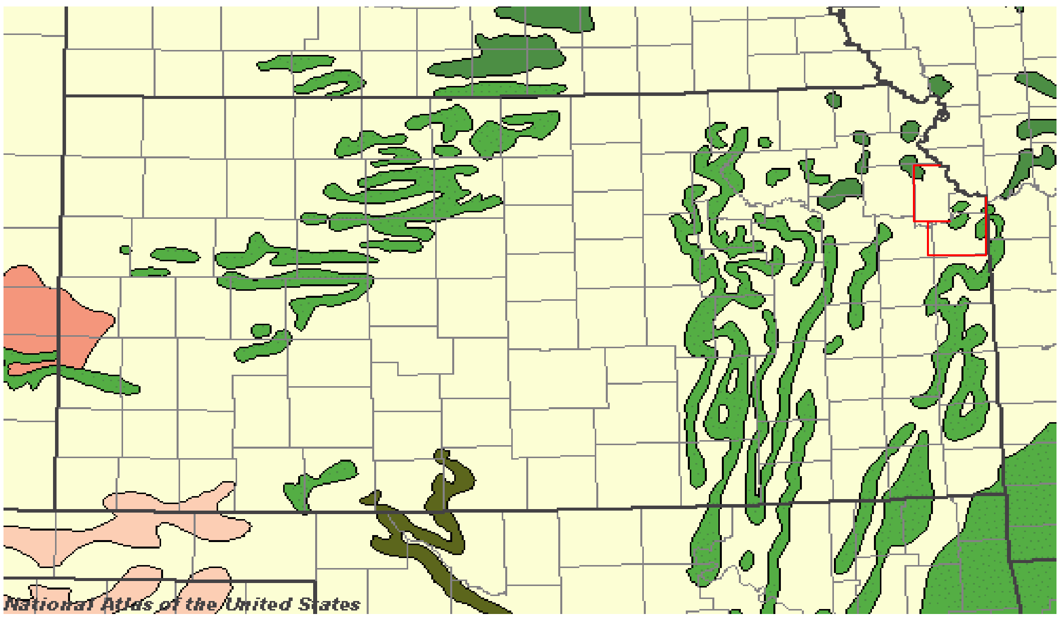


Source http://www.engg.ksu.edu/CHSR/outreach/tosnac/sites/docs/04.pdf

Another area of concern is 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 also particularly prone to sinkholes.

Figure 3.69 illustrates the location of karst features and features analogous to karst in Kansas. The green areas shown in the map show fissures, tubes, and caves generally less than 1,000 feet long with 50 feet or less vertical extent in gently dipping to flat-lying carbonate rock. The planning area shows karst features in all three counties. There are limited documented problems associated with natural limestone subsidence and sinkholes in Kansas. However, eastern Kansas has anthropogenic risk associated with limestone mines.

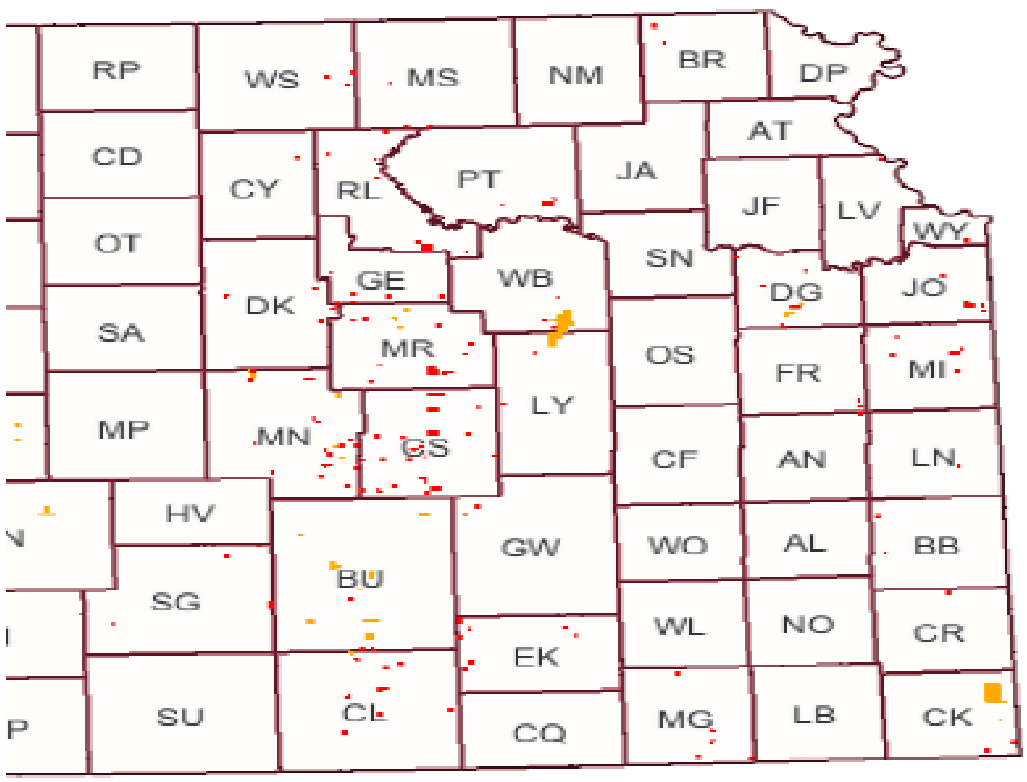
Figure 3.69. Karst Features in Kansas



Previous Occurrences

The following map shows one-mile square sections of land in the eastern side of the state where sinkhole locations have been documented in writing. Red indicates sinkhole occurrences and yellow indicates springs. Region L, indicated by LV, WY, and JO show that Wyandotte and Johnson County have had documented sinkhole locations.

Figure 3.70. Sinkholes in Eastern Kansas



Records maintained by KDHE, indicate that $1,144.39 has been spent in Leavenworth County during the years that records were available for the Abandoned Mine Land Program. Historical costs capture only the remediation costs eligible for KDHE's programs. The potential for other structural damage and economic impacts exists for all counties that have subsurface void spaces.

The Kansas Department of Health and Environment's Surface Mining Section is the agency responsible for the reclamation of abandoned coal mines in Kansas under the Surface Mining and Control Reclamation Act of 1977 (P.L. 95-87). Federal funds are available through the office of Surface Mining Reclamation and Enforcement for the reclamation of past mining problems which are hazardous to the health, safety, and general welfare of the public. The Abandoned Mine Land (AML) Program receives reports yearly on coal mine subsidence alone.

KDHA provided the following data:

- Coal Subsidence Projects,

- Coal Emergency Program Projects for the remediation of sites which are in immediate threat to the health and safety of the general public.

The following Table shows the Coal Emergency Fund Expenditures from 1980 to October 2012 for the state of Kansas.

Table 3.110. Coal Emergency Fund Expenditures by County, 1980 to Oct. 2012)

County	# of projects	cost
Bourbon	9	$58,815
Cherokee	734	$2,880,030
Crawford	1851	$4,535,670
Crawford/ck	1	$723
Leavenworth	2	$37,765
Linn	2	$0
Neosho	1	$0
Osage	3	$0
Shawnee	1	$0
Wabaunsee	3	$96,660
Wyandotte	1	$0
Total		**$7,609,662**

Source: State Hazard Mitigation Plan

Other Notable Land Subsidence Events

- **2010**: Kansas City, MO. - Ramps to a major highway shut down because of a growing sinkhole in the pavement. I-470 westbound near the Three Trails Interchange is closed because of a partial collapse where Westbound I-470 meets westbound I-435.
- **1998–1999:** Two medical buildings were damaged in Wyandotte County.
- **1965–1966:** Subsidence over abandoned limestone mines in Wyandotte County damaged roads and destroyed houses.

Extent

The planning committee has deemed that land subsidence in the area of concern would be negligible.

Probability of Future Events

Based on historical records, the planning region is **“Unlikely**” to have an event happen within a 10 year window.

Impact and Vulnerability

The KDHE Abandoned Mine Land Program estimates there are over 350 abandoned coal mine sites in the State of Kansas that alone identified with health and safety problems. While not all abandoned mines include subsidence issues it is a concern.

Records maintained by KDHE, indicate that of the counties in the planning area, Leavenworth County has been the recipient of the Abandoned Mine Land Programs with an annualized cost of $1,144.39. The following Table 3.111 shows the counties in the state that have used this program to address their abandoned mines subsidence issues. The whole state is reflected to show a contrast and comparison model.

Table 3.111. Annualized Cost for Abandoned Mine Land Programs by County

County	Total Annualized
Bourbon	$1,782.27
Cherokee	$270,223.64
Crawford	$158,760.55
Crawford/Ck	$21.91
Leavenworth	$1,144.39
Wabaunsee	$2,929.09
Total	**$434,861.85**

Source: State Hazard Mitigation Plan

The above annualized amounts of historical costs capture only the remediation costs eligible for KDHE's programs. The potential for other structural damage and economic impacts exists for all counties that have subsurface void spaces. Damages will be more isolated in general compared to other hazards, but future disruptions to transportation and other infrastructure as well as structural damage are possible.

To analyze vulnerability to land subsidence in the State, the November 2006 KDHE report entitled "Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas" was further studied for additional details about land subsidence vulnerability.

In the report, subsidence areas are grouped into three categories as follows:

- Category I: High Risk
- Category II: Medium Risk
- Category III: Low Risk

All documented acres of subsurface void space were classified according to these risk categories for each of the following causes of void space:

- Lead and Zinc Mines
- Coal Mines
- Limestone Mines
- Gypsum Mines
- Salt Solution Mining
- Rock Salt Mines
- Hydrocarbon Storage Caverns

With the known number of acres in each risk category for each county with documented subsurface void spaces, a weighted vulnerability calculation was completed. Acreage in risk Category I (High Risk) received a multiplier of three, acreage in risk Category II (Moderate Risk) received a multiplier of two and acreage in risk Category III (Low Risk) received a multiplier of one. **Table 3.112** provides the results of this vulnerability analysis for counties with known subsurface void spaces, organized by Mitigation Planning Region.

Table 3.112. Subsurface Void Space Vulnerability Analysis

County	Lead/ Zinc Cat. I Acres	Coal Category I	Coal Category II	Coal Category III	Limestone Category I	Limestone Category II	Limestone Category III	Gypsum Category II	Salt Solution Category I	Salt Solution Category II	Salt Solution Category III	Rock Salt Category III	Hydrocarbon Storage Category III	Total Sub-surface Void Space	Weighted Calculation
Mitigation Planning Region L															
Johnson					209	209	277							695	1,322
Leavenworth				1100	40	40	40							1,220	1,340
Wyandotte					394	323	347							1,064	2,175
Subtotal	**0**	**0**	**0**	**1100**	**643**	**572**	**664**	**0**	**0**	**0**	**0**	**0**	**0**	**2,979**	**4,837**

Source: Data from KDHE, "Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas" November 2006; Data tabulated and assigned weighted scores by AMEC; Void Space Unknown indicates that known coal mines are present. However subsurface void space is not known

Table 3.113. Top 10 Counties Vulnerable to Land Subsidence According to Weighted Calculation

Mitigation Planning Region	County	Total Sub-surface Void Space	Weighted Calculation
H	Crawford	69,000	150,100
H	Cherokee	33,769	85,753
J	Osage	4,000	8,000
G	Reno	2,889	3,949
L	Wyandotte	1,064	2,175
F	Ellsworth	2,134	2,158
G	Rice	1,141	1,350
L	Leavenworth	1,220	1,340
L	Johnson	695	1,322
E	Barber	520	1,040

Source: State Hazard Mitigation Plan

Weighted Calculation: With the known number of acres in each risk category for each county with documented subsurface void spaces, a weighted vulnerability calculation was completed. Acreage in risk Category I (High Risk) received a multiplier of three, acreage in risk Category II (Moderate Risk) received a multiplier of two and acreage in risk Category III (Low Risk) received a multiplier of one.

Summary

Land subsidence is a concern in Region L, but is considered a rare occurrence. When it does happen the cost can be high. All three counties in the planning area are rated in the top 10 most vulnerable counties in Kansas for this hazard due to the coal mines in Leavenworth County and the make-up of the land in the Region which has a high limestone component. Both of these are highly susceptible to collapse.

Local Mitigation Concerns

- Comparison of the weighted vulnerability calculation considering known subsurface void spaces with the top 10 counties for housing unit gains and populations gains shows that Leavenworth and Johnson Counties are in the top 10 for both housing and population gains, and scored within the top 10 counties in the weighted vulnerability calculation for land subsidence. With these growths, and the developments that are associated with them, land subsidence could become an even bigger issue as the urban areas spread out toward the more susceptible land areas that pose the most risk for subsidence, such as the coal mines in Leavenworth County.

- Wyandotte County is not growing at as fast a pace as Leavenworth and Johnson counties, yet it is the county on record as having the notable incidents with the latest being in 1999. The Kansas City incident was not on the Kansas side, but it was close enough to Wyandotte County to merit concern. Known for its industrial areas, Wyandotte could experience heavy financial burdens should sinkholes develop in this area.

Development in Hazard Prone Areas

Comparison of the weighted vulnerability calculation considering known subsurface void spaces with the top 10 counties for housing unit gains and populations gains reveals that Leavenworth and Johnson Counties are in the top 10 for both housing and population gains and scored within the top 10 counties in the weighted vulnerability calculation for land subsidence. However, land subsidence is very uncommon in the planning area. Leavenworth County has worked with KDHE through the Abandoned Mine Land Program to provide land clearing, backfilling, grading, erosion and site drainage control, guardrail and fence installation, demolition and disposal, and re-vegetation to mitigate for potential subsidence issues and to protect the public. Current mining operations are responsible for these same actions via the Kansas Statute Annotated 49-401. Land subsidence in Johnson and Wyandotte Counties is also uncommon because there is very little extraction of underground water which would affect the make-up of the soil that would lead to subsidence. By following regulatory guidelines during development procedures and construction, the hazards risk are negligible to development in the region.

Johnson County

Table 3.114. Johnson County CPRI: Land Subsidence

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance

Johnson County						
Land Subsidence	1	1	4	1	1.30	Low

Leavenworth County

Table 3.115. Leavenworth County CPRI: Land Subsidence

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Land Subsidence	1	1	4	1	1.30	Low

Wyandotte County

Table 3.116. Wyandotte County CPRI: Land Subsidence

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Land Subsidence	1	1	4	1	1.30	Low

Consequence (Impact) Analysis

The information in **Table 3.117** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.117. EMAP Consequence Analysis: Land Subsidence

Subject	Ranking	Impacts/Land Subsidence
Health and Safety of Persons in the Area of the Incident	Moderate to Severe	Local impact expected to be moderate to severe for the incident area.
Responders	Minimal	Impact to responders would be minimal.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP, unless a facility is impacted.
Property, Facilities, and Infrastructure	Severe	Localized impact to facilities and infrastructure in the incident area has the potential to do severe damage.
Delivery of Services	Minimal	Impacts to the delivery of services could be severe if roads/utilities are affected. Otherwise impact would be non-existent to minimal.
Environment	Minimal	Impact to the area would be minimal.
Economic Conditions	Minimal	Impacts to the economy will depend on the severity of the damage.
Public Confidence in Jurisdiction’s Governance	Minimal to Severe	Local development policies will be questioned (minimal to severe)

3.2.13 Landslide

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description

Landslides are a phenomenon that is not new to the planning area. A landslide is the downhill movement 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 must have an elevated terrain, with the potential for landslides increasing as the slope angle increases in degrees. Anything that increases the slope angle can trigger a landslide (e.g., a stream actively eroding a hill, construction practices). Slope steepness is the primary factor determining slope stability, but soil and rock types are also important. The most common rocks found in Kansas are shale's, limestone, and sandstones. Shale's—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. Limestone and sandstones exposed in cliffs or roadcuts can pose a risk for rock fall, especially when they overlie shale's.

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 are often associated with other hazard events (e.g., earthquakes, flooding, and heavy rainfall).

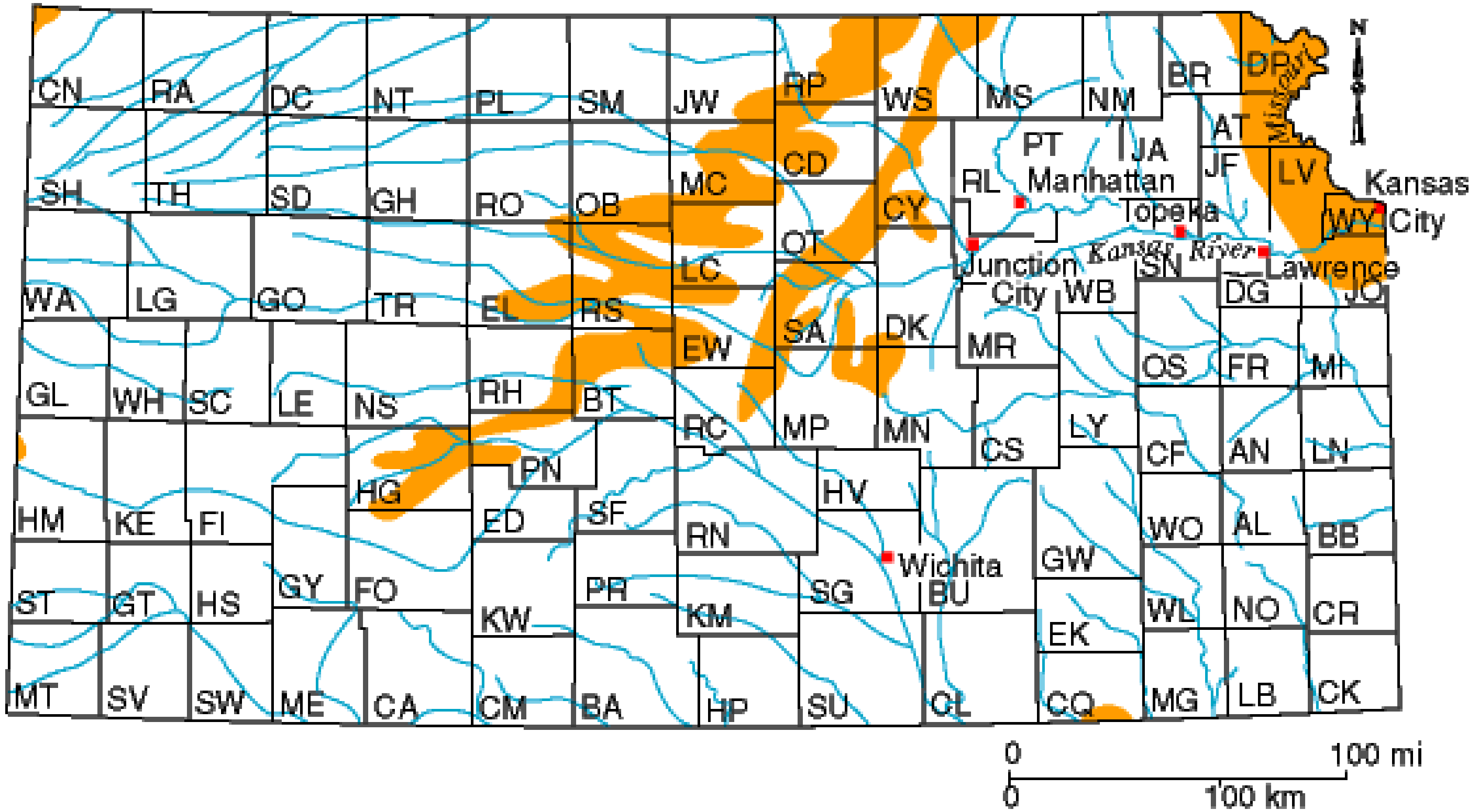
Landslides occur occasionally in Region L and are a localized problem, but growth of cities provides potential for more property losses. Landslides can occur when underlying shale's become saturated with water in wet years. Rocks and overlying soils then slip down slope and are a particular problem in areas of housing or where road construction has occurred.

Location

While the probability of a landslide happening in Region L is unlikely, Johnson County historically shows the event is possible in a 5 year window. Vulnerability to landslide hazards is a function of location, type of human activity, use, and frequency of landslide events. The risk posed by landslide to the planning area is low, but not impossible in the metro area.

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, including the Kansas City metropolitan area within the boundaries of Region L **(see Figure 3.71).**

Figure 3.71. Landslide-Prone Areas of Kansas



Source: Kansas Geological Survey, http://www.kgs.ku.edu/Publications/AnnRep02/hazards/hazards.html

Landslides in the hilly terrain along the Kansas and Missouri rivers in and around the planning area have caused millions of dollars in property damage. In 1997, the Kansas Geological Survey began an effort to map the landslide hazards of northeastern Kansas. The pilot area was Atchison, because of the steep bluffs along the Missouri River. A statistical method called multiple logistic regression has been used to create a landslide-hazard map for Atchison, Kansas, and surrounding areas. Data included digitized geology, slopes, and landslides, manipulated using ArcView GIS. Additional information including landslide hazard maps is available for the study area from the Kansas Geological Survey (reference the KGS M Series Maps).

Previous Occurrences

The most costly landslide in Kansas was in 1995 in Overland park. Two houses were destroyed and four lots were damaged with an estimated value of $1.5 million. Other landslides in the planning area include:

- **July 2001**: Mission, Kansas (Johnson County). A 180 foot wide landslide accord along the north side of Foxridge Drive. The earthen mass moved laterally and downward approximately 2 feet.

- **1998:** Kansas City intense rainfall on October 4, 1998 caused excessive pressure on retaining walls at the Woodlawn Cemetery in Kansas City, KS (north of Parallel and east of 9th St). Also several roads throughout the County, (51st & Douglas Ave, and Barnes Dr between Pomeroy Dr & 74th St) experienced landslide damage. The total landslide damage was over $1 million to repair through FEMA's Public Assistance funds.

- **1990:** Leawood, Kansas (Johnson County): two homes were damaged at an estimated cost of $120,000.

- **1995**: Johnson County saw a couple of homes destroyed in a landslide in 1995, resulting in a total of $1.5 million dollars in damages. (see Figure 3.72).

Extent

A Landslide in the Region is not expected to be of a catastrophic nature. The planning committee has determined the extent of this hazard is: Limited.

Probability of Future Events

According to the Geological Survey, Region L is in an area that is more prone to landslides, due to its co-location to the Missouri River. However, while it is prone to landslides, historically the incidences are few and far between. The planning committee has ranked this hazard's probability as "**Unlikely"**, with a 1 in 10 years chance of occurring.

Impact and Vulnerability

While not a regular or normal event, losses due to landslides in the planning area will continue. Landslide losses are primarily related to damage to property. However, if a sudden landslide impacts an inhabited structure, injuries or deaths could occur. Historically, landslides in Kansas have been isolated events impacting a few properties or a particular area. Often, damages in terms of estimated losses are not reported. Additionally, there is not a repository for damages to be reported, other than NCDC. The NCDC database does not include any previous landslide events in the Region, let alone in Kansas. This is likely because the events are generally isolated and do not impact large areas.

It is not possible at this time to determine quantitative estimates for potential losses associated with the landslide hazard.

Landslides were ranked 19th on the planning significance for area. Region L is notable for its hills, oftentimes having steep slopes. These slopes are prone to landslides, especially during periods of heavy rain. Wildfire can exacerbate a landslide by depleting the soil of its ‘anchor’. Region L has been noted to have wildfires and landslides, with the worst being in Johnson County.

Local Mitigation Concerns

- Region L is located along the Missouri River corridor and the Kansas River, which according the U.S. Geological Survey makes it more prone to landslides. Coupled with increased development trends to accommodate the increase in the population base and the hilly terrain, a landslide could potentially cause the loss of life and property.

- Areas that have seen wildfires or human modification of the land that have destroyed vegetation are prone to landslides, specifically during rain events. With the drought from 2011 to present, the Region has seen an increase in the incidence of wildfires (discussed in the Wildfire section). Human modification to include landscaping or development also brings the risk of landslides. Particularly if a home or business is on a hill, which includes slopes that have been altered for construction of buildings and roads. Johnson County saw a couple of homes destroyed in a landslide in 1995, causing a total of $1.5 million dollars. Figure 3.72 shows one of the homes that was destroyed in this 1995 disaster.

Figure 3.72. 1995 Johnson County Landslide

Source: Kansas Geological Survey, http://www.kgs.ku.edu/Publications/AnnRep02/hazards/hazards.html

- Landslides have a significant impact on transportation corridors, fuel and energy conduits, and communications linkages. Ground-failure events have devastating economic effects on Federal, State, local, and private roads, and bridges. Railroads, electric and telecommunication lines, dams, levees, and waste repositories can be affected by land movement. Road building and construction often exacerbate the landslide problem in hilly areas by altering the landscape, slopes, and drainages and by changing and channeling runoff, thereby increasing the potential for landslides. Landslides and others forms of ground failure also have adverse environmental consequences, such as dramatically increased soil erosion, siltation of streams and reservoirs, blockage of stream drainages, and loss of valuable watershed, grazing, and timber lands.

Development in Hazard Prone Areas

Of the landslide-prone areas, Johnson and Leavenworth are also rated in the top 10 Kansas Counties for Housing Unit Gains Additionally, these two counties are in the top 10 Kansas Counties for Population Gains If construction is occurring in or near landslide hazard areas, more structures/population will be at risk to damage/injury from landslides.

The effects of landslides on people and structures can be lessened by total avoidance of landslide hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. The hazard from landslides can be reduced by avoiding construction on steep slopes and existing landslides, or by stabilizing the slopes. Stability increases when ground water is prevented from rising in the landslide mass by (1) covering the landslide with an impermeable membrane, (2) directing surface water away from the landslide, (3) draining ground water away from the landslide, and (4) minimizing surface irrigation. Slope stability is also increased when a retaining structure and/ or the weight of a soil/rock berm are placed at the toe of the landslide or when mass is removed from the top of the slope. While landslides have occurred in in the planning region, they are not widespread or common. Development in the area has not been stymied due to the low risk of landslides, however, the low risk can be mitigated by using construction methods that can stand up to this hazard should it occur such as water drainage design, foundation design requirements that accommodate the type of soils being built on, the cut, fill, and sloping of the lot in relationship to the location of the foundation, and setback requirements. One way to ensure the proper construction techniques are applied is by having a geotechnical report accomplished. Building lower density in residential lots on slopes can also reduce the potential for landslides by reducing the number of cuts and fills for driveways and house pads. In short, development that fits the terrain and does not use extensive excavation and drainage alterations will reduce risk from landslide hazards in the planning area.

Johnson County

Table 3.118. Johnson County CPRI: Landslide

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Landslide	1	2	4	1	1.75	Low

Leavenworth County

Table 3.119. Leavenworth County CPRI: Landslide

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Landslide	1	2	4	1	1.75	Low

Wyandotte County

Table 3.120. Wyandotte County CPRI: Landslide

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Landslide	1	2	4	1	1.75	Low

Consequence (Impact) Analysis

The information in **Table 3.121** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.121. EMAP Consequence Analysis: Landslide

Subject	Ranking	Impacts/Landslide
Health and Safety of Persons in the Area of the Incident	Moderate to Severe	Localized impact could be moderate to severe for the incident area.
Responders	Minimal	Impact to responders would be minimal.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP, unless a facility is impacted.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact to facilities and infrastructure in the incident area has the potential to do severe damage if they are on, or in, the area of the landslide.
Delivery of Services	Minimal	Impacts to the delivery of services could be severe if roads/utilities are affected. Otherwise impact would be non-existent to minimal.
Environment	Minimal	Impact to the area would be minimal other than the immediate area.
Economic Conditions	Minimal	Impacts to the economy will depend on the severity of the damage, i.e., are roads blocked, did any businesses get caught in the landslide.
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Local development policies will be questioned (minimal to severe).

3.2.14 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. Of the estimated 1,000 people who are struck by lightning each year on the U.S., only 10 percent are killed, but survivors may suffer life-long disabilities.

Severe thunderstorms strike the region 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 wild land fires. The widespread and frequent nature of thunderstorms makes lightning a relatively common occurrence. Of particular concern to the planning area is protection of facilities and communications systems that are important to emergency response operations, protection of public health and maintenance of the jurisdictional economies. The threat to communications systems includes tornado sirens, which could get knocked out just when they are needed most.

According to the National Oceanic and Atmospheric Association, there are 7 main types of lightning:

Intra – Cloud: This is the most common type of lightning and completely inside of a cloud.

Cloud to Cloud: This type of lightning occurs between two or more clouds.

Cloud to Air: Lightning that is generated in a positively charged cloud top and reaches out to negatively charged air around it.

Bolt from the blue: Originates within the updraft of a storm, travels horizontally for many miles, then strikes the ground.

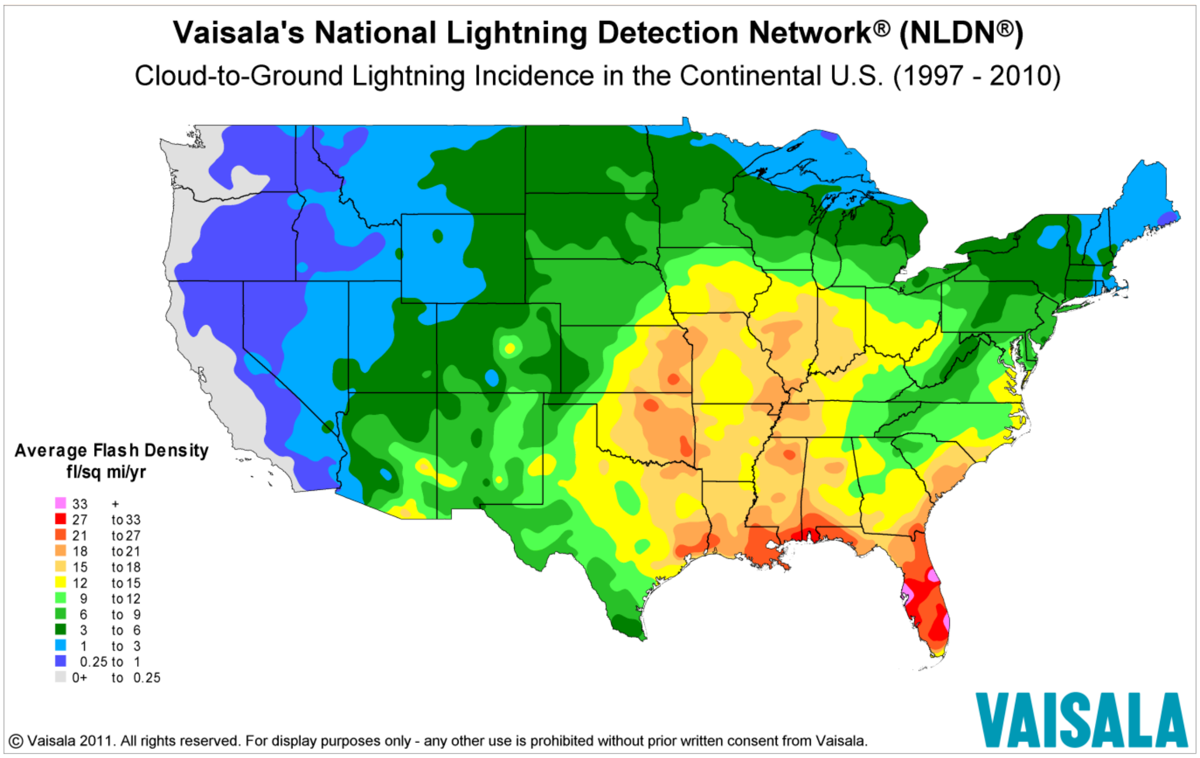
Anvil Lightning: Lightning that develops in the anvil of a thunderstorm cloud and travels straight down to strike the ground.

Heat Lightning: Lightning from a thunderstorm that is too far away to be heard.

Location

The Northeastern part of Kansas, which includes Region L, has an average of 18 to 21 lightning strikes per square mile per year, which makes it a regularly occurring hazard. It affects the agricultural farmlands and the urban landscape without discretion. **Figure 3.73** indicates the distribution of lightning throughout the U.S. from 1997 to 2010.

Figure 3.73. Location and Frequency of Lightning in U.S., 1997 - 2010



Source: Vaisala, http://www.vaisala.com/en/products/thunderstormandlightningdetectionsystems/Pages/NLDN.aspx

Previous Occurrences

26 July 2000 - A lightning strike sparked a house fire in Leawood, Johnson County, which resulted in an estimated $50,000 in damage.

11 September 2000 - Lightning sparked a house fire in Lenexa, Johnson County which caused $325,000 in damage to the house and its contents.

10 July 2001 – $25,000 in damage was done in Olathe, Johnson County, when a severe thunderstorm rolled through.

20 August 2005 - Lightning struck a residence, causing $30,000 in damage at Fort Leavenworth, KS.

14 August 2006 - Lightning hit a home and caused major damage from a fire that broke out in Overland Park, KS, Johnson County. Damage was estimated at $150,000.

28 February 2007 – Lightning struck a transformer on the roof of a middle school resulting in $5,000 in damage in Bonner Springs, Wyandotte County, KS.

2 June 2008 - A 36 year old female was standing in the doorway of her home, when lightning struck nearby. She was transported to the hospital complaining of deafness. Basehor, KS, Leavenworth, KS.

Extent

While lightning is a common hazard in the planning area, the extent of its damage on people and property is: Limited.

Probability of Future Events

Region L experiences Lightning on a regular basis throughout the year, particularly during the May – September time frame. However, as can be seen in the previous occurrences, it can strike during other months also as shown on the 28 February 2007 event. While lightning strikes regularly occur, where and when it strikes is difficult to pin down. There is no good data on the exact number of lightning incidents in the planning area during a given year, however, to one degree or another Lightning is a presence every year. The probability for this hazard is "**Highly Likely**".

Impact and Vulnerability

To determine potential financial loss estimates to lightning in the region, the available historical loss data was annualized. In the case of frequently occurring weather-related hazards such as lightning, annualized historical loss data is considered to be the best resource for determining future potential losses. The planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (2000 – 2012). According to this data, the annualized property loss for the planning area from lightning is $48,749 **Table 3.122.**

County	Annualized Property Loss 2000 - 2012
Johnson	$45,833
Leavenworth	$2,500
Wyandotte	$416
Total	$48,749

Source: NCDC. http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Deaths and injuries from lightning in the planning area have been minimal according to the NCDC database for the period 2000 – 2012 as reflected in **Table 3.123** below.

Table 3.123. Deaths and Injuries from Lightning in Region L, 2000 – 2012.

County	Events	Deaths	Injuries
Leavenworth	2	0	1 female
Johnson	4	0	0
Wyandotte	1	0	0

Source: NCDC. http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=20%2CKANSAS

Severe thunderstorms and the associated lightning events will continue to cause damage to anything and everything exposed to the weather elements. Historically NCDC has reported 1 injury in the Region from 2000 through 2012.

Lightning is a regular occurrence in the planning area and is a known hazard as it pertains to buildings, crops, and people. It can affect communication systems which include warning systems and power. The most common months for lightning strikes is May through September, the very time period that people are enjoying recreational activities outdoors such as the golf course and lakeside.

The statistical analysis method was used to refine and assess the relative vulnerability of each of Region L's counties to lightning. The planning committee assigned ratings to pertinent factors that were examined at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density and crop exposure (annualized crop losses were not used since USDA did not have insured crop loss amounts to use in the tabulation). Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties.

The following are the data sources of the six factors: Social Vulnerability Index for Region L's counties from the Hazards and Vulnerability Research Institute at the University of South Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010) and USDA's Census of Agriculture (2007). It was determined that since lightning is a common occurrence in Kansas, that using historical events and property damages from 2006 forward provides adequate events to describe the lightning problem in the planning area.

Table 3.124 below provides the data for each of the six factors described above taken into consideration to determine overall vulnerability to lightning. The data is provided by county.

Table 3.124. Vulnerability of Kansas Counties Factor Amounts for Lightning

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)
Region L							
Johnson	1	1	$150,000	$21,429	$43,871,468	1,149.60	$29,472,000
Leavenworth	1	1	$0	$0	$4,877,783	164.7	$20,983,000
Wyandotte	3	1	$5,000	$714	$12,066,666	1,039.00	$0
total		**3**	**$155,000**	**$22,143**	**$60,815,917**		**$50,455,000**

Note: The Census of Agriculture did not publish crop exposure in Wyandotte County to avoid disclosure of individual operations.

Table 3.125 provides the ranges for the 1-10 lightning vulnerability factor ratings. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.125. Ranges for Lightning Vulnerability Factor Ratings

	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure
1		1	$143 - $3,600	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500
2	1	2	$3,601 - $7,200	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000
3		3	$7,201 - $10,800	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500
4	2	4	$10,801 - $14,400	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000
5		5	$14,401 - $18,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500
6	3	n/a	$18,001 - $21,600	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000
7		n/a	$21,601 - $ 25,200	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500
8	4	n/a	$25,201 - $28,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000
9		n/a	$28,801 - $33,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500
10	5	n/a	$33,001 and up	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000

Source: State Hazard Mitigation Plan

Table 3.126 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and Table **3.127** provides the rating values assigned that were considered in determining overall vulnerability to lightning.

Table 3.126. Ranges for Overall Lightning Vulnerability

Ranges	Low	Medium-Low	Medium	Medium-High	High
	7 - 13	14 – 18	19 – 23	24 – 28	29 - 34

Source: State Hazard Mitigation Plan

Table 3.127. Vulnerability of Region L Counties to Lightning

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Overall Vulnerability Rating	Lightning Vulnerability
Region L								
Johnson	2	1	6	10	10	2	31	High
Leavenworth	2	1	0	2	2	2	9	Low
Wyandotte	6	1	1	3	10	1	22	Medium

Source: State Hazard Mitigation Plan

Table 3.128 below lists the top ten vulnerable counties in Kansas relative to each other concerning lightning events. This table gives the top ten counties in Kansas in order to put the counties of Region L in perspective as to their vulnerability.

Table 3.128. Top Ten Counties: Vulnerable to Lightning

Mitigation Planning Region	County	Lightning Vulnerability
G	Sedgwick	High
L	Johnson	High
A	Rawlins	High
A	Thomas	High
I	Riley	Medium
G	Cowley	Medium
L	Wyandotte	Medium
K	Brown	Medium
F	Dickinson	Medium
J	Shawnee	Medium

Source: State Hazard Mitigation Plan

Summary

The entire region is susceptible to lighting strikes. Of great concern is lightning during periods of drought which can result in wildfires and damage property and put lives in danger. Johnson County and Wyandotte County are in the Top 10 counties in Kansas for being the most vulnerable to lightning strikes.

Local Mitigation Concerns

- As with many hazards, lightning can go hand in hand with other natural disasters. With the drought of 2011 to present, lightning can cause a fire risk should it strike within the planning area. The dry grass is ripe for an ignition, and lightning can be the spark that could create a wildfire that threatens crops, buildings, and lives.

- Outdoor recreation within the planning area is a major concern when it comes to lighting due to the mass number of people that attend various events. Places such as the Kansas Speedway, which can hold approximately 80,000 individuals, offers no protection in the event of a thunderstorm associated with lightning. The result could be a stampede to get out of the strike zone which lends itself to casualties and potential fatalities.

Development in Hazard Prone Areas

Virtually all structures, communication towers, power systems and electrical components in the planning area are vulnerable to lightning. Lightning causes untold numbers of dollars in damages to homes, schools, businesses and barns each year. Fires, electrical fires, electricity loss and damage to equipment are a few of the problems associated with lightning strikes.

Johnson County

Table 3.129. Johnson County CPRI: Lightning

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Lightning	4	2	2	1	2.80	Moderate

Leavenworth County

Table 3.130. Leavenworth County CPRI: Lightning

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Lightning	4	2	2	1	2.80	Moderate

Wyandotte County

Table 3.131. Wyandotte County CPRI: Lightning

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Lightning	4	2	2	1	2.80	Moderate

Consequence (Impact) Analysis

The information in **Table 3.132** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.132. EMAP Consequence Analysis: Lightning

Subject	Ranking	Impacts/Lightning
Health and Safety of Persons in the Area of the Incident	Minimal to Severe	Impact to the health and safety of persons could be minimal to severe if within the incident area.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal	Temporary relocation may be necessary if government facilities experience damage (Minimal).
Property, Facilities, and Infrastructure	Minimal to Severe	Impact could be severe if property, facilities or infrastructure take a direct hit which could result in fire or destruction.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained (minimal to severe).
Environment	Minimal to Severe	Impact will be isolated, yet severe to any trees, animals, etc., that take a direct hit, or is in the path of any fire that may be generated due to the lighting strike.
Economic Conditions	Minimal	Local economy impact should be fairly minimal, unless the lightening causes fires which damage businesses and stops revenue (minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal	Response and recovery will be in question if not timely and effective, specifically if electricity and other utilities are affected (minimal).

3.2.15 Major Disease Outbreak

Calculated Priority Risk Index	Planning Significance
2.75	Moderate

Description

Infectious diseases are human illnesses caused by microscopic agents, including viruses, bacteria, parasites, and fungi or by their toxins. They may be spread by direct contact with an infected person or animal, ingesting contaminated food or water, vectors such as mosquitoes or ticks, contact with contaminated surroundings such as animal droppings, infected droplets, or by aerosolization. Kansas's public health and health care communities must be prepared to rapidly identify and contain a wide range of biological agents. Each year local public health departments and the Kansas Department of Health & Environment investigate disease "outbreaks" of routine illnesses such as food borne illness and sexually transmitted diseases. There have also been outbreaks of vaccine-preventable diseases such as mumps. During 2009, a pandemic "scare" served as a wake-up call to the public health and medical care communities regarding the requirements for personnel, pharmaceuticals, equipment and public education during large scale disease outbreaks.

While there are a number of biological diseases/agents that are of concern to the planning area, the following categories of disease are being addressed in this plan: vaccine preventable disease, food borne disease, and community associated infections as having significant recurring impact on the potential morbidity of Region L. The following descriptions are general and it should be noted that individuals may experience more or less severe consequences based upon their own circumstances.

While there are a number of biological diseases that are of concern to the planning area, the planning committee chose to focus its narrative on the ones being followed the most closely, which are measles, mumps, pertussis, influenza, pandemic influenza, and food borne illnesses.

Vaccine Preventable Disease

Measles

Measles (rubeola) is a respiratory disease caused by a virus. The disease of measles and the virus that causes it share the same name. The measles virus normally grows in the cells that line the back of the throat and lungs. Measles typically causes fever, runny nose, cough and a rash all over the body.

About one out of 10 children with measles also gets an ear infection, and up to one out of 20 gets pneumonia. About one out of 1,000 gets encephalitis, and one or two out of 1,000 die. While measles is almost gone from the United States, it still kills nearly 200,000 people each year around the world. Measles can also make a pregnant woman have a miscarriage or give birth prematurely. Measles spreads through the air by breathing, coughing or sneezing. It is so contagious that any child who is exposed to it and is not immune will probably get the disease.

Mumps

Mumps is a contagious disease that is caused by the mumps virus. Mumps typically start with a few days of fever, headache, muscle aches, tiredness, and loss of appetite, and is followed by swelling of salivary glands. Anyone who is not immune from either a previous mumps infection or from vaccination can get mumps.

Most people with mumps recover fully. However, mumps can occasionally cause complications, and some of them can be serious. Complications may occur even if a person does not have swollen salivary glands (parotitis) and are more common in people who have reached puberty.

Complications of mumps can include:

- Inflammation of the testicles (orchitis) in males who have reached puberty, which rarely leads to sterility
- Inflammation of the brain (encephalitis) and/or tissue covering the brain and spinal cord (meningitis)
- Inflammation of the ovaries (oophoritis) and/or breasts (mastitis) in females who have reached puberty
- Temporary or permanent deafness

Pertussis

Pertussis is a highly communicable, vaccine-preventable disease that lasts for many weeks and is typically manifested in children with paroxysmal spasms of severe coughing, whooping, and posttussive vomiting. Major complications are most common among infants and young children and include hypoxia, apnea, pneumonia, seizures, encephalopathy, and malnutrition. Young children can die from pertussis. In 2007, 10 children died in the United States from Pertussis. Most deaths occur among unvaccinated children or children too young to be vaccinated. Children who are too young to be fully vaccinated and those who have not completed the primary vaccination series are at highest risk for severe illness. Like measles, pertussis is highly contagious with up to 90% of susceptible household contacts developing clinical disease following exposure to an index case. Adolescents and adults become susceptible when immunity wanes, but can receive a booster shot of the new combination vaccine called Tdap.

Influenza

Influenza (flu) is a viral infection of the nose, throat, bronchial tubes, and lungs. There are two main types of virus: A and B. Each type includes many different strains, which tend to change each year. In Kansas, influenza occurs most often in the winter months. Illnesses resembling influenza may occur in the summer months, but these are usually the result of other viruses that exhibit symptoms commonly referred to as influenza-like illness or ILI.

Influenza is highly contagious and is easily transmitted through contact with droplets from the nose and throat of an infected person during coughing and sneezing. Typical symptoms include headache, fever, chills, cough, and body aches. Although most people are ill for only a few days some may have secondary infections, such as pneumonia, and may need to be hospitalized.

Anyone can get influenza, but it is typically more serious in the elderly and people with chronic illnesses such as cancer, emphysema, or diabetes or weak immune systems. It is estimated that thousands of people die each year in the United States from flu or related complications.

Pandemic Influenza

A pandemic is a global disease outbreak. A pandemic flu is a human flu that causes a global outbreak, or pandemic, of serious illness. A flu pandemic occurs when a new influenza virus emerges for which people have little or no immunity, and for which there is no vaccine.

This disease spreads easily person-to-person, causing serious illness, and can sweep across the country and around the world in a very short time. The Centers for Disease Control and Prevention (CDC) has been working closely with other countries and the World Health Organization to strengthen systems to detect outbreaks of influenza that might cause a pandemic and to assist with pandemic planning and preparation.

During 2009 and 2010 health professionals around the globe worked to combat the H1N1 influenza virus. This relatively mild and stable influenza virus circulated across the globe and caused one of the most robust worldwide vaccination campaigns since the 1970s. Health professionals continue to monitor the possibility of an avian (bird) flu pandemic associated with a highly pathogenic avian H5N1 virus. Since 2003, avian influenza has been spreading through Asia. A growing number of human H5N1 cases contracted directly from handling infected poultry have been reported in Asia, Europe, and Africa, and more than half the infected people have died. There has been no sustained human-to-human transmission of the disease, but the concern is that H5N1 will evolve into a virus capable of human-to-human transmission.

An especially severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Pandemics are generally thought to be the result of novel strains of viruses. Because of the process utilized to prepare vaccines, it is impossible to have vaccine pre-prepared to combat pandemics. A portion of the human and financial cost of a pandemic is related to lag time to prepare a vaccine to prevent future spread of the novel virus. In some cases, current vaccines may have limited activity against novel strains.

Food borne Disease

Norovirus

Noroviruses are a group of related, single-stranded RNA, non-enveloped viruses that cause acute gastroenteritis in humans. The most common symptoms of acute gastroenteritis are diarrhea, vomiting, and stomach pain. Norovirus is the official genus name for the group of viruses previously described as “Norwalk-like viruses” (NLV).

The incubation period for norovirus-associated gastroenteritis in humans is usually between 24 and 48 hours, but cases can occur within 12 hours of exposure. Norovirus infection usually presents as acute-onset vomiting, watery non-bloody diarrhea with abdominal cramps, and nausea. Low-grade fever also occasionally occurs, and diarrhea is more common than vomiting in children. Dehydration is the most common complication, especially among the young and elderly, and may require medical attention. The symptoms of norovirus infection usually last 24 to 72 hours.

Recovery is usually complete and there is no evidence of any serious long-term sequelae. Studies with volunteers given the virus have shown that asymptomatic infection may occur in as many as 30% of infections, although the role of asymptomatic infection in norovirus transmission is not well understood.

Noroviruses are transmitted primarily through the fecal-oral route, either by consumption of fecally contaminated food or water or by direct person-to-person spread. Environmental and fomite contamination may also act as a source of infection. Good evidence exists for transmission due to aerosolization of vomitus that presumably results in droplets contaminating surfaces or entering the oral mucosa and being swallowed. No evidence suggests that infection occurs through the respiratory system.

Noroviruses are highly contagious and as few as 10 viral particles may be sufficient to infect an individual. During outbreaks of norovirus gastroenteritis, several modes of transmission have been documented; for example, initial food borne transmission in a restaurant, followed by secondary person-to-person transmission to household contacts. Although pre-symptomatic viral shedding may occur, shedding usually begins with the onset of symptoms and may continue for two weeks or more after recovery. It is unclear to what extent viral shedding over 72 hours after recovery signifies continued infectivity.

Salmonellosis

Salmonellosis is an infection with bacteria called *Salmonella*. Most persons infected with *Salmonella* develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The illness usually lasts four to seven days, and most persons recover without treatment. However, in some persons, the diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

Salmonella is actually a group of bacteria that can cause diarrheal illness in humans. They are microscopic living creatures that pass from the feces of people or animals to other people or other animals. There are many different kinds of Salmonella bacteria. Salmonella serotype Typhimurium and Salmonella serotype Enteritidis are the most common in the United States. Salmonella germs have been known to cause illness for over 100 years. They were discovered by an American scientist named Salmon, for whom they are named.

Many different kinds of illnesses can cause diarrhea, fever, or abdominal cramps. Determining that *Salmonella* is the cause of the illness depends on laboratory tests that identify *Salmonella* in the stool of an infected person. Once *Salmonella* has been identified, further testing can determine its specific type.

Location

Region L is vulnerable to outbreaks causes by viruses and bacteria due to the dense population base, which increases the amount of institutional settings such as dormitories, daycares, and other avenues where groups of people are in contact, which can lead to the spread of diseases.

Previous Occurrences

- During the summer of 2012, the planning area saw the closing of outdoor pools early due to an outbreak of a highly contagious disease caused by the cryptosporidium parvum. Cryptosporidium is a waterborne disease that can cause gastrointestinal illness associated with diarrhea.
- The Johnson County Department of Health and Environment reported a community-wide outbreak of Pertussis. 485 cases reported in Johnson County as of December 2012.

Table 3.133 and Table 3.134 show other reportable diseases, by county, in the Region.

Table 3.133. Reportable disease by county for the planning area for 2002 – 2011 (part 1 of 2).

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Chlamydia	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	Gonorrhea	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	HIV/AIDS	Legionellosis	Listeriosis
Mitigation Planning Region L																		
Johnson	0	0	0	37	1,312	0	18	2	38	187	3	1	1	3	0	48	7	3
Leavenworth	0	0	0	5	264	0	0	0	1	53	1	0	0	0	0	*	0	0
Wyandotte	0	0	0	7	1,187	0	7	0	6	389	2	0	1	1	0	19	2	1
Total	0	0	0	49	2,763	0	25	2	45	629	6	1	2	4	0	67	9	4

Source: Kansas Department of Health and Environment, *Zero to five cases reported. Not shown to protect confidentiality.

Table 3.134. Reportable disease by county for the planning area for 2002 – 2011 (part 2 of 2).

County	Lyme Disease	Malaria	Measles	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	Syphilis, 1° & 2°	Syphilis, early latent	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Mitigation Planning Region L																				
Johnson	3	4	6	1	2	0	2	0	68	21	8	11	13	8	5	1	7	0	2	16
Leavenworth	2	0	0	0	0	0	0	0	8	0	2	1	1	0	0	0	1	0	0	2
Wyandotte	1	1	0	0	1	0	10	0	20	1	9	3	10	3	3	0	5	0	0	0
Total	**6**	**5**	**6**	**1**	**3**	**0**	**12**	**0**	**96**	**22**	**19**	**15**	**24**	**11**	**8**	**1**	**13**	**0**	**2**	**18**

Source: Kansas Department of Health and Environment, *Zero to five cases reported. Not shown to protect confidentiality.

Previous Occurrences of Pandemic Influenza

There have been four acknowledged pandemics in the past century:

- **1918–19 Spanish flu (H1N1):** This flu is estimated to have sickened 20-40% of the world's population. Over 20 million people lost their lives. Between September 1918 and April 1919, 500,000 Americans died. The flu spread rapidly; many died within a few days of infection, others from secondary complications. The attack rate and mortality was highest among adults 20-50 years old; the reasons for this are uncertain. Recently, the origin of the pandemic was traced to an outbreak of influenza in Haskell County, Kansas, in January 1918. Army personnel in Haskell County reported to Camp Funston (now Ft. Riley), which meant soldiers and their friends and families likely carried the virus from the county to the camp. Camp Funston sent a constant stream of soldiers to other American locations and to Europe, enabling the spread of the disease throughout the country and around the world. By the end of 1918, the Kansas death toll was around 12,000.
- **1957–58 Asian flu (H2N2):** This virus was quickly identified because of advances in technology, and a vaccine was produced. Infection rates were highest among school children, young adults, and pregnant women. The elderly had the highest rates of death. A second wave developed in 1958. In total, there were about 70,000 deaths in the United States. Worldwide deaths were estimated between one and two million. Information about how this pandemic affected Kansas was not available.
- **1968–69 Hong Kong flu (H3N2):** This strain caused approximately 34,000 deaths in the United States and more than 700,000 deaths worldwide. It was first detected in Hong Kong in early 1968 and spread to the United States later that year. Those over age 65 were most likely to suffer fatal consequences. This virus returned in 1970 and 1972 and still circulates today.

- **2009 H1N1 Influenza:** The 2009 H1N1 Pandemic Influenza began in Kansas with the first identified case on April 24, 2009. Kansas was the third state to positively identify this novel strain of influenza and was the first non-border state to confirm a positive identification. During the 2009 H1N1 Pandemic a total of 29 Kansans died as a result of confirmed infection with the disease.

Extent

The severity and magnitude of a Major Disease Outbreak are dependent on the etiology of the disease. A highly contagious disease could spread like wildfire throughout the planning area, because of the density of the population. The planning committee has determined that in the case of a contagious Major Disease Outbreak, the extent could be catastrophic and multiple deaths could occur.

Probability of Future Events

While it is impossible to predict outbreaks, the local Health Agencies in conjunction with KDHE, report to, and provide data on, the reportable diseases that affect each county, bringing awareness to the population. These agencies also promote vaccinations to prevent against contagious diseases for adults and children in order to protect against an outbreak. In the planning area the probability of a future event is **'Possible'** for a large-scale major disease outbreak.

Impact and Vulnerability

It is difficult to ascertain the Regional cost for the impacts of Major Disease Outbreaks. However, according to *The annual impact of seasonal influenza in the US: Measuring disease burden and costs* by Molinari et al., nationally the economic burden of influenza medical costs, medical costs plus lost earnings, and the total economic burden were $10.4 billion, $26.8 billion and $87.1 billion respectively. The financial burden of healthcare-associated infections nationally has been estimated at $33 billion annually. There is no data currently available on the economic impact of previous illness in Kansas. Using pandemic influenza as the worst case scenario for estimating potential losses, the Kansas Department of Health and Environment's Pandemic Influenza Planning includes the following vulnerability estimates. It has been estimated that a medium-level pandemic could cause, in Kansas:

- Between 229,203 and 534,807 persons may require outpatient care
- Between 5,016 and 11,706 may require hospitalization
- Between 1,163 and 2,714 individuals may die

The majority of these deaths, hospitalizations, etc. would occur in more highly populated counties.

The U.S. Centers for Disease Control and Prevention (CDC) estimates 76 million people suffer foodborne illnesses each year in the United States, accounting for 325,000 hospitalizations and more than 5,000 deaths. Foodborne disease is extremely costly. Health experts estimate that the yearly cost of all foodborne diseases in this country is $5 to $6 billion in direct medical expenses and lost productivity. Infections with the bacteria *Salmonella* alone account for $1 billion yearly in direct and indirect medical costs.

The entire planning area is vulnerable to a major disease outbreak. As evidenced by the Annual Infectious Disease Summaries completed by the KDHE Bureau of Surveillance and Epidemiology (http://www.kdheks.gov/epi/index.html) the planning area has connections with one or multiple disease outbreaks each year, with few exceptions. Due to the density of the population base, and the higher pediatric and elderly populations, potential casualty losses are expected to be higher than the rest of the state. Region L has an advantage over other Regions in that they are in closer proximity to more Health professionals and medical capabilities. With the new health care laws being enacted, insurance will potentially become a lesser issue with access to these facilities in the case of a disease outbreak.

Although infectious diseases do not respect geographic boundaries, several populations in the planning area are at specific risk to infectious diseases. Communicable diseases are most likely to spread quickly in institutional settings such as dormitories, long-term care facilities, day care facilities, schools, etc.

The planning committee ranked the disease outbreak as possible based on a pandemic scenario within the next five years. The magnitude of an infectious disease outbreak is related to the ability of the public health and medical communities to stop the spread of the disease. Most disease outbreaks that cause catastrophic numbers of deaths are infectious in nature, meaning that they are spread from person to person. The key to reducing the catastrophic nature of the event is to stop the spread of disease. This is generally done in three ways: (1) identification and isolation of the ill, (2) quarantine of those exposed to the illness to prevent further spread, and (3) education of the public about methods to prevent transmission. The public health and health care providers in Region L routinely utilize all three methods to reduce morbidity and mortality from infectious disease. Other less common ways to contain the spread of any disease outbreaks would be to close schools, day cares, and other public events. These measures could have far-reaching economic impacts on the community and might shutdown facilities for 30 days or more. Day care and school closures could have a serious impact on businesses as parents might not be able to find child care services in order to report to work.

Summary

The entire planning area is vulnerable to a major disease outbreak. The Annual Infectious Disease Summaries completed by the KDHE Bureau of Surveillance and Epidemiology (http://www.kdheks.gov/epi/index.html) shows that all counties in the Region have connections with multiple disease outbreaks each year.

The demographics of Region L show a higher vulnerability to disease outbreaks due to the dense population base, and the number of elderly and very young people. Within the planning area there is also a higher number of institutional settings such as dormitories, long-term care facilities, day care facilities, schools, etc., which also lend themselves to infectious disease outbreaks.

Local Mitigation Concerns

- Major Disease Outbreak in the human population tends to occur where groups of people gather. Region L is the most densely population area in Kansas, and as such large numbers of the population are in direct contact daily with each other. From schools to sporting events, to concerts, the planning area provides many outlets for a major disease outbreak to spread. Daycares, nursing homes, and hospitals also contribute to this hazard event, particularly with the large over 65 and under 5 year age groups.

- A major area of concern is parents deciding not to vaccinate their children due to the perceived repercussions in doing so. Vaccinations have been tied unscientifically to an increase in autism and other disorders which make parents wary of vaccinating their children, regardless of the scientific benefits. This lack of vaccinations give rise to incidents of pertussis, mumps, measles, and other predominantly childhood diseases. 2012 saw an outbreak of Pertussis in Johnson County with 485 reported cases. Lack of vaccinations in a densely populated area contributes to contagious disease spreading.

Development in Hazard Prone Areas

Water-borne illness is very common, although the drinking water system as a source of contamination is not. The impacts and potential losses are largely economic and are dependent on the type, extent, and duration of the illness. As the population in the planning area grows in size, and ages, the vulnerability to this hazard is likely to increase.

Johnson County

Table 3.135. Johnson County CPRI: Major Disease Outbreak

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Major Disease Outbreak	3	4	1	4	3.10	High

*The hazard of Major Disease Outbreak went from a moderate planning significance to a high significance during this planning period due to the probability increasing from an event could possibly happen in the next five years, to it is likely to be experienced in the next three years. Historically, the pertussis outbreak in 2012 and the waterborne illnesses over the past couple of years were the main events that increased the CPRI for Johnson County. Further detail of the events that affected the CPRI can be found on page 3.218 – 3.219.

Leavenworth County

Table 3.136. Leavenworth County CPRI: Major Disease Outbreak

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Major Disease Outbreak	2	4	2	4	2.80	Moderate

Wyandotte County

Table 3.137. Wyandotte County CPRI: Major Disease Outbreak

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Major Disease Outbreak	2	3	1	4	2.35	Moderate

Consequence (Impact) Analysis

The information in **Table 3.138** provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP)

Table 3.138. EMAP Impact Analysis: Major Disease Outbreak

Subject	Ranking	Impacts/Major Disease Outbreak
Health and Safety of Persons in the Area of the Incident	Severe	Impact over a widespread area could be severe depending on type of outbreak and whether it is a communicable disease. Casualties are dependent on warning systems, warning times and the availability of vaccines, antidotes, & medical svc.
Responders	Severe	Impact to responders could be severe, especially if they reside in the area and or their type of exposure during response. With proper precautions and safety nets in place the impact is lessened.
Continuity of Operations	Minimal	Continuity of Operations will be greatly dependent on availability of healthy individuals. COOP is not expected to be exercised (minimal).
Property, Facilities, and Infrastructure	Minimal	Access to facilities and infrastructure could be affected until decontamination is completed
Delivery of Services	Minimal	Delivery of services could be affected if there are road blocks or mass hysteria of any level (minimal).
Environment	Severe	Impact could be severe for the immediate impacted area depending on the source of the outbreak. Impact could have far-reaching implications if disease is transferable between humans and animals or to wildlife.
Economic Conditions	Severe	Impacts to the economy could be severe if the disease is communicable. Loss of tourism, revenue, and business as usual will greatly affect the local economy and the state as a whole.
Public Confidence in Jurisdiction's Governance	Severe	Response and recovery will be in question if not timely and effective. Availability of medical supplies, vaccines, and treatments will come into question (minimal to severe).

3.2.16 Radiological

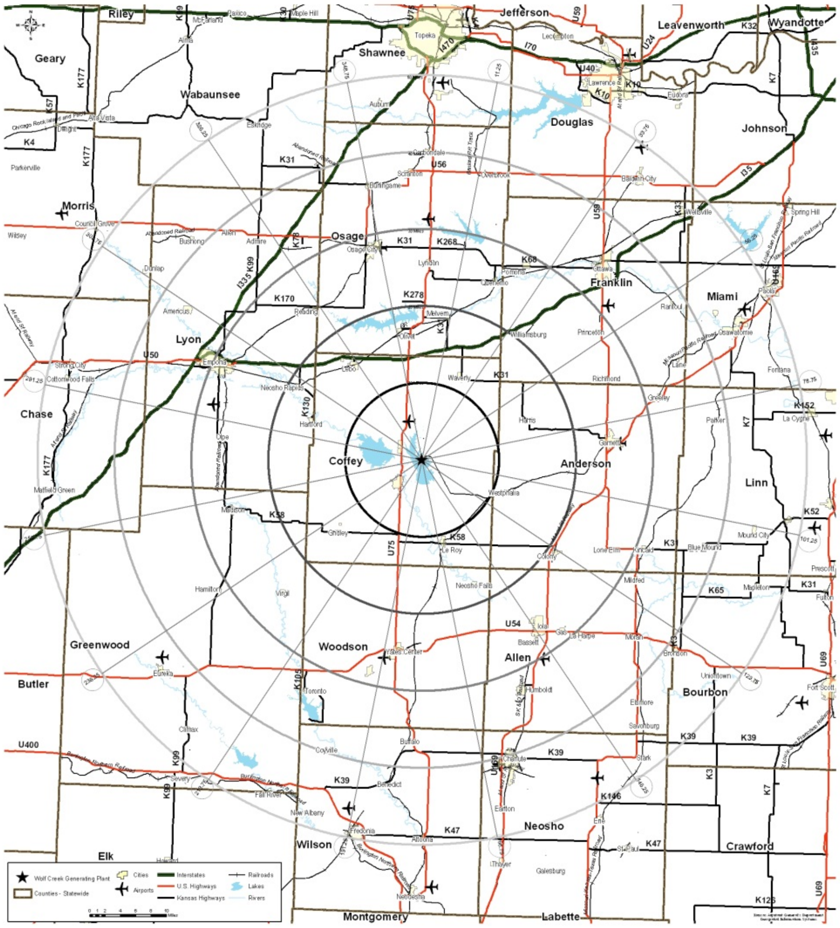
Calculated Priority Risk Index	Planning Significance
2.10	Moderate

Description

A Radiological event in the planning area could happen as a result of transportation accidents, hazardous materials, industrial and medical uses and lost or stolen sources to which the public could be exposed, or contaminated, with a high level of radiation. Radiological accidents could cause injury or death, contaminate property and valuable environmental resources, as well as disrupt the functioning of communities and their economies. There have been no reported events of this type in the planning area, and all information contained in this hazard profile remains valid and current for the 2013 update.

The planning area has one commercial plant that they plan for: The Wolf Creek Nuclear Power Plant in Coffey County. Because Region L is not located in the 10-mile, and only slightly in the 50-mile emergency planning zones (EPZ) for this plant (see figure 3.73a), this mitigation plan will not address it as a hazard to the planning area. However, the nuclear fuel rods in transit, along with diagnostic and therapy medical radioactive materials used in hospitals, and other materials, including pharmaceuticals and industrial sources can be an issue for the planning area.

Figure 3.73a. 50 mile Wolf Creek IPZ, which includes a small portion of Johnson County



Another radiological concern in the region is Radon. Radon is a radioactive, colorless, odorless, tasteless noble gas that occurs naturally as an indirect decay product of uranium or thorium. Radon is one of the densest substances that remains a gas under normal conditions. It is also the only gas under normal conditions that only has radioactive isotopes. Because it is gaseous it is easily inhaled and is responsible for the majority of the public exposure to ionizing radiation. Because of its density, radon can accumulate to higher than normal concentrations in buildings, especially in low areas such as basements and crawls spaces. It is considered a health hazard and epidemiological studies have shown a clear link between radon and the incidence of lung cancer. During the 2008 legislative session in Kansas, a law was passed, K.S.A. 58-3078a, which requires information about radon and a recommendation to test for radon be provided to all homebuyers on their residential real estate contract**.**

Location

Region L is vulnerable to transportation accidents, hazardous material, industrial, and medical uses that have radiation as a component. Johnson County has a higher percentage of hospitals and medical centers that could facilitate a higher incidence of exposure should an accident or thefts occur. All three counties in the planning area have a highly visible transportation node that could potentially increase their chance of a spill or accident resulting in radioactive material being leaked.

Previous Occurrence

The following is a table of incidences for the planning area. Actual narratives could not be obtained.

Table 3.139. Radiological Incidences in Region L 2006 - 2009

LICENSEE	CITY	EVTDATE	DESC	CO	CLASSEVT
McAfee Henderson &	LEAVENWORTH	02/19/2006	LOST/ABANDONED/STOLEN	LV	Moisture/density gauge stolen, not recovered.
GEOTECHNOLOGY, INC.	OVERLAND PARK	08/09/2006	TRANSPORTATION	JO	Moisture/density gauge struck by vehicle. No loss of radioactive material
Honeywell	OLATHE	07/27/2006	LOST/ABANDONED/STOLEN	JO	Lost static eliminator containing. Not recovered. Radioactive material has decayed to non
ACUREN INSPECTION INC	SHAWNEE	09/04/2006	OTHER	JO	Attempted theft of industrial radiography source. Security controls prevented theft.
Tetra Tech	KANSAS CITY	08/14/2007	EQUIPMENT	WY	Moisture/density gauge damaged. No loss of radioactive material
APTUIT INC	LENEXA	04/22/2008	RADIOACTIVE MATERIAL REL.	JO	Release of small amount of radioactive material. No exposures above limits
APTUIT INC	LENEXA	08/20/2008	RADIOACTIVE MATERIAL REL.	JO	Release of small amount of radioactive material. No exposures above limits
KLEINFELDER CENTRAL INC	Lenexa	06/06/2009	LOST/ABANDONED/STOLEN	JO	Moisture/density gauge stolen. Gauge was recovered.

Source: Kansas Department of Health and Environment

Extent

Should a significant radiological incident occur, the planning committee has determined that the magnitude would be critical with injuries and/or illnesses resulting in permanent disability.

Probability of Future Hazard Events

Region L is not within the 10- mile, and only slightly within the 50-mile emergency planning zones, however, they could potentially be susceptible to radiological events through their transportation nodes, hazardous material, industrial, and medical uses which have radiation as a component. The planning area is a highly urbanized area with medical centers that could be subjected to theft of entities containing radiological elements. The incidences of radiological release are a rare occurrence in Region L and have been given a probability of “**Unlikely**” by the planning committee.

Impact and Vulnerability

The potential danger from an accident is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume (cloud-like formation) of radioactive gases and particles. The major hazards to people in the vicinity of the plume are radiation exposure to the body from the cloud and particles deposited on the ground, inhalation of radioactive materials and ingestion of radioactive materials.

The planning area is not within the 10 mile and only slightly within the 50 mile emergency planning zone of Wolf Creek nuclear plant, however the transportation nodes increase the vulnerability to the Region. A truck transporting fuel rods, or medical equipment that is involved in an accident can put the entire population at risk. Region L is also a very urbanized area with multiple hospitals, elderly care and hospice institutions. An accident, spill or theft in one of these places that handle radioactive material on a daily basis could be catastrophic.

Summary

The threat of a radiological incident to the region is not through nuclear power plants, but through everyday uses within the workplace. Hazardous materials, industrial, and medical uses that have radiological elements are the threat to the planning area. The incidents would tend to be human caused whether through human error, theft, or neglect.

Local Mitigation Concerns

- Region L is a highly urbanized area that has a dense population and transportation nodes that are thoroughfares for the movement of goods and materials to the continental United States. The make-up of these goods and materials include the movement of radiological elements at any given time through the planning area. Of high concern to the planning committee is a potential accident on their nodes that could lead to the release of radiological materials putting the citizens, motorists, and tourist at risk of exposure.

- As the most urbanized and densely populated portion of the State of Kansas, Region L has a high medical footprint. The hospitals, Medical Centers, and nursing homes all utilize medical entities that contain radiological elements that could be subject to release or even theft.

- The planning area is not within the 10, and only slightly within the 50 mile emergency planning zone for a nuclear power plant incident. However, a concern is if the weather makes for conditions that could move a plume from Wolf Creek in its direction and thus endanger the population. While this is not an expected concern, it is notable for its potential.

Development in Hazard Prone Areas

Contaminated sites in urban environments are a concern as often the sewer system and other underground structures can act as conduits for the migration of non-soluble radionuclides in the subsurface. This should be a consideration for excavation near or down gradient from a known contaminated site.

During all lawful operations of radioactive materials, the licensee is responsible for ensuring that the area around the source material is cordoned off or shielding is used to prevent unnecessary exposures. Inspections of practices and security measures are regularly conducted to ensure compliance and conformity to regulations in order to protect the public. The frequency of inspections can be adjusted in response to perceived risk. Public risk can be reduced by minimizing the duration of exposure, shielding the source material and maximizing the distance from the source.

Johnson County

Table 3.140. Johnson County CPRI: Radiological

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Radiological	1	3	4	3	2,25	Moderate

Leavenworth County

Table 3.141. Leavenworth County CPRI: Radiological

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Radiological	1	3	2	3	1.95	Low

Wyandotte County

Table 3.142. Wyandotte County CPRI: Radiological

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Radiological	1	2	4	2	1.85	Low

Consequence (Impact) Analysis

The information in **Table 3.143** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.143. Consequence (Impact) Analysis: Radiological

Subject	Ranking	Impacts/Radiological
Health and Safety of Persons in the Area of the Incident	Severe	Impact expected to be severe for persons within the incident area. Protection capabilities and warning times will greatly affect the severity.

Responders	Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Temporary relocation could be necessary if government facilities are in close proximity to the incident area. This temporary relocation could become significant depending on clean-up (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe to property, facilities, and infrastructure.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the affected area (minimal to severe).
Environment	Severe	Localized impact within the incident area could be severe to native plants, wildlife and natural habitats. Clean up and remediation will be required.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation (minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Impact will be dependent on whether or not the incident could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes (minimal to severe).

3.2.17 Soil Erosion and Dust

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description

Soil erosion and dust are both ongoing problems for the planning area. Both can cause significant loss of valuable agricultural soils, damage crops, harm environmental resources and have adverse economic impacts. Soil erosion in the region is largely associated with periods of drought, when winds are able to move tremendous quantities of exposed dry soil (wind erosion), and flooding (stream bank 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. Thus it removes the most fertile part of the soil and lowers soil productivity, which can result in lower crop yields or poorer grade pastures and increase economic costs.

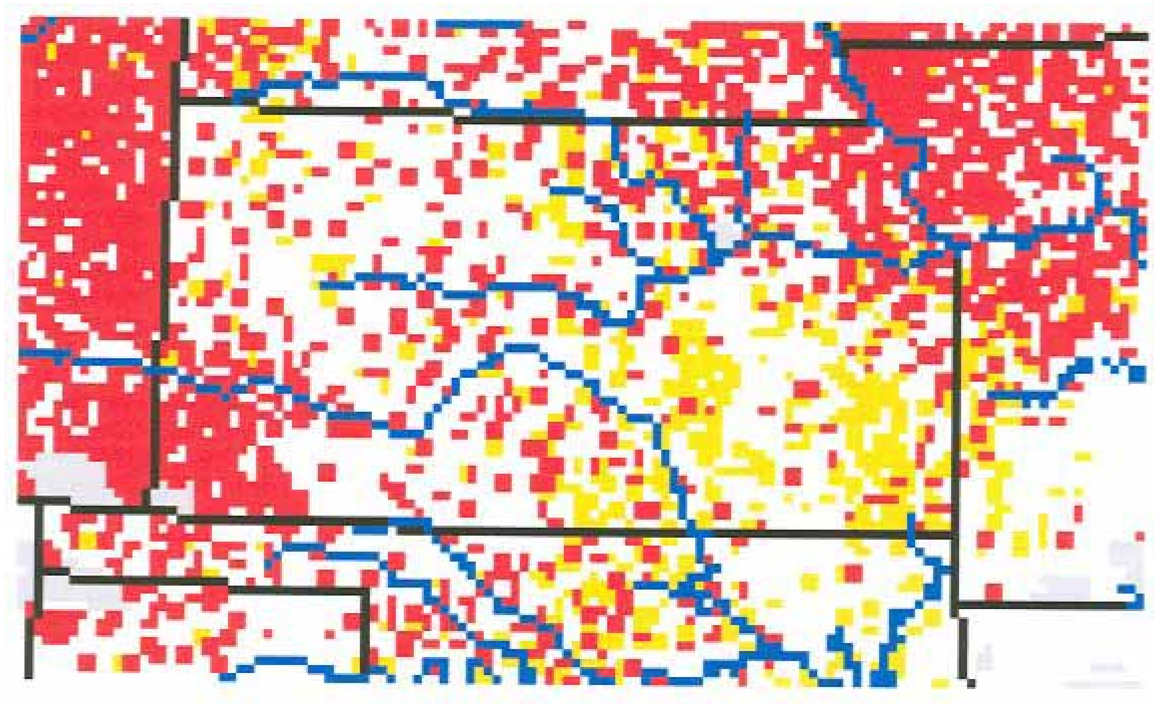
Stream bank erosion, which can remove agricultural land and damage or destroy roads and bridges and utility lines, occurs each year, particularly in the spring when high runoff is most common. A large proportion of all eroded soil material ends up in rivers, streams and lakes, which makes waterways more prone to flooding and contamination and reduces water supply storage space.

Erosion increases the amount of dust carried by wind. Dust can also threaten agriculture and have 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. It 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 incidences of asthma are related to dust. Blowing dust can be severe enough to necessitate highway closures because of low visibility, which can cause vehicle accidents. The risk rating for dust or wind erosion is relatively low for the planning area.

Location

Soil Erosion and Dust is a concern for the planning area. During periods of drought and wind events, soil erosion and dust can aggravate allergies and asthma, deplete farmland of vital top soil, disperse cropland seeds, and cause revenue losses due to clogged machinery and crop loss. Soil Erosion also affects all the counties in the planning area, as they all border major rivers.

Figure 3.74. Locations of Excessive Erosion of Farmland, 1997



Source: Kansas Hazard Mitigation Plan, 2007

Legend
Red: 5,000 acres of highly erodible land
Yellow: 5,000 acres of non-highly erodible land with excessive erosion above the tolerable soil erosion rate.

Previous Occurrences

No prior occurrences are on record for this region. Because the effects of soil erosion and dust are normally cumulative it is difficult to gauge when or if it has happened.

Extent

While soil erosion is not uncommon in the planning are, the extent of damages to people and property would be: Negligible. There have been no prior occurrences of a worthy note.

Probability of Future Events

There are no solid historical events that can give a good probability, which resulted in the planning committee rating this hazard as “Possible” within the next five years.

Impact and Vulnerability

There have not been any regional or state-wide studies to estimate the dollar value of top soil lost to soil erosion and dust. However, Table 3.144 shows the historical estimates for tons per acres soil lost annually for cultivated cropland, non-cultivated cropland, conservation Reserve Program (CRP) land and pastureland, for the State of Kansas.

Table 3.144. Kansas Average Wind Erosion in Tons/Acre/Year by Broad Cover/Use and Year

Broad Cover/Use	1982	1987	1992	1997	2002	2007
Cultivated Cropland	2.747	2.963	2.062	1.482	1.463	1.734
Noncultivated Cropland	.907	.830	.887	.339	.413	.501
CRP Land	n/a	10.478	.640	.328	.394	.860
Pastureland	.009	.016	.022	.015	.019	.034

Source: 2007 National Resources Inventory, http://www.ks.nrcs.usda.gov/technical/ks_nri.html, dated April 22, 2010
Note: Estimated average annual wind erosion is tons per acre per year with margins of error.

The impact of this hazard on the Region would be difficult to detect to the time factor involved before noticeable differences in loss of soil were apparent. Wind erosion can cause crop loss, fertility loss, moisture loss and loss of valuable top soil. Blowing soil causes dirt clouds, drifting sand and hard feelings between neighbors. Blowing soil cuts off growing crops, covers fences, closes roads and gives rural and urban communities a bad perception of farmers.

Agricultural land, bridges, and roads are the most susceptible to soil erosion and dust. Flood waters are the main culprit to these commodities, as the water erodes the soil by washing it out. Dust is exacerbated during drought conditions and can cause havoc on agricultural fields and can potential be a health hazard for individuals suffering from pulmonary disease.

Local Mitigation Concerns

- The main mitigation concern for this hazard, in the planning area, is the structural integrity of the bridges and roads as soil erosion occurs. During periods of heavy rains, soil erosion can wash the ground anchor away from the support structure causing them to collapse. This, in turn, puts lives in danger along with property loss.

Development in Hazard Prone Areas

Buildings and infrastructure are generally not affected by dust. Buildings and infrastructure can be affected by soil erosion if the erosion creates an unstable building, bridge or infrastructure.

Johnson County

Table 3.145. Johnson County CPRI: Soil Erosion and Dust

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Soil Erosion and Dust	2	1	1	4	1.75	Low

Leavenworth County

Table 3.146. Leavenworth County CPRI: Soil Erosion and Dust

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Soil Erosion and Dust	2	1	1	4	1.75	Low

Wyandotte County

Table 3.147. Wyandotte County CPRI: Soil Erosion and Dust

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Soil Erosion and Dust	2	1	1	4	1.75	Low

Consequence (Impact) Analysis

Wind erosion can cause crop loss, fertility loss, moisture loss and loss of valuable top soil. Blowing soil causes dirt clouds, drifting sand and hard feelings between neighbors. Blowing soil cuts off growing crops, covers fences, closes roads and gives rural and urban communities a bad perception of farmers.

The information in **Table 3.148** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.148. EMAP Consequence Analysis: Soil Erosion and Dust

Subject	Ranking	Impacts/Soil Erosion and Dust
Health and Safety of Persons in the Area of the Incident	Minimal	Impact tends to be agricultural; however, dust can be a danger to susceptible individuals in the form of air pollutants (minimal).
Responders	Minimal	With proper preparedness and protection, impact to the responders is expected to be minimal.
Continuity of Operations	Minimal	Minimal expectation for utilization of the COOP.
Property, Facilities, and	Minimal to	Impact to property, facilities, and infrastructure could be severe,

Subject	Ranking	Impacts/Soil Erosion and Dust
Infrastructure	Moderate	depending on the site of the soil erosion. This could adversely affect utility poles/lines, and facilities. Dust can also adversely affect machinery, air conditioners, etc.
Delivery of Services	Minimal	Impact on the delivery of services should be non-existent to minimal, unless roads and utilities are affected.
Environment	Severe	The impact to the environment could be severe. Soil erosion and dust can severely affect farming, ranching, wildlife and plants due to production losses and habitat changes.
Economic Conditions	Minimal	Impacts to the economy will be dependent on how extreme the soil erosion and dust are. Potentially it could severely affect crop yield and productivity. Seedling survival and growth is stressed by erosion and dust, as is the top soil which agriculture is dependent on.
Public Confidence in Jurisdiction's Governance	Minimal	Planning, response, and recovery may be questioned if not timely and effective (minimal).

3.2.18 Terrorism/Agro-terrorism

Calculated Priority Risk Index	Planning Significance
2.65	Moderate

Description

The Federal Bureau of Investigation defines terrorism as “the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.” The threat of terrorism, both international and domestic, is ever present, and an attack is likely to occur when least expected.

The Southern Poverty Law Center reported that in 2012, there were three active hate groups in Kansas: one neo-Nazi group (National Socialist Movement in Lansing), one racist skinhead group (Midland Hammerskins in Wichita), and one anti-gay group (Westboro Baptist Church in Topeka). Other groups, such as the Animal Liberation Front (ALF), Earth Liberation Front (ELF), and People for the Ethical Treatment of Animal (PETA) have sympathizers in the state. Although no major terrorist acts have been attributed to any of these latter groups, their involvement in violent acts is meant to disrupt governmental functions and cannot be discounted.

Agro-terrorism consists of acts to intentionally contaminate, ruin, or otherwise make agricultural products unfit or dangerous for consumption or further use. Agriculture is an important industry in Kansas. The introduction of a biological agent into the population of 6.4 million cattle or the nearly 10 million acres of wheat would be financially devastating and would have a major impact on the food supply of the state and the nation. A major attack involving the nation’s food supply could be launched in a rural area that has little capacity to respond. Potential terrorists’ targets for livestock disease introduction would be concentration points, such as the state’s licensed feedlots livestock markets. Additionally, Kansas has over 120 agricultural crop-dusters, many of which are configured for chemical spraying.

Location

The planning area is susceptible to terrorism of any ideology due to the large population base, and the available transportation nodes. Terrorist tend to strike where large venues of people are likely to be, such as malls, Kansas Speedway, Sprint Center, and other entertainment venues. Densely populated areas also facilitate terrorist being able to blend in better so they can strike with as little warning as possible. The transportation corridor within the Region is attractive for their escape, should a terrorism campaign be successful. Another attraction for terrorist in the planning area is the Missouri and Kansas River, which could also aid in their initial campaign and their exit strategy.

Agro-terrorism is a concern across the state, as well as in Region L. All three counties have an agricultural footprint that could facilitate an agro-terrorism event that would affect many people.

Previous Occurrences

No previous terrorist or agro-terrorism events have been noted in the planning area. However, there are sympathies for terrorist groups.

- **January 2009**, according to the Kansas City Tribune, a chapter of the Muslim American Society (MAS-KC), held a rally in support of Hamas, a group that the United States has cited as being a terrorist group.
- **1989** at a Kansas City auditorium, a masked man described in Arabic the 'oceans of blood' spilled in Hamas' armed attacks on Israeli soldiers and civilians, thanking two nonprofit organizations for being allies.
- **May 2005**, Daveed Gartenstein-Ross stated in an interview in The Weekly Standard that, "MAS is a U.S. front group for the Muslim Brotherhood, which was a claim supported by a Chicago Tribune story that ran in 2004. Their goal is to see sharia law as the law of the United States. In 2007 MAS's ties to the Brotherhood were confirmed as reported by the Investigative Project on Terrorism.

Extent

While there have not been any terrorist events in the planning area, should a worse case scenario occur the planning committee has determined that extent could potentially be Catastrophic. In a hypothetical situation the event could result in multiple deaths, although it is unlikely to occur.

Probability of Future Events

Region L could potentially be attractive to a Terrorist Cell due to its central location in the United States, its large population base, and the transportation nodes. It is also an area that is full of historical and cultural buildings, with a military presence. Based on the three historical events, of which none were violent, the probability of this hazard affecting the planning area with the next 10 years is "**Unlikely**".

Impact and Vulnerability

The impact to the planning area could potentially include all infrastructure, critical facilities, crops, humans and animals. The degree of impact would be directly related to the type of incident and the target. Potential losses could include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses, loss of human life, injuries to persons, loss of food supplies, disruption of the food supply chain, and immediate damage to the surrounding environment. Secondary effects of infrastructure failure could include public safety hazards, spread of disease, increased morbidity and mortality among the local and distant populations, public panic and long-lasting damage to the environment. Terrorism events are rare occurrences and specific amounts of estimated losses for previous occurrences are not available due to the complexity and multiple variables associated with these types of hazards.

In some instances, information about these events is secure and unavailable to the public in order to maintain national security and prevent future attacks.

As discussed previously, it is difficult to quantify potential losses in terms of the jurisdictions most threatened by CBRNE (chemical, biological, radiological, nuclear, and high yield explosive) attack events due to the many variables and human element. Therefore, for the purposes of this plan, the loss estimates will take into account several hypothetical scenarios. Please note that these hypothetical scenarios are included to provide a sample methodology for local jurisdictions to estimate potential losses. The hypothetical scenarios include: a chemical attack, a biological attack, an improvised explosive device (IED) attack, and a radiological attack. For comparative purposes, these hypothetical attack scenarios will all be staged at the same venue, a college football stadium in the planning area during a home football game. The hypothetical stadium is situated on less than one square mile in an urban area and has a seating capacity of approximately 35,000 persons. Surface area and parking structures are located adjacent to the stadium.

Analysis of vulnerable populations is aided by a program developed by Johns Hopkins University in 2006 called Electronic Mass Casualty Assessment and `Planning Scenarios

(EMCAPS) http://www.hopkins-cepar.org/EMCAPS/EMCAPS.html which utilizes scenarios developed by the Department of Homeland Security.

****THE FOLLOWING HYPOTHETICAL SCENARIOS ARE FOR INSTRUCTIONAL AND ILLUSTRATIVE PURPOSES ONLY****

Chemical Attack – Mustard Gas

Scenario Overview: Mustard gas is released from a light aircraft onto the stadium during a home football game. The agent directly contaminates the stadium and the immediate surrounding area. This particular type of attack would cause harm to humans and could render portions of the stadium unusable for a short time period in order to allow for a costly clean-up. There might also be a fear by the public of long-term contamination of the stadium and subsequent boycott of games resulting in a loss of revenue and tourism dollars.

Assumptions: (1) The population density at the stadium on game day is high – approximately 93 percent of the seats, 33,250 are filled and an additional 5,000 persons remain outside the stadium in the adjacent parking areas. (2) Sulphur mustards are extremely toxic and may damage eyes, skin and respiratory tract. Death sometimes results from secondary respiratory infections. (3) The rate of “worried well” is equal to 9 times the number of infected cases.

Described Losses:

Severe Eye Injuries (1-2 hours)	28,688 persons
Severe Airway Injuries (1-2 hours)	28,688 persons
Severe Skin Injuries (2 hrs to days)	34,425 persons
Total “Worried Well” Cases (9 times the number of affected cases)	309,825 persons
Deaths	765 persons

Cost of Decontamination @ $12/person (assumes all persons with skin injuries will require decontamination and approximately 1/10 of the worried well will demand to be decontaminated) - total persons = 65,408	$ 784,896

Notes: Victims will require decontamination and both long and short term treatment. Services may need to be suspended at the area until all investigations are conducted.

Biological Attack – Pneumonic Plague

Scenario Overview: Canisters containing aerosolized pneumonic plague bacteria are opened in public bathrooms. Each release location will directly infect 110 people; hence, the number of release locations dictates the initial infected population. The secondary infection rate is used to calculate the total infected population. This particular weapon of mass destruction (WMD) attack method would not cause damages to buildings or other infrastructure, only to human populations.

Assumptions: (1) The population density at the stadium on game day is high. (2) The population density of the stadium city is high (5,572 persons / sq mile – assumes that the normal population is doubled on game day). (3) The number of dispersion devices is 30. Devices are assumed to be placed in crowded seating areas. (4) Pneumonic plague has a 1-15 percent mortality rate in treated cases and a 40-60 percent mortality rate in untreated cases. (5) The rate of “worried well” is equal to 9 times the number of infected cases.

Described Losses:

Initial Infected Populations	3,300 persons
Secondary Infected Population	6,623 persons
Total Plague Cases	9,923 persons
Total Deaths (Treated Cases 7%)	694 persons
Total “Worried Well” Cases (9 times the number of infected cases)	89,307 persons

Improvised Explosive Device Attack – ANFO

Scenario Overview: An Improvised Explosive Device (IED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a panel van to a parking area during a time when stadium patrons are leaving their cars and entering the stadium and detonated. Potential losses with this type of scenario include both human and structural assets.

Assumptions: (1) The population density in the parking lot during the beginning and ending of the games is high, at least 1 person /25 square feet. (2) The quantity of ANFO used is 4,000 lbs, similar to that used by Timothy McVeigh in the Oklahoma City bombing. (3) The Lethal Air Blast Range for such a vehicle is 200 feet according to the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF) Standards. (4) The Falling Glass Hazard distance is 2,750 feet according to BATF Explosive Standards.

Described Losses:

Total Dead	1,391 persons
Total Traumatic Injuries	2,438 persons
Total Urgent Care Injuries	11,935 persons
Injuries not Requiring Hospitalization	4,467 persons
Structures and Other Physical Assets (Damages would certainly occur to vehicles and depending on the proximity of other structures, damages would occur to the stadium complex itself. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of structures nearby and the amount of insurance held by vehicle owners.)	Vehicles – Replacement cost for approximately 100 vehicles @ $15,000 per vehicle inside the 200 ft BATF described Lethal Air Blast range = $ 150,000 Repair / repainting cost for approximately 500 vehicles @ $ 4,000 per vehicle inside the BATF described Falling Glass Hazard = $2,000,000

Radiological Dispersion Device – Dirty Bomb Attack

Scenario Overview: An Improvised Explosive Device (IED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a panel van to a parking area during a time when stadium patrons are leaving their cars and entering the stadium and detonated. Potential losses with this type of scenario include both human and structural assets. The bomb also contains 2,700 Curies of Cesium-137 (Cs-137).

Assumptions: (1) The population density in the parking lot during the beginning and ending of the games is high, at least 1 person /25 square feet. (2) The quantity of ANFO used is 4,000 lbs, similar to that used by Timothy McVeigh in the Oklahoma City bombing. (3) The Lethal Air Blast Range for such a vehicle is 200 feet according to the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF) Standards. (4) The Falling Glass Hazard distance is 2,750 feet according to BATF Explosive Standards.

Described Losses:

Total Dead	1,391 persons
Total Traumatic Injuries	2,438 persons
Total Urgent Care Injuries	11,935 persons
Injuries not Requiring Hospitalization	4,467 persons
Radiological Poisoning Injuries that Need Aggressive Treatment	13
Radiological Poisoning Injuries that Need Non-Critical Treatment	440
Radiological Poisoning Injuries that could Self Medicate with Proper Public Information	62,378
Structures and Other Physical Assets (Damages would certainly occur to vehicles and depending on the proximity of other structures, damages would occur to the stadium complex itself. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of structures nearby and the amount of insurance held by vehicle owners.)	Vehicles – Replacement cost for approximately 100 vehicles @ $15,000 per vehicle inside the 200 ft BATF described Lethal Air Blast range = $ 150,000 Repair / repainting cost for approximately 500 vehicles @ $ 4,000 per vehicle inside the BATF described Falling Glass Hazard = $2,000,000

The vulnerability of the planning area to a terrorism or agro-terrorism event is low. However, the planning significance is moderate in order to be better prepared should this man made hazard occur. Leavenworth, Johnson, and Wyandotte counties have thousands of small businesses, along with national and international corporations that, if interrupted by an event, could potentially cause significant economic loss. The loss of life because of the densely populated area would be catastrophic, and if the transportation nodes were targeted could result in more lives and economic loss as freight does not reach its intended destination. The resulting paranoia and fear after an attack could set the Region back, much as the country was set back after 911. Some of the interest in Region L that could be at risk of a terrorist attack, include:

- Dense Population
- Active Military installation at Fort Leavenworth
- Close vicinity to a nationwide telecommunication provider
- Venues for large amounts of people to congregate

While agri-terrorism is not as huge of a concern in the planning area as many areas of the state are, it is still a high visibility area due to its close proximity to large amounts of people and marketplaces.

A strategic nuclear, biological, or chemical attack on the United States could have the most devastating and far-reaching consequences. The use of these weapons against the United States is unlikely. Unfortunately, however, as long as such weapons exist, there is always a chance that they could be used. The potential for traditional war-related attacks, using conventional weapons, is a scenario that is more likely to occur, based on currently available information, however even attacks of that variety are rare. Attackers are likely to have either very specific targets such as Women's clinics, or desire large publicity from the attacks.

It is expected that the likelihood of attack is directly related to population density or more likely to an event that is occurring or to a specific location of importance to the attacker. For example, a large venue event, such as a sporting event attended by tens of thousands of people might be considered a desirable target. Most large public venues occur in densely populated areas since those areas are able to provide the infrastructure support (hotels, eateries, etc) for large numbers of people.

Summary

Dense populations, quickly accessible transportation modes, large venues for people, i.e., concerts, active military installations, and an industrial and agricultural foothold are all entities that are attractive to terrorist. All of these entities are provided in Region L, making it vulnerable to a terrorist/agri-terrorist attack. While this is unlikely to occur, the planning significance is moderate in order to prepare for an event in case it should happen.

Local Mitigation Concerns

- Because the Region is bordered by the Missouri River and Kansas River, the concern of waterway access for terrorist is greater. These are also major sources of the water supply for agriculture and drinking water and should these rivers be disrupted due to a chemical release the entire region could potentially be at risk to sickness, death, or disruption. These rivers also provide electricity to the Region and should a terrorist take out the plants it could throw the region into economic, sustainment, and personal havoc.

- The location of the region in the United States is of concern. To hit the middle of the United States would be a bold move by any terrorist, but it would make the point that no one or place is safe. While this is a difficult concept to mitigate, extra vigilance could help stop any attack.

- Leavenworth County is rated in the top 10 counties in Kansas for the number of farms. Agricultural terrorism is a concern, not only for the economy, but also for the lives that depend on the agricultural product. Should terrorist use chemicals on the crops and they make it to tables, loss of life could be huge. Tainting the livestock feedlots could also cause a severe disruption in the food chain. By hitting Region L with agricultural terrorism, terrorist could access a lot of people with half the work. This is a big concern.

- Of concern for Region L is the new Burlington Northern and Santa Fe Intermodel that introduces risk for terrorism.

Development in Hazard Prone Areas

As more and more large public events are held in Region L, more potential may exist for these venues to become targets of attack. With human-caused hazards such as this that can have multiple variables involved, increases in development are not necessarily always factors in determining risk, although the physical cost of the event may increase with the increased or newly developed areas.

Johnson County

Table 3.149. Johnson County CPRI: Terrorism/Agro-terrorism

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Terrorism/Agro-terrorism	1	4	4	4	2.65	Moderate

Leavenworth County

Table 3.150. Leavenworth County CPRI: Terrorism/Agro-terrorism

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Terrorism/Agro-terrorism	1	4	4	4	2.65	Moderate

Wyandotte County

Table 3.151. Wyandotte County CPRI: Terrorism/Agro-terrorism

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Terrorism/Agro-terrorism	1	4	4	4	2.65	Moderate

Consequence (Impact) Analysis

Table 3.152. EMAP Impact Analysis: Terrorism/ Agri-terrorism

Subject	Ranking	Impacts/Terrorism/Agri-Terrorism
Health and Safety of Persons in the Area of the Incident	Severe	Impact could be severe for persons in the incident area.
Responders	Minimal to Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Depending on damage to facilities/personnel in the incident area, re-location may be necessary and lines of succession execution (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe for explosion, moderate to low for Hazmat.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the affected area especially if communications, road and railways, and facilities incur damage (minimal to severe).
Environment	Minimal to Severe	Localized impact within the incident area could be severe depending on the type of human caused incident.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation (minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Impact will be dependent on whether or not the incident could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes. (minimal to severe)

3.2.19 Tornado

Calculated Priority Risk Index	Planning Significance
3.70	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 1,500 injuries. High winds not associated with tornadoes are profiled separately in this document in **Section 3.2.21** Windstorm.

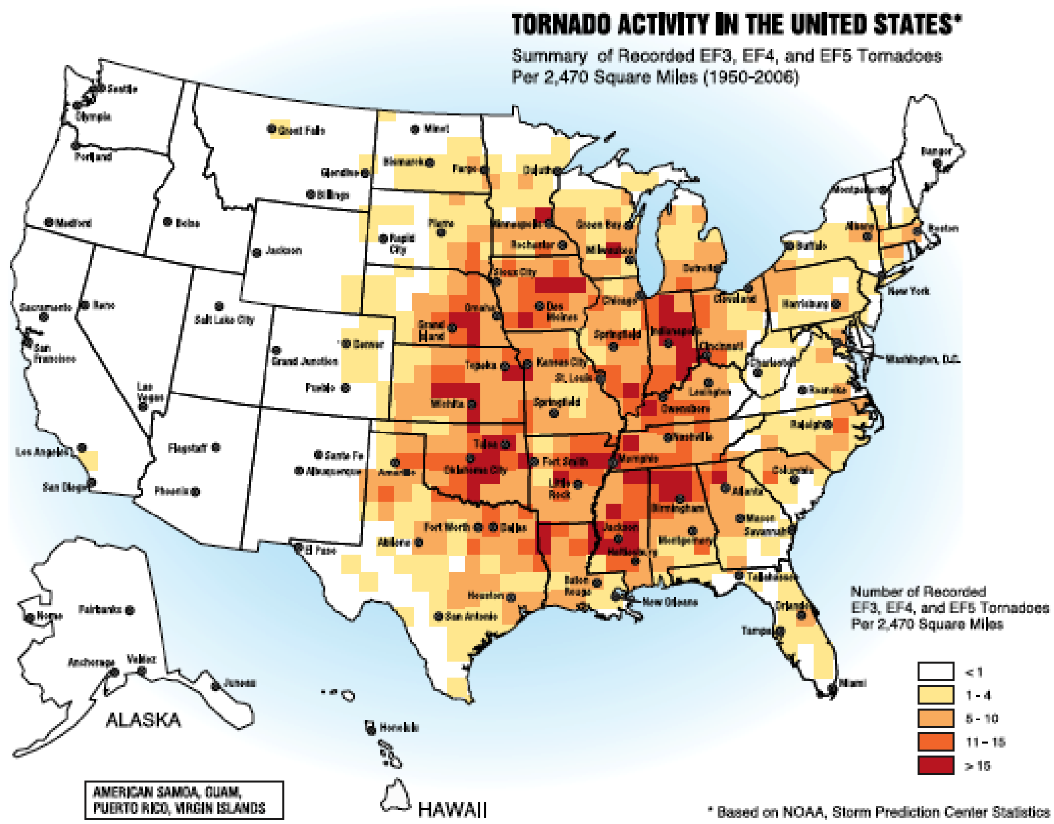
Although tornadoes have been documented on every continent, they occur most frequently in the United States east of the Rocky Mountains. Region L is situated in an area that is generally known as “Tornado Alley.” Climatologically conditions are such that warm and cold air masses meet in the center of 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.

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.

Location

Tornadoes can happen anywhere in the planning area. **Figure 3.75** shows the tornado activity in the United States. Region L shows 5 – 10 recorded EF3 – EF5 tornadoes between the years 1950 and 2006.

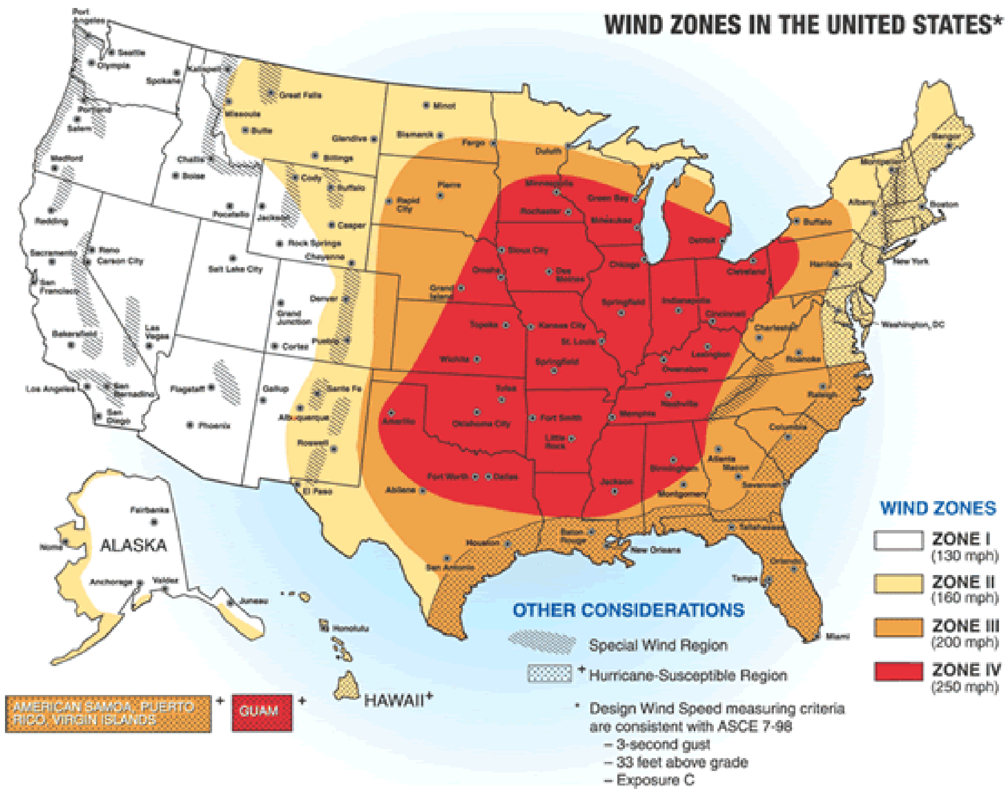
Figure 3.75. Tornado Activity in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition

Figure 3.76 shows the Wind Zones in the United States, with Region L being in Zone IV (250 mph).

Figure 3.76. Wind Zones in the United States



Previous Occurrences

There have been no tornadoes of a catastrophic nature in the planning area since the last plan. However, there have been several strong systems that have spawned funnel clouds and EF0 and EF1 tornadoes, resulting in property damage.

- June 2008 - Brief EF0 tornado touchdown on open country near 166th and Kansas Avenue at 1905CST. No damage reported.
- September 2008 - Several small severe thunderstorms, spawned several brief tornadoes over parts of east central Kansas, during the late afternoon and early evening hours of Friday, September 12, 2008. Most of the tornadoes were observed in open country and caused no damage. However, one did cause some minor house damage near Desoto Kansas. All of the tornadoes were classified as EF0. Heavy rains also caused flash flooding in Leavenworth county.
- April 2009 - An Ef1 tornado touched down at 1735 CST near the intersection of 238th Street and Loring Street. The tornado crossed Interstate 70, and then remained nearly parallel to the Interstate, before lifting at 1750 CST, near the intersection of Metro Avenue and 190th Street. Two homes sustained major damage and several barns were destroyed. Numerous trees were uprooted and several outbuildings were damaged.

- May 2012 – two tornadoes reported in Olathe, KS. This system brought thunderstorms, heavy rain, and hail to the area.

Extent

Tornadoes are classified according to the EF- Scale (the original F – Scale was developed by Dr. Theodore Fujita, a renowned severe storm researcher). The Enhanced F- Scale (see Table 3.153) attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original F scale was implemented in the U.S. on February 1, 2007.

Table 3.153. Enhanced Fujita Scale with Potential Damage

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

Source: NOAA Storm Prediction Center

In the past 12 years, Johnson County has experienced 9 tornado events. These have all been rated on the Enhanced Fujita Scale as EFO’s.

In the past 12 years, 2000 – 2012, Leavenworth County has experienced 10 tornado events. Five of these have been rated as EF0, four have been rated as EF1, and one event on May 5, 2003 was rated as an EF2. Total damages to property were reported as $7.023 million, with 2 injuries during the EF2 event.

Between the years 2000 and 2012, Wyandotte County had a total of 3 tornado events. Two were rated as EF0s, and one on 4 May 2002 was rated an EF4. This tornado caused $15.5 million in property damage and resulted in 2 deaths and 30 injuries.

Because it was determined that Region L is in Zone IV due to potential wind speeds, and due to historic events, the planning committee determined that the planning area could experience an EF5 tornado. The magnitude of a tornado this size would be catastrophic. It could result in multiple deaths.

Probability of Future Events

All of Kansas is susceptible to tornadoes, and Region L is no exception. While there have not been any tornadoes greater than an EF1 since the last plan, the probability remains **"Highly Likely**" that an event of any size will occur within the next three years.

- Johnson County has had 9 tornado events within the last 12 years, resulting in a 75% chance of this occurring in a given year.
- Leavenworth County has had 10 tornado events within the last 12 years, resulting in an 83% chance of a tornado occurring in any given year.
- Wyandotte County has had 3 tornadoes within the last 12 years, resulting in a 25% chance of the county having another tornado within the year.

Impact and Vulnerability

When Figures 3.75 and 3.76 above are compared, it is apparent that Region L is in a high tornado activity area. Region L resides in Zone IV, which is the highest wind zone there is, and is a good indicator of the potential for tornadoes.

Table 3.154 shows the incidence of tornadoes and statistics in the Region from 1952 – 2011.

Table 3.154.   Tornado Statistics for the Planning Area, 1952 – 2011

County	Tornadoes	Fatalities	Injuries	Longest Path	Widest Path
Johnson	38	44	224	69 miles	440 yards
Leavenworth	32	2	63	66 miles	880 yards
Wyandotte	10	2	50	26 miles	500 yards

Source: Tornado Project, http://www.tornadoproject.com/

Insured Crop Loss Data

According to the USDA Risk Management Agency, insured crop losses for Region L as a result of tornado damage for the ten year period of 2002-2011 totaled $0.00 as shown in **Table 3.155.**

Table 3.155. Crop Insurance Paid for Tornado Damages by Year, 2002-2011

County	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Johnson	$0	$0
Leavenworth	$0	$0
Wyandotte	$0	$0
Subtotal	**$0**	**$0**

Source: USDA Risk Management Agency

To determine potential financial loss estimates to tornadoes in the planning area, the available historical loss data was annualized to determine future potential losses. The planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (1993 – 2012). Table 3.156 shows the estimates financial loss for each county in Region L.

Table 3.156. Potential Financial Loss Estimates for Tornadoes in Region L

County	Potential Financial Loss (estimated)
Johnson	$25,900
Leavenworth	$389,100
Wyandotte	$775,000
Total	$1,190,000

Source: State Hazard Mitigation Plan

Tornadoes have a warning time of approximately 30 minutes or less. They can change paths quickly, which limits the time in which to take shelter. Tornadoes are very difficult to see at night, and during intense rain and hail, often give very little or no warning of when a tornado is on the ground.

To refine and access the relative vulnerability of each of Region L's counties to tornadoes, assigned ratings to pertinent factors were examined at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

Tornados that touch-down can create a unique path of destruction unlike a wide-spread winter storm event that can affect entire regions of the State. So using the prior events as a factor can give the perception that a county has a higher overall vulnerability to tornadoes.

The following are the data sources for the rating factors: Social Vulnerability Index for Kansas counties from the Hazards and Vulnerability Research Institute at the University of South

Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010), USDA's Census of Agriculture (2007) and USDA Risk Management Agency

(2002 – 2011). It was determined that for tornado, historical events and property damages are needed back to 1993 to adequately describe the tornado hazard in the planning area.

Table 3.157 below provides the factor's amount per county that are considered for tornado vulnerability.

Table 3.157. Vulnerability of Region L Counties Factor Amounts for Tornadoes

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region L									
Johnson	1	8	$518,000	$25,900	$43,871,468	1,149.60	$29,472,000	$0	$0
Leavenworth	1	15	$7,782,000	$389,100	$4,877,783	164.7	$20,983,000	$0	$0
Wyandotte	3	3	$15,500,000	$775,000	$12,066,666	1,039.00	$0	$0	$0
Total		**26**	**$23,800,000**	**$1,190,000**	**$60,815,917**		**$50,455,000**	**$0**	**$0**

Note: The Census of Agriculture did not publish crop exposure in Wyandotte County to avoid disclosure of individual operations.

The following are the 1 – 10 ranges for the tornado vulnerability factor ratings. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.158. Ranges for Tornado Vulnerability Factor Ratings

Ratings	Social Vulnerability	Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss Insurance Paid
1		3 - 7	$500 - $500,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	$0 - $1,000
2	1	8 - 12	$500,001 - $1,000,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$1,001 - $2,000
3		13 - 17	$1,000,001 - $1,300,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$2,001 - $3,000
4	2	18 - 22	$1,300,001 - $2,000,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$3,001 - $4,000
5		23 - 27	$2,000,001 - $3,000,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$4,0001- $5,000
6	3	28 - 32	$3,000,001 - $4,000,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$5,001 - $6,000
7		33 - 37	$4,000,001 - $7,000,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$6,001 - $7,000
8	4	38 - 42	$8,000,001 - $11,000,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$7,001 - $8,000
9		43 - 47	$11,000,001 - $13,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$8,001 - $9,000
10	5	48 - 54	Above $13,000,001	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$9,001 and up

Source: State Hazard Mitigation Plan

Table 3.159 provides the calculated ranges applied to determine the Medium, Medium-High and High vulnerable counties and Table **3.160** provides the seven rating values assigned that were considered in determining overall vulnerability to tornadoes. The entire Region is vulnerable to tornadoes so the overall ranges started with Medium and goes higher.

Table 3.159. Ranges for Overall tornado Vulnerability

Ranges	Medium	Medium-High	High
	9 - 19	20 – 29	30 - 40

Source: State Hazard Mitigation Plan

Table 3.160. Vulnerability of Region L Counties to Tornadoes

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Tornado Vulnerability
Mitigation Planning Region L									
Johnson	2	2	1	10	10	2	1	28	Medium-High
Leavenworth	2	3	1	2	2	2	1	13	Medium
Wyandotte	6	1	2	3	10	1	1	24	Medium-High

Source: State Hazard Mitigation Plan

Table 3.161 lists the top 10 vulnerable counties in Kansas relative to each other concerning tornadoes. The one EF5 destructive tornado in Greensburg, Kiowa County was deemed a statistical outlier and was not included in this analysis. Otherwise, Kiowa County would be the highest rated county.

Table 3.161. Top 10 Vulnerable Counties in Kansas for Tornadoes (yellow highlight represents county in Region L).

Mitigation Planning Region	County	Overall Vulnerability Rating	Tornado Vulnerability
G	Sedgwick	34	High
E	Barton	32	High
B	Rush	30	Medium-High
G	Harper	29	Medium-High
A	Sherman	28	Medium-High
E	Stafford	28	Medium-High
L	Johnson	28	Medium-High
A	Sheridan	27	Medium-High
B	Rooks	27	Medium-High
F	Republic	27	Medium-High

Source: State Hazard Mitigation Plan

Mobile Home Vulnerability

Of the more than 560 people killed in the U.S between 2001 and 2010 by tornadoes, 51 percent were in mobile homes, according to the National Oceanic and Atmospheric Administration. According to the *2012 Kansas Severe Weather Awareness Week* packet, people living in mobile homes are killed because of tornadoes at a rate 20 times higher than people living in permanent homes. Only 33 percent of those who died were in permanent structures, and 16 percent were outside a home.

Yet mobile homes make up only about 7 percent of the nation's housing. They represent about 5.2 percent of homes in Kansas, with 65,184 units according to the U.S. Census Bureau.

Table 3.162 provides the number of mobile home units per county according to the U.S. Census Bureau American Community Survey 2005 – 2009.

Table 3.162. Number of Mobile Home Units per County

County	Number of Mobile Homes
Johnson	1,392
Leavenworth	873
Wyandotte	1,676
Total	3,941

Source: State Hazard Mitigation Plan

Summary

Johnson, Leavenworth, and Wyandotte Counties are all vulnerable to tornado activity. Johnson County has had the most tornadoes in the Region, with a total of 38 reported, and 244 fatalities in the last 60 years. Wyandotte County has had the least with 10 reported tornado events. The vulnerability of this Region is enhanced due to its dense population, housing, and business industries. Due to the density of the population and building base in the region, if an EF1 tornado hits the area it can do severe damage.

Local Mitigation Concerns

- A big concern of a tornado in any region is the potential loss of life and destruction of property. Region L is a densely population area, with housing and buildings in close proximity to each other. Even an EF0 tornado has the ability to inflict damages when it is spawned in an urban area.
- Region L has a high industrial and business footprint, nationally and internationally. Many of these buildings are predominantly windows, which during a tornado event can inflict damaging personal injury to people inside the building and outside of the building. Should a tornado hit the business area of any of these counties the damage to humans could be catastrophic due to glass and flying debris.
- The Region recognizes that poor resiliency in existing buildings, particularly residential, are an issue. Training and Education in structural resiliency for Code Enforcers is an essential component for ensuring new construction is built to sustain damages.

Development in Hazard Prone Areas

New development anywhere in the planning area will be susceptible to tornado impacts. New manufactured housing development will be most susceptible to damage, particularly if not anchored properly. The extent of new manufactured housing development is not known. The inclusion of residential safe rooms into new construction is an area requiring further consideration in order to protect the populace, as well as community and school safe rooms. The Boy Scouts of America Camp Naish, and the DeSoto school district both benefited from their prior mitigation plan participation by having safe rooms built with funding through the HMGP program.

Johnson County

Table 3.163. Johnson County CPRI: Tornado

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Tornado	4	4	4	1	3.70	High

- The hazard of Tornado for Johnson County went from a 2.80 planning significance to a 3.70 planning significance during this plan. This is attributed to the fact that the last plan indicated that the probability was 49% that this event would happen in any given year, however the CPRI was calculated with a less than 33% chance, or Likely to occur. This plan corrects this to reflect the true probability based on historical data.

Leavenworth County

Table 3.164. Leavenworth County CPRI: Tornado

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Tornado	4	3	4	1	3.40	High

Wyandotte County

Table 3.165. Wyandotte County CPRI: Tornado

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Tornado	2	4	4	1	2.80	Moderate

Consequence (Impact) Analysis

The information in **Table 3.166** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.166. EMAP Consequence Analysis: Tornado

Subject	Ranking	Impacts/Tornado
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe depending on whether individuals were able to seek shelter and get

		out of the trajectory of the tornado. Casualties are dependent on warning systems and warning times.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal to Severe	Temporary/Permanent relocation may be necessary if government facilities experience damage (minimal to severe).
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be severe in the trajectory path. Roads, buildings, and communications could be adversely affected. Damage could be severe.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained. Depending on the incident size the damage could be severe.
Environment	Minimal to Severe	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the trajectory of the tornado. If a jurisdiction takes a direct hit then the economic conditions will be severe. With an indirect hit the impact could still be anywhere from low to severe.
Public Confidence in Jurisdiction’s Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Warning systems and warning time will also be questioned (minimal to severe)

3.2.20 Utility/Infrastructure Failure

Calculated Priority Risk Index	Planning Significance
3.00	High

Description

Critical infrastructure involves several different types of facilities and systems including: electric power, transportation routes, natural gas and oil pipelines, water and sewer systems, storage networks, and internet/telecommunications systems. Failure of utilities or other components of the infrastructure in the planning area can seriously impact public health, functioning of communities and the economy. Disruption of any of these services could result from the majority of the natural, technological, and manmade hazards described in this plan. In addition to a secondary or cascading impact from another primary hazard, utilities and infrastructure can fail as a result of faulty equipment, lack of maintenance, degradation over time, or accidental damage such as damage to buried lines or pipes during excavation.

Electric Power

Disruption of electric power supply can be a cascading impact of several other hazards. The most common hazards analyzed in this plan that disrupt power supply are: flood, tornado, windstorm, and winter weather as these hazards can cause major damage to power infrastructure. To a lesser extent, extreme temperatures, dam and levee failure, lightning, and terrorism can disrupt power. Extreme heat can disrupt power supply when air conditioning use spikes during heat waves which can cause brownouts. Dam and levee failure, are similar to flood in that infrastructure can be damaged or made inaccessible by water. Lightning strikes can damage substations and transformers, but is usually isolated to small areas of outage. Many forms of terrorism could impact power supply either by direct damage to infrastructure or through cyber-terrorism targeting power supply networks.

The largest electric utility providers in Region L are Kansas City Power & Light, Westar Energy, City of Gardner, and Leavenworth-Jefferson Elec. Coop., Inc.

Figure 3.77, Figure 3.78, and Figure 3.79 show the location of the electric lines for Johnson, Leavenworth, and Wyandotte Counties, respectively.

Figure 3.77. Map of Johnson County Electric Lines

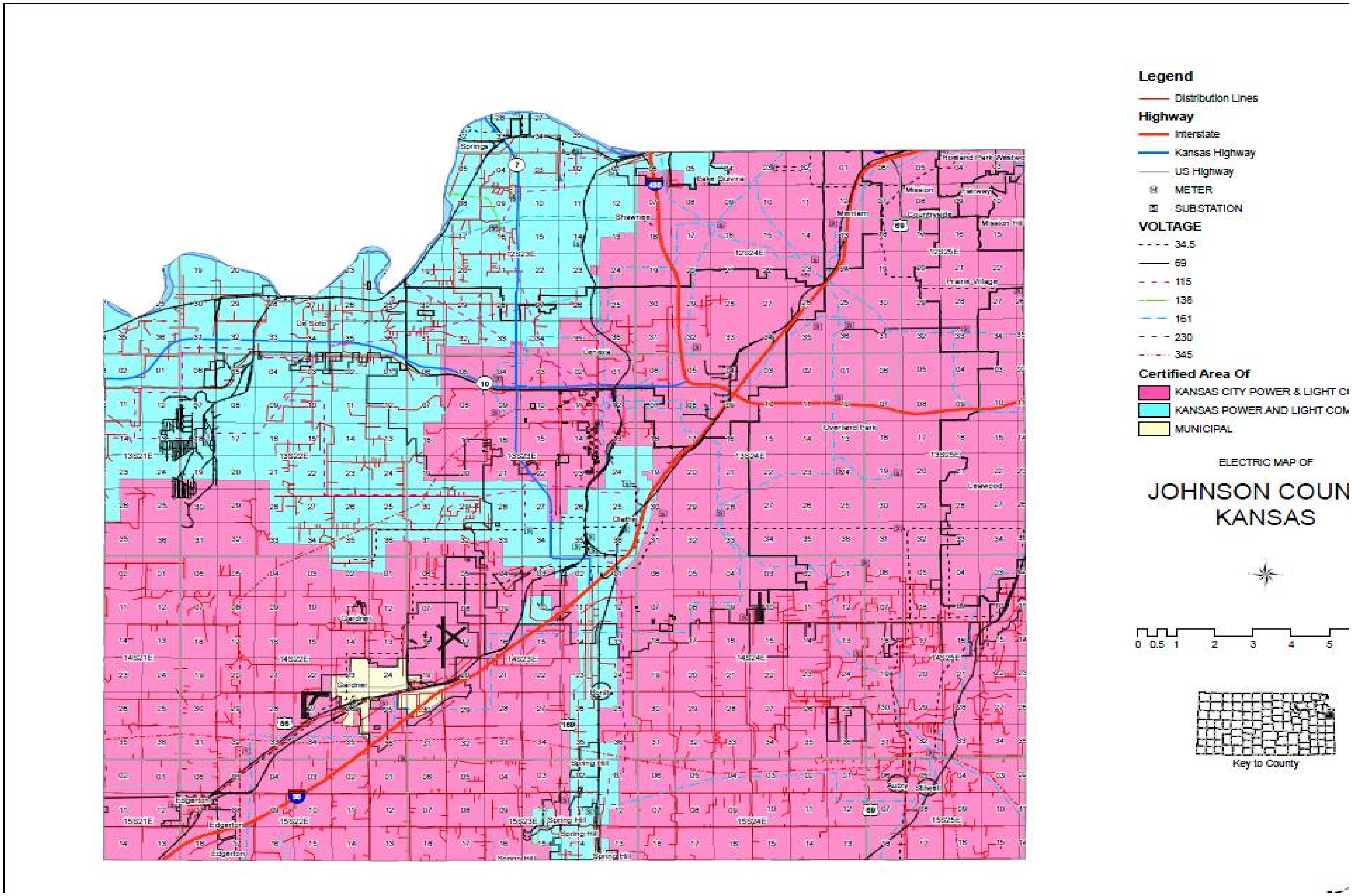


Figure 3.78. Map of Leavenworth County Electric Line

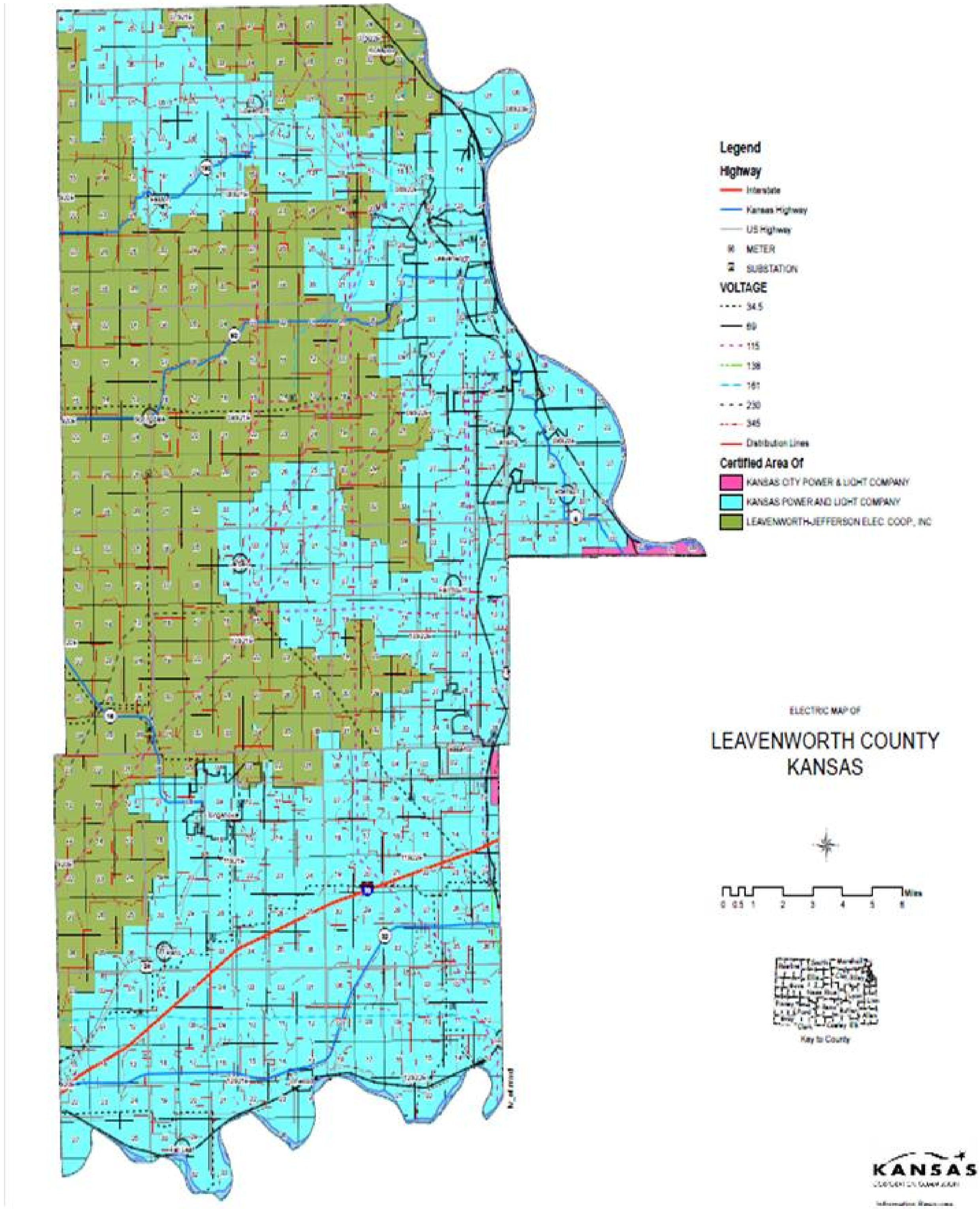
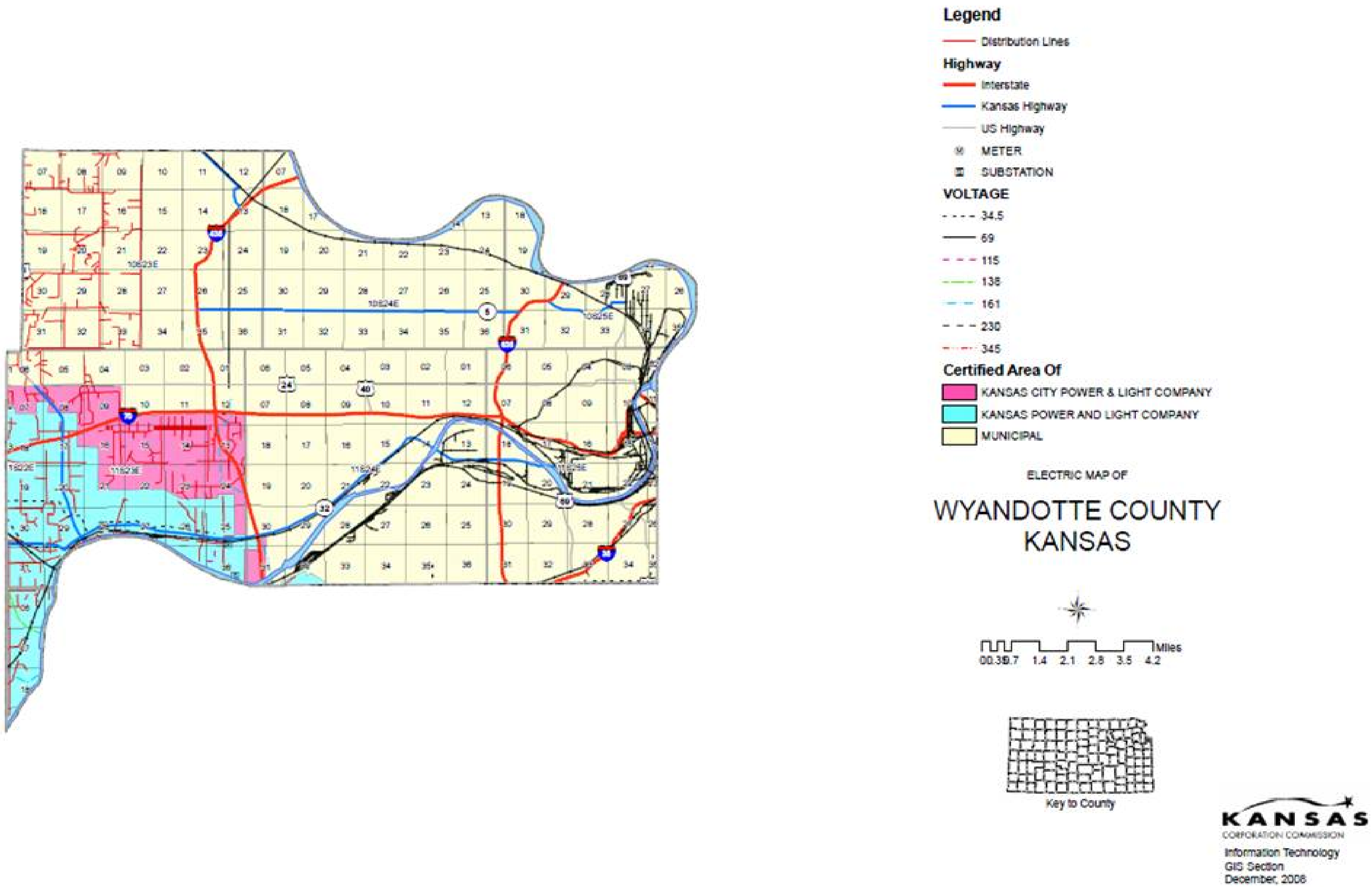


Figure 3.79. Map of Wyandotte County Electric Lines



Transportation Routes

Transportation routes can also be impacted by many of the hazards discussed in this plan. The primary hazards that impact transportation are: Flood, Hazardous Materials, and Winter Weather. Flood events, both riverine and flash flood can make roads and bridges impassible due to high water. Flood waters can also erode or scour road beds and bridge abutments. Highway and railroad accidents that involve hazardous materials can impact transportation routes as road and railroad closures, as well as evacuations may be necessary. Winter Weather frequently impacts transportation as roads become treacherous or impassible due to ice and snow. Secondary hazards that impact transportation routes include: dam and levee failure if routes are in inundation areas, extreme temperatures can cause damage to pavement (especially asphalt), land subsidence can damage roads/railroads if subsidence area is near the route, landslide can cause debris and rock falls onto roadways, terrorism can target routes, tornado can directly damage infrastructure or deposit debris in routes, wildfire can cause decreased visibility on transportation routes due to smoke, and windstorm can cause vehicle accidents or overturning (particularly cargo vans).

Natural Gas and Oil Pipelines

Primary hazards that can impact natural gas and oil pipelines are earthquake, expansive soils, land subsidence, landslide, and terrorism.

Water and Sewer Systems

The primary hazards that can impact water supply systems are: drought, flood, hazardous materials, and terrorism. The primary hazard that impacts sewer systems is flood.

Storage Networks

If damaged, storage networks and infrastructure can disrupt government and business functions. All state government and most local governments and businesses utilize redundant systems to decrease vulnerability to outages. All hazards that can disrupt electric power can also impact storage networks as electricity is required to power the infrastructure. In addition, the networks themselves can be damaged if the hazard impacts the facility where the network is located. The primary hazards that can cause direct damage are: flood, lightning, terrorism, and tornado.

Internet/Telecommunications

Internet and telecommunications infrastructure can be impacted by a number of hazards as well. The types of hazards and impacts to internet and telecommunications infrastructure are very similar to electric power supply. Land line phone lines often utilize the same poles as electric lines. So, when weather events such as windstorm or winter weather cause lines to break, both electricity and telephone services experience outages. With the increasing utilization of cellular phones, hazard events such as tornado that can damage cellular repeaters can cause outages. In addition, during any hazard event, internet and telecommunications systems can become overwhelmed due to the surge in call/usage volume.

Location

The entire planning area in Region L is vulnerable to Utility/Infrastructure Failure due to equipment or maintenance failure, or as a secondary hazard when the primary hazard is a Tornado, Winter Storm, Wind Storm, Lightning, Terrorism, expansive soil, drought, etc. All of these have the capacity to directly hit the utility and infrastructure of the planning area, or indirectly such as with earth movement during a drought or expansive soil, or flood event.

Previous Occurrences

- **FEMA-4035-DR: Flooding—September 23, 2011:** Four counties in northeast Kansas were declared for flooding that occurred from June 1 to August 1, 2011 along the Missouri River. The counties included are Atchison, Doniphan, Leavenworth, and Wyandotte. Damages as a result of this event were estimated to be nearly $7.4 Billion and primarily involved damages to roads and bridges.

- **FEMA-1741-DR—February, 2008 (December 6-19, 2007):** An ice storm caused numerous power outages and approximately 130,000 Kansas customers were without power. Specifically, Kansas Rural Electric Cooperatives reported 49,000 customers without power, Westar reported 76,000 customers, Kansas City Power & Light reported 4,300 customers, and Kansas City, Kansas Board of Public Utilities reported 800 customers without power. FEMA's Public Assistance costs were $355,651,857 for this disaster.

Extent

While utility/infrastructure failure is common during winter storms, tornados, etc., it is a manageable failure. Normally the power lines are affected, however the utility companies are very aggressive in restoring their use. The planning committee has deemed this hazard as negligible to the planning area.

Probability of Future Events

Utitlity/Infrstructure failure are normally tied to other weather hazards such as tornadoes, winter storms, and high winds. Region L has a high propensity for weather that is conducive to these hazards, which in turn makes the possibility of a utility/infrastructure failure a high reality. The planning committee has determined that this event is **Highly Likely** during the calendar year.

Impact and Vulnerability

Since utility/infrastructure failure is generally a cascading impact of other hazards, it is not possible to quantify estimated potential losses specific to this hazard due to the variables associated with affected population, duration of outages, etc...

Although the limitless variables make it difficult to estimate future losses on a statewide basis, FEMA has developed standard loss of use estimates in conjunction with their Benefit-Cost Analysis methodologies to estimate the cost of lost utilities on a per-person, per-use basis (See **Table 3.167).**

Table 3.167. FEMA Standard Values for Loss of Service for Utilities and Roads/Bridges

Loss of Electric Power	**Cost of Complete Loss**
Total Economic Impact	$126 per person per
Loss of Potable Water	**Cost of Complete Loss**
Total Economic Impact	$93 per person per
Loss of Wastewater	**Cost of Complete Loss**
Total Economic Impact	$41 per person per
Loss of Road/Bridge	**Cost of Complete Loss**
Vehicle Delay Detour	$38.15 per vehicle per
Vehicle Delay Mileage	$0.55 per mile (or

Source: State Hazard Mitigation Plan and FEMA.gov.

The impact of a major utility/infrastructure event would be dependent on time of year, location, and event length. If a major event happened in the middle or summer or winter during extreme temperatures than the elderly and very young population could be at risk as they try to stay cool or warm. If a major transportation node collapsed due to expansive soil, lives could be lost and services could be disrupted. The whole population could be effected if the event went on for a considerable length of time.

While every community in the State is at risk to utility/infrastructure failure, the vulnerability is somewhat elevated in the planning area due to the higher population density, development, and economic activities of the Kansas City Metropolitan Area that would be disrupted by a major infrastructure failure event.

In recent years, regional electric power grid system failures in the western and northeastern United States have demonstrated that similar failures could happen in Kansas. This vulnerability is most appropriately addressed on a multi-state regional or national basis.

Summary

Region L is vulnerable to this hazard, mainly as a secondary repercussion from other hazards that occur in the area. Tornadoes, Winter Storms, Floods, Expansive Soils, Extreme Temperatures, Drought, and many more play a role I the integrity of the utility/infrastructure arena. While most events of utility or infrastructure failure only last for 3 to 5 days, it can be detrimental to the safety of people, property and structural integrity. Because it is a highly urbanized region, a glitch or failure in utilities/infrastructure could upset everyday life, seamless travel, and the ability to survive, especially within our vulnerable populations.

Local Mitigation Concerns

- Utility/Infrastructure Failure is often times associated with another hazard which compounds the issue. Should a major blackout affect the Region, it could potentially affect up to a million people with responders trying to find shelter and food to sustain these lives, regardless of the extreme temperature caveat. Roads and Bridges could be damaged which hurt the supply routes, as well as any people traveling on them at the time.

- The vulnerable population is a particular concern during a utility/infrastructure failure event. They are not always able to get around on their own and rely on mobile food banks for sustenance. Any disruption in service could potentially put these lives in danger.

- Rolling blackouts could see an increase in theft and violence, particularly in the urban areas. The economy could suffer as a result, as well as the community's confidence in their officials to keep them safe.

- Another potential issue is the occurrence of unmapped utility lines. Wyandotte County discovered unmapped fiber optic lines that went from their county into Leavenworth that belonged to the Department of Homeland Security. This discovery came about by accident due to the lack of communication. Regardless of whether a county owns the lines or not, it is imperative that they know what is buried within their jurisdiction.

Development in Hazard Prone Areas

Increases in development and population growth in the planning area, also increases the demand for utilities as well as the level of impacts when the utilities fail. One way to mitigate for this hazard is by burying utility lines in new construction and replacing existing lines when funding is available.

Johnson County

Table 3.168. Johnson County CPRI: Utility/Infrastructure Failure

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Utility/Infrastructure Failure	3	2	4	3	2.85	Moderate

Leavenworth County

Table 3.169. Leavenworth County CPRI: Utility/Infrastructure Failure

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Utility/Infrastructure Failure	4	1	4	2	2.90	Moderate

Wyandotte County

Table 3.170. Wyandotte County CPRI: Utility/Infrastructure Failure

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Utility/Infrastructure Failure	4	1	4	3	3.00	High

Consequence (Impact) Analysis

The information in **Table 3.171** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.171. EMAP Consequence Analysis: Utility/Infrastructure Failure

Subject	Ranking	Impacts/Utility/Infrastructure Failure
Health and Safety of Persons in the Area of the Incident	Moderate to Severe	Localized impact will be moderate to severe for persons with functional and access needs, and the elderly, depending on length of failure and time of year.
Responders	Minimal	Impact to responders will be minimal if properly trained and equipped.
Continuity of Operations	Minimal	Due to the nature of the hazard, the COOP plan is not expected to be activated, however, if the recovery time is excessive than temporary relocation may become necessary (minimal).
Property, Facilities, and Infrastructure	Minimal	Impact is dependent on the nature of the incident, e.g., electric, water, sewage, gas, communication disruptions). (Minimal)
Delivery of Services	Minimal	Delivery of services could be affected within and around the affected area (minimal).
Environment	Minimal	Impact, depending on the nature of the incident, should be minimal.
Economic Conditions	Minimal	Economic conditions could be adversely affected depending on damages suffered, extent of damages, etc. (minimal)
Public Confidence in Jurisdiction's Governance	Minimal	Impact will be dependent on whether or not the government or non-government entities response, recovery, and planning were not timely and effective (minimal).

3.2.21 Wildfire

Calculated Priority Risk Index	Planning Significance
2.80	Moderate

Description

Wildfires in the planning area typically originate in pastures or accidents following the ignition of dry grasses (by natural or human sources). Ranchers and farmers intentionally ignite vegetation to restore soil nutrients or alter the existing vegetation growth. These fires have the potential to get out of control and erupt into wildfires. Wildfires are also associated with lightning and drought conditions, as dry conditions make vegetation more flammable. Wildfires may also originate, or spread to forested areas, or other areas with concentrations of woody fuel that can cause wildfires to increase in intensity and spread. The Eastern Red Cedar is of particular concern in the planning area. This invasive evergreen species can take over fence rows and un-planted fields, adding to wildfire fuel and risk. Additionally, this type of fuel, as well as other tree plantings near structures can cause structures to be consumed by wildfires, putting inhabitants at risk.

Wildfires tend to peak in March and April when people are conducting controlled burns in grassland and fields When conditions green up later in the summer and the humidity is higher, the risk of wildfires is generally lower. This trend, however, does not continue in years of extreme drought when hot and dry weather prevail.

The wild land/urban interface is the area where human improvements such as homes, ranches and farms come in contact with the wild lands. Urban expansion has driven the increased building of homes in wild land areas. Wherever people are living in or adjacent to wild land areas, the threat of wildfire exists. As the rural population increases, so does the risk to life and property from wildfire.

Location

The entire planning area is susceptible to wildfire events. The wildfire risk in Region L is of a higher concern than its western county counterparts. This is largely because of the population growth in the eastern part of the State resulting in increasing encroachment into the wildland/urban interface. Additionally, the effects of smoke emissions from wildfires are more of a concern in the more urban eastern counties due to higher populations in those areas.

According to the 2011 *Kansas Forest Action Plan*, with the exception of Eastern Red cedar/hardwood, most forest types in the region do not pose significant fire management issues. However, grasslands are a different story. These areas and the wild land-urban interface where development has occurred are the focus of wild land fire management issues in the area.

Previous Occurrences

- 8 August 2012 – More than 100 acres burned when a stolen car was set on fire in a field that led to the blaze. The fire was in the vicinity of 183rd Street and State Line Road, and 187th Street and Mission Road. A trailer and all-terrain vehicle were also set on fire. Firefighters stopped the fires from damaging any homes.

- 19 August 2012 – 5 grass fires were ultimately put out in Johnson County in the cities of Olathe (2), Lenexa, Mize and Shawnee. No buildings were damaged.

- 2012 – Wyandotte county saw a fire that began at 57th Street and I70 spreading toward Muncie Drive. Fire Crews stopped the fire about 100 feet from four or five homes in the rural, wooded area.

- 21 August 2012 – three grass fires in Leavenworth County, one begin near Tonganoxie were put out after burning 50 acres and 7 acres and the other of undetermined acreage. The seven acre fire near Tonganoxie destroyed one mobile home.

Extent

In the year 2012 alone the planning area saw four reported incidents for Wildfire. One mobile home was destroyed and four homes were threatened. With the incidence of drought that has affected the state, as well as the rise in average temperatures; the extent of wildfires could potentially be greater. The planning committee has determined that during this planning period the Magnitude is: Negligible.

Probability of Future Events

Historical records for this hazard are difficult to obtain. There is no consistency of when to report a wildfire, or what criteria should be followed. When a wildfire is located in a city often times the authorities do not report it as a wildfire, even though it may have been present in an open dry field. However, wildfires do occur on an annual basis in the planning area resulting in this hazard's probability being **"Highly Likely".**

Impact and Vulnerability

According to the USDA's Risk Management Agency on Crop Insurance, no payments have been made for loss of crops due to wildfire in the planning area. However, as seen in previous occurrences, property loss, although rare in this region, does happen as seen with the mobile home that was burned.

Although some data is available from the National Fire Incident Reporting System (NFIRS) in terms of previous events, this data has limitations in providing useful statistical data for analysis. The most problematic issues are that not all fire departments report to NFIRS and of those that report, not all incidents are reported. This current lack of local level, (i.e. fire district or county), requirements and a past lack of enforcement of state statutes has led to a lack of fire occurrence data for both prescribed burns and wildfires being available. Changes in enforcement of wildfire reporting requirements at the state level, as well as prescribed fire reporting requirements that are part of the EPA-mandated Kansas Flint Hills Smoke Management Plan (approved in 2011), will give the Kansas Forest Service a much greater opportunity to begin using real-time fire occurrence data to assist in making the best fire management decisions.

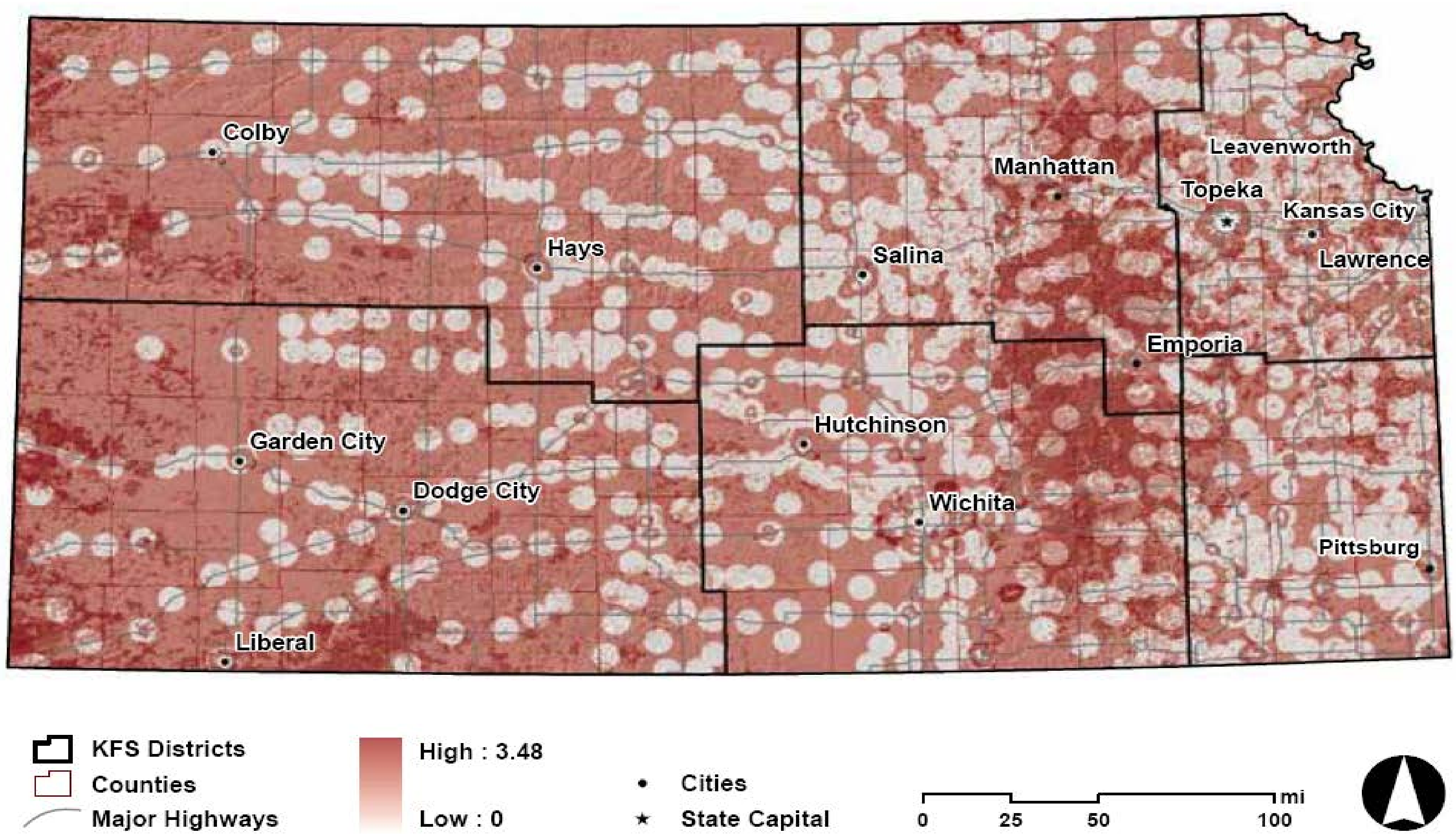
In light of the data limitations associated with available statistics, and with the publication of the 2011 *Kansas Forest Action Plan*, the planning committee determined that the best available data for the vulnerability analysis for the Wildfire Hazard is the 'Weighted Sum' analysis that was completed and utilized to develop a 'Wildfire Risk' composite layer as part of the Forest Action Plan.

The 'Wildfire Risk' composite layer was developed using a 'Weighted Sum' analysis to combine six data layers produced from a combination of eight separate datasets. In close consultation with the Kansas Forest Service's Fire Management Coordinator and other Fire Management staff six data inputs were developed to represent Wildfire Risk in Kansas. These data inputs and their corresponding analysis weight are listed below:

1) Wildland Urban Interface—from 3 data sets (.85)
2) ISO Fire Station Coverage Gaps (.75);
3) Conservation Reserve Program Lands (.60);
4) Eastern Redcedar in Grasslands (.75);
5) 'Moderate' Fire Potential risk and (.53);
6) 'High' Fire Potential risk (.80).

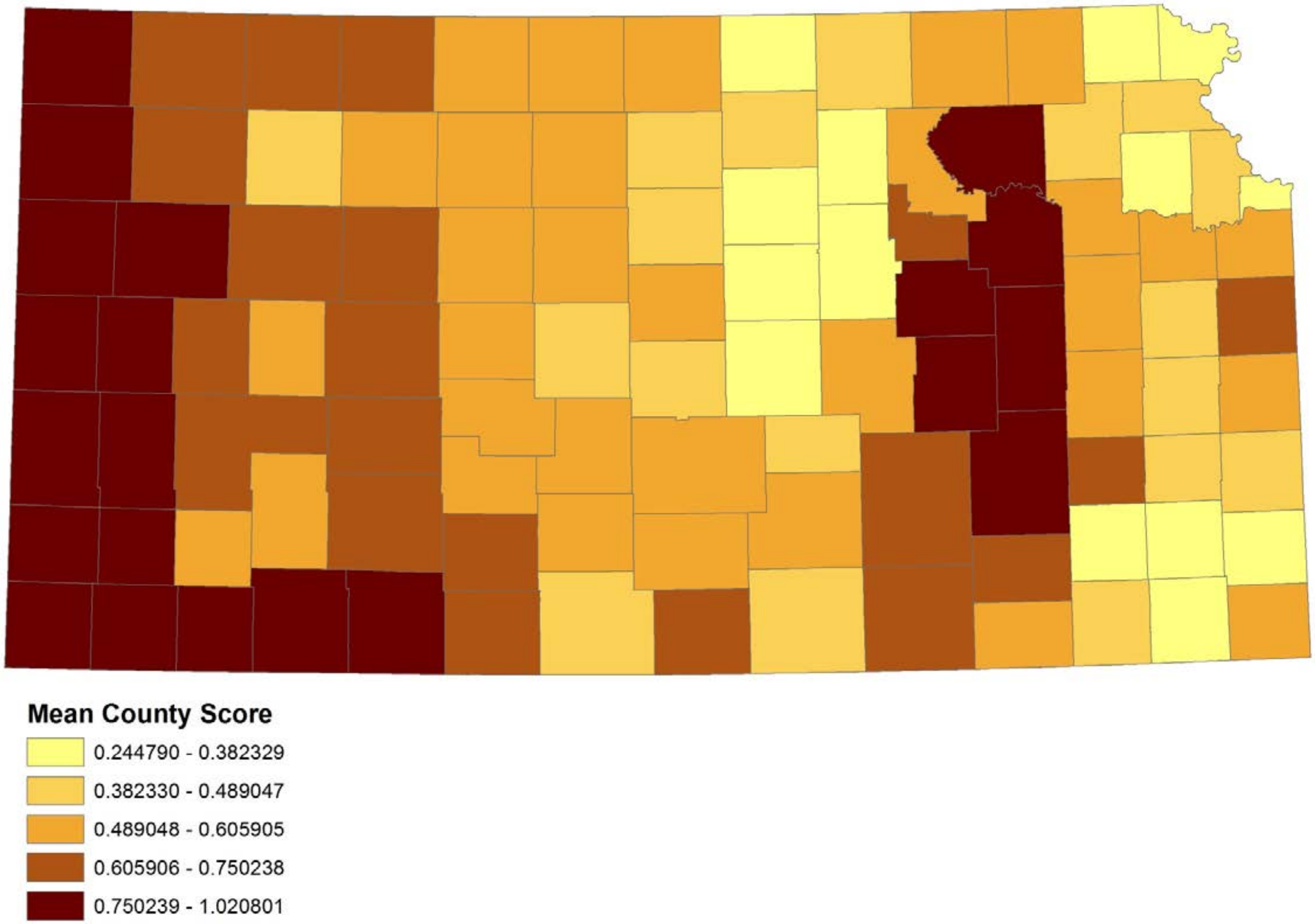
For more detailed descriptions of these six data layers, see pages 27-28 of the *Kansas Forest Action Plan*, http://www.kansasforests.org/assessment.shtml. The six data layer inputs were combined using the 'Weighted sum' analysis. The resulting raster contains values ranging from 0 to 3.48. The higher the numbers (darker shading) indicate higher wildfire risk. **Figure 3.80** is the resulting composite map**. Figure 3.81** that follows provides a map indicating the mean score for each county. **Then Table 3.168** provides a table of the mean score for each county.

Figure 3.80. Issues that Create Wildfire Risk—Composite Map



Source: Kansas Forest Service, *Kansas Forest Action Plan*, 2011

Figure 3.81. Wildfire Risk (by Mean County Score)



Source: Kansas Forest Service

Table 3.168. Mean Wildfire Risk Score for Kansas Counties by Mitigation Planning Region

County	Mean Wildfire Risk Score
Mitigation Planning Region L	
Johnson	0.52408075333
Leavenworth	0.41779085994
Wyandotte	0.28411415219
Planning Region Average	0.40866192182

Source: State Mitigation Plan 2013

When the mean wildfire risk score is compared to all the counties in Kansas, Region L did not rate in the Top 10.

Community Wildfire Protection Plans

One way for communities at risk to wildfire to reduce their overall vulnerability is development of Community Wildfire Protection Plans (CWPP) to identify specific areas at risk and actions that can be taken to reduce risk. The Healthy Forests Restoration Act (HFRA) provided communities with an opportunity to influence where and how federal agencies implement fuel reduction projects on federal lands. A CWPP is the most effective way to take advantage of this opportunity. Additionally, communities with Community Wildfire Protection Plans in place are given priority for funding of HFRA hazardous fuels reduction projects.

CWPPs can take a variety of forms, based on the needs of the people involved in their development. They may address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection—or all of the above. The three main components of a CWPP are:

1) Collaboration between all affected or potentially affected jurisdictions,
2) Assessment of the wildfire hazards in an area that leads to recommendation for prioritized fuel reduction, and
3) A section on recommendations towards reducing structural ignitability.

In Kansas, the Kansas Forest Service coordinated with several Local Hazard Mitigation Planning efforts to integrate a Community Wildfire Hazard Assessment into Local Hazard Mitigation Plans. By doing so, the requirements of the main components of the CWPP have been met. The language in the HFRA provides maximum flexibility for communities to determine the substance and detail of their plans and the procedures they use to develop them. Table 3.169 shows the counties in the Region and their status into the Community wildfire Protection Plan, and as a Firewise Community.Wyandotte's CWPP is pending, while Johnson County's CWPP has been approved. Leavenworth has not begun the process at the writing of this plan.

Table 3.169. Participation in CWPP and Firewise

County	Community Wildfire Protection Plan			Firewise
	No	Pending	Approved	
Johnson			X	No
Leavenworth	X			No
Wyandotte		X		No

Firewise Communities

Taking steps to become a Firewise Community is another way communities with wildfire risk can reduce their wildfire vulnerability. The five steps of Firewise recognition http://www.firewise.org/communities/usa-recognition-program/program-criteria.aspx

- Obtain a wildfire risk assessment as a written document from your state forestry agency or fire department.
- Form a board or committee, and create an action plan based on the assessment.
- Conduct a "Firewise Day" event.
- Invest a minimum of $2 per capita in local Firewise actions for the year.
- Submit an application to your state Firewise liaison

Currently no county in Region L is a Firewise Community. However, whether or not communities have a CWPP or have taken steps to become a Firewise Community, many have adopted burn ban ordinances or placed specific bans on burning during conditions favorable to wildfire, such as drought.

Summary

Wildfires have been, currently are, and will be an issue for the planning area. Whether through natural means, or human caused, wildfires have the potential to put lives and property in danger. While there are many causes of wildfires, lightning and human caused top the list. Once an area has had a wildfire, and the land resides on a slope of any etiology, the chance of a landslide and soil erosion is increased. The planning area is known for its hill elevations and the construction that has been done for residences and businesses on these slopes. There is also marked presence of open land in the area that is also prone to wildfires. These types of fires can spread quickly, especially during drought conditions, endangering homes, businesses, crops, livestock, and property.

Local Mitigation Concerns

- The wind in Kansas normally blows in an eastwardly direction, so that when wildfires are present outside of the planning area, the smoke blows into their Region. This could be a health concern for all of the population, but specifically the vulnerable population that are elderly, young, and/or have health issues such as asthma, emphysema, etc.

- Wildfires in the Region can be a contributor to landslides and soil erosion. When a wildfire burns off all the grass it takes the 'anchor' for the soil. Subsequently, when it rains this soil is easily washed away. When on a slope it could potentially result in a landslide.

- Because it is a densely population region with residences and buildings in close proximity to each other, a wildfire in the area could be catastrophic to home and business owners. A fire in a region like Region L would have no problem jumping from structure to structure.

- The more urban an area is, the more diversity in the population. Individuals who have not been trained in wildfire prevention are more prevalent, increasing the incidence of fires that can spread to wildfire proportions.

- Wild fire suppression in the rural areas is a concern due to lack of an expanded water supply.

- Large grass fires could cause power outages and high water use demands causing water suppliers to have limited drinking water supply as well as limited water storage for fire protection.

Development of Hazard Prone Areas

Agricultural and wildlands have a higher risk for wildfires than urban areas. However, the wildland/urban interface is a high risk area as the counties in Region L see population growth and a subsequent growth in housing construction encroach more and more into what used to be wildland.

Johnson County

Table 3.170. Johnson County CPRI: Wildfire

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Wildfire	4	1	4	2	2.90	Moderate

Leavenworth County

Table 3.171. Leavenworth County CPRI: Wildfire

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Wildfire	4	1	4	1	2.80	Moderate

Wyandotte County

Table 3.172. Wyandotte County CPRI: Wildfire

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Wildfire	4	1	4	1	2.80	Moderate

Consequence (Impact) Analysis

The information in Table 3.173 provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.173. EMAP Consequence Analysis: Wildfire

Subject	Ranking	Impacts/Wildfire
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas.
Responders	Minimal to Severe	Impact to responders is could be severe depending on the size and scope of the fire, especially for fire fighters. Impact will be low to moderate for support responders with the main threat being smoke inhalation.
Continuity of Operations	Minimal to Severe	Temporary relocation may be necessary if government facilities experience damage (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Localized impact could be severe to facilities and infrastructure in the incident area. Property, Facilities, and infrastructure are all vulnerable to destruction by wildfire.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained (minimal to severe).
Environment	Severe	Impact will be severe for the immediate impacted area with regards to trees, bushes, animals, crops, etc. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Moderate	Impacts to the economy could be moderate in the immediate area.
Public Confidence in Jurisdiction’s Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Evacuation orders, shelters availability could be called in to question (minimal to severe).

3.2.22 Windstorm

Calculated Priority Risk Index	Planning Significance
3.05	High

Description

Relatively frequent strong winds are a weather characteristic of the region. The planning area is located within wind zones III and IV, the highest inland categories. 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. 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 the planning area 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 super cell thunderstorms or a line of thunderstorms that typically develop on hot and humid days.

An unusual phenomenon that can happen in Region L is a derecho. This is a cluster of thunderstorms that merge into a line that begins moving east or southeast. As it progresses the winds increase and produce damage along that path much like a tornado would only it covers a much wider area. Whereas tornadoes are more isolated events that tend to hit a certain area, a derecho is a very large weather event that covers a much greater area, sometimes up to hundreds of miles at once. The damage can be significant to structures, nature, and people.

Location

The entire planning region is susceptible to high wind events. Whether due to Thunderstorms, Tornadoes, or solely wind events such as a Derecho, the Region can count on high wind events.

Previous Occurrences

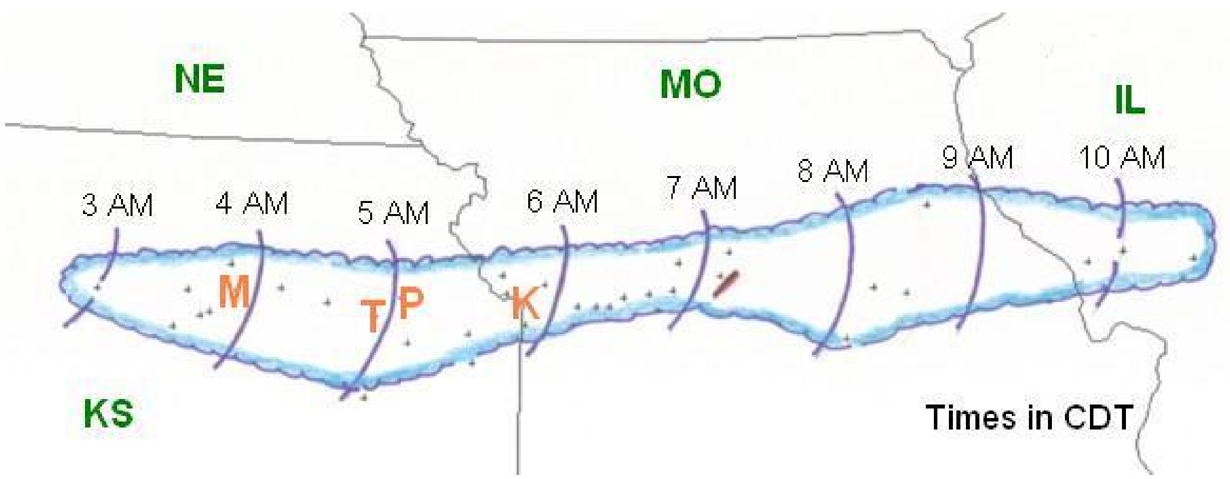
28 February 2012 - A strong cold front, associated with a low pressure system over the Central Plains, moved east northeast across the region, with a broken line of thunderstorms. A few of the storms were severe with damaging winds, during the evening hours of February 28, 2012. Thunderstorm wind gusts were estimated up to 60 mph on Douglas Avenue.

3 August 2012 - Thunderstorm wind gusts were estimated up to 60 mph, at the corner of 199th and Blackbob Road.

6 June 2011 - Scattered severe thunderstorms were observed across extreme eastern Kansas, during the evening hours of June 1, 2011. There were several reports of hail and damaging winds. Large trees were snapped off at ground level. A barn was destroyed at 155th Street and Fairmont Road.

6 April 2010 – Leavenworth - Severe thunderstorms brought large hail and damaging winds to the area, during the afternoon hours of April 6, 2010. Thunderstorm winds were estimated up to 60 mph.

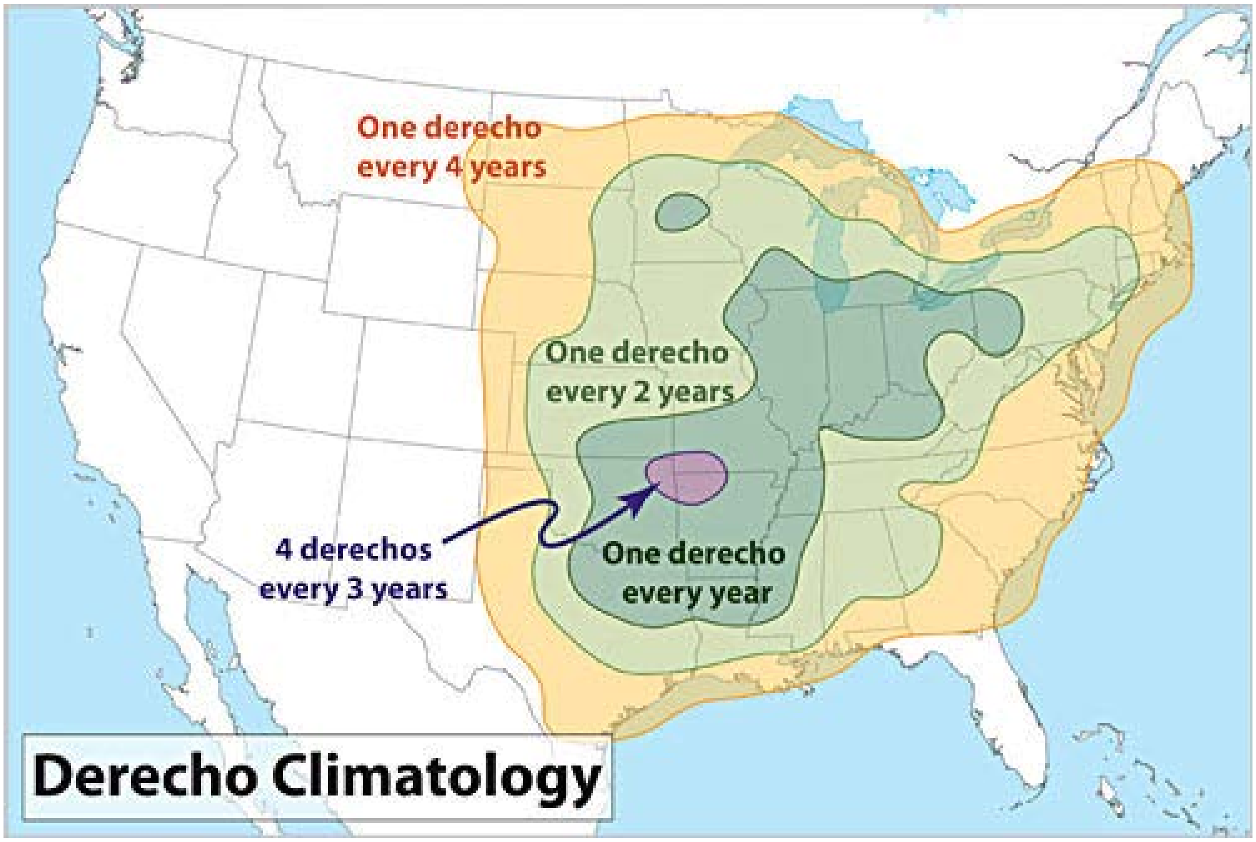
7 June 1982 - During the pre-dawn hours of Monday, June 7, 1982, a derecho formed over north central Kansas (KS) and roared eastward causing considerable damage and some injuries as it crossed northern Kansas, central Missouri (MO), and west central Illinois (IL) (Fig. 1). The most intense part of the storm occurred along a band from just west of Manhattan, KS (orange "M" in Fig. 1) through the central and northern parts of the Kansas City metropolitan area (orange "K" in Fig. 1). Measured peak wind gusts included 62 mph at Manhattan, 78 mph at Topeka (orange "T" in Fig. 1), 90 mph at Lake Perry, KS (orange "P" in Fig. 1), and 78 mph at Kansas City International Airport. Gusts were estimated to have reached 90 to 100 mph in several places, including the northern Kansas City suburb of Parkville, MO. Along the most intense part of the derecho path ("M" to "K"), mobile homes were overturned, buildings were damaged, planes were overturned at the airports in Topeka and Kansas City, and thousands of trees were damaged or blown down (Fig 1). Six people were injured in the overturned mobile homes. Much of the area lost electrical power, including the northern two-thirds of the Kansas City metropolitan area (noaa.gov).



Source: http://www.spc.noaa.gov/misc/AbtDerechos/casepages/kc1982mem2003pwrpage.htm

The following map depicts the area's that have the highest incidence of Derecho's. Region L falls in the 1 derecho every 1 to 2 year window.

Figure 3.82. Incidence of Derecho's



Source: NOAA.gov

Extent

Between the years 2000 and 2012, the Counties in Region L saw a combined 516 wind events that were reported. Following is a breakdown by county of high winds associated with thunderstorms. This table represents only the reported data and is not an all-inclusive list. Wind events and property damage could be higher, however only what has been reported is shown in Table 3.174.

Table 3.174. High Wind Events Associated with and without Thunderstorms in Region L, 2000-2012

Johnson County					
High Wind Event	**Wind Associated With Thunderstorms**	**Deaths**	**Injuries**	**Property Damage with TSTM Winds**	**Crop Damage**
9	126	0	0	693K	0.00K
Leavenworth County					
1	230	0	0	873.4K	0.00
Wyandotte County					
8	160	0	0	906K	0.00

Totals					
18	**516**	**0**	**0**	**1512.4M**	**0.00K**

Source: National Climatic Database

Magnitude: "Limited". Injuries and/or illnesses do not result in permanent disability.

Probability of Future Occurrences

Based on the historical data presented of 516 wind events in Region L within the last 12 years, the probability that at least one wind event will occur in the Region in any given year is 100%. This hazard's CPRI probability is "**Highly Likely**" within a calendar year.

Impact and Vulnerability

To determine potential financial loss estimates to wind in the planning area, the available historical loss data was annualized. In the case of frequently occurring weather-related hazards such as wind, annualized historical loss data is considered to be the best resource for determining future potential losses. The planning team obtained loss data from the National Climatic Data Center (NCDC) storm events (2006 – 2012) and the USDA Risk Management Agency insured crop loss payments (2002 – 2011) since agriculture plays such as important role in the Kansas economy. Following is the annualized property losses from wind, 2006 - 2012:

Table 3.175. Annualized Property Losses for Region L, 2006 - 2012

County	Annualized Property Loss ($)
Johnson	$11,571
Leavenworth	$73,307
Wyandotte	$21,420

Source: State Hazard Mitigation Plan

All three counties in the planning area are vulnerable to windstorms. The statistical analysis method was used to refine and assess the relative vulnerability of each of Region L's counties to wind. Ratings were assigned to pertinent factors that were examined at the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties.

The following are the data sources of the factors: Social Vulnerability Index for Region L counties from the Hazards and Vulnerability Research Institute at the University of South Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010), USDA's Census of Agriculture (2007) and USDA Risk Management Agency (2002 – 2011). It was determined that since wind is a common occurrence in the planning area, that using historical events and property damages from 2006 forward provides adequate events to describe the wind problem in Kansas.

Table 3.176 below provides the factor's amount per county that are considered for wind vulnerability. It is important to remember that this is a snapshot in time and not all-inclusive.

Table 3.176. Vulnerability of Region L Counties Factor Amounts for Wind

County	SoV1 Rating (1-5)	Prior Events 2006 – 2012	Property Damages	Annualized Property Damages	Total Building Exposure ($1000s)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Johnson	1	61	$81,000	$11,571	$43,871,468	1,149.60	$29,472,000	$109,685	$10,969
Leavenworth	1	60	$513,500	$73,357	$4,877,783	164.7	$20,983,000	$0	$0
Wyandotte	3	13	$150,000	$21,429	$12,066,666	1,039.00	$0	$0	$0
Total		**134**	**$744,500**	**$106,357**	**$60,815,917**		**$50,455,000**	**$109,685**	**$10,969**

Note: The Census of Agriculture did not publish crop exposure in Wyandotte County to avoid disclosure of individual operations

Table 3.177. Ranges for Wind Vulnerability Factor Ratings

Ratings	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss
1		9 - 34	$0 - $200,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	19 - $40,800
2	1	35 - 56	$200,001 - $400,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$40,801 - $81,576
3		57 - 78	$400,001 - $600,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$81,577 - $122,352
4	2	79 - 100	$600,001 - $800,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$122,353 - $163,128
5		101 - 122	$800,001 - $1,000,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$163,129 - $203,904
6	3	123 - 144	$1,000,001 - $3,000,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$203,905 - $244,680
7		145 - 165	$3,000,001 - $5,000,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$244,681 - $285,456
8	4	166 - 187	$5,00,001 - $7,000,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$285,457 - $326,232
9		188 - 209	$7,000,001 - $9,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$326,233 - $367,008
10	5	210 - 232	$9,000,001 - $25,460,428	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$367,009 - $407,783

Source: State Hazard Mitigation Plan 2013

Table 3.178 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and Table 3.179 provides the seven rating values assigned that were considered in determining overall vulnerability to wind. Table 3.180 that follows provides the mapped results of this analysis by county.

Table 3.178. Ranges for Overall Wind Vulnerability

Ranges	Low	Medium-Low	Medium	Medium-High	High
	9 - 14	15 - 19	20 - 24	25 – 29	30 - 34

Source: State Hazard Mitigation Plan 2013

Table 3.179. Vulnerability of Region L Counties to Wind

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Wind Vulnerability
Johnson	2	3	1	10	10	2	1	29	Medium-High
Leavenworth	2	3	1	2	2	2	0	12	Low
Wyandotte	6	1	1	3	10	1	0	22	Medium

Source: State Hazard Mitigation Plan 2013

Table 3.180 below lists the top vulnerable counties in Kansas relative to each other concerning wind events.

Tab le 3.180. Top Kansas Counties: Vulnerable to Wind (Region L is highlighted in yellow).

Mitigation Planning Region	County	Overall Vulnerability Rating	Wind Vulnerability
A	Sherman	34	High
G	Sedgwick	31	High
C	Stanton	29	Medium-High
L	Johnson	29	Medium-High
A	Cheyenne	27	Medium-High
D	Finney	26	Medium-High
A	Thomas	25	Medium-High
C	Morton	25	Medium-High
D	Haskell	25	Medium-High
B	Norton	24	Medium
C	Greeley	24	Medium
C	Stevens	24	Medium

Source: State Hazard Mitigation Plan 2013

Summary

Often it is the loss of electrical power that most impacts city dwellers following a strong wind event, whether due to thunderstorm winds or a derecho. This loss may be due to falling trees and tree limbs severing or shorting electrical lines, or to direct destruction of the overhead electrical distribution plant by high winds. Large portions of a metropolitan area may remain without electrical power for days or even weeks after a major wind event.

Local Mitigation Concerns

- Utility lines are at issue for Region L, specifically lines that provide the energy to power air conditioners or furnaces to the vulnerable populations. The population growth in this area is also seeing a growth in the elderly population as they move from rural areas to urban areas in order to be closer to family and medical services. The elderly population growth is expected to continue as the baby boomers age, and with this growth is a growing dependence on electricity. Lives could be at risk during an extreme temperature event should the utilities be out due to high winds.

Development in Hazard Prone Areas

Future development projects should consider windstorm hazard at the planning, engineering and architectural design stage with the goal of reducing vulnerability. The entire planning area is subject to high wind events so all development (with the exception of sub-surface development) is and will be exposed to high winds. Wind resistant design and construction practices, strategic use of landscaping and stringent means for securing outside storage facilities, signs, etc., can all be incorporated into codes or promoted as means of minimizing vulnerability to windstorms.

Johnson County

Table 3.181. Johnson County CPRI: Windstorm

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Windstorm	4	2	3	2	3.05	High

Leavenworth County

Table 3.182. Leavenworth County CPRI: Windstorm

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Windstorm	4	2	3	2	3.05	High

Wyandotte County

Table 3.183. Wyandotte County CPRI: Windstorm

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Windstorm	4	2	3	2	3.05	High

Consequence (Impact) Analysis)

The information in **Table 3.184** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.184. EMAP Consequence Analysis: Windstorm

Subject	Ranking	Impacts/Windstorm
Health and Safety of Persons in the Area of the Incident	Minimal to Moderate	Impact of the immediate area could be minimal to moderate for affected areas.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal	Temporary relocation may be necessary if government facilities experience damage (minimal).
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be minimal to moderate to facilities and infrastructure in the incident area. Utility lines most affected and could be severe.
Delivery of Services	Minimal	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained (minimal).
Environment	Minimal to Severe	Impact may be severe for the immediate impacted area with regards to trees, bushes, crops, etc. Impact will lessen as distance increases from the immediate incident area (minimal to severe).
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the trajectory of the windstorm. Revenue could be impacted if tourism, businesses are halted due to structural damages and infrastructure damage (minimal to severe).
Public Confidence in Jurisdiction’s Governance	Minimal	Response and recovery will be in question if not timely and effective. Warning systems in place and the timeliness of those warnings could be questioned (minimal).

3.23 Winter Storm

Calculated Priority Risk Index	Planning Significance
3.30	High

Description

Winter storms in Region L 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 planning area and its residents for days, weeks, or even 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 that the region is most concerned about.

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 3.3.7,** Extreme Temperatures). The National Weather Service describes different types of winter storm events as follows:

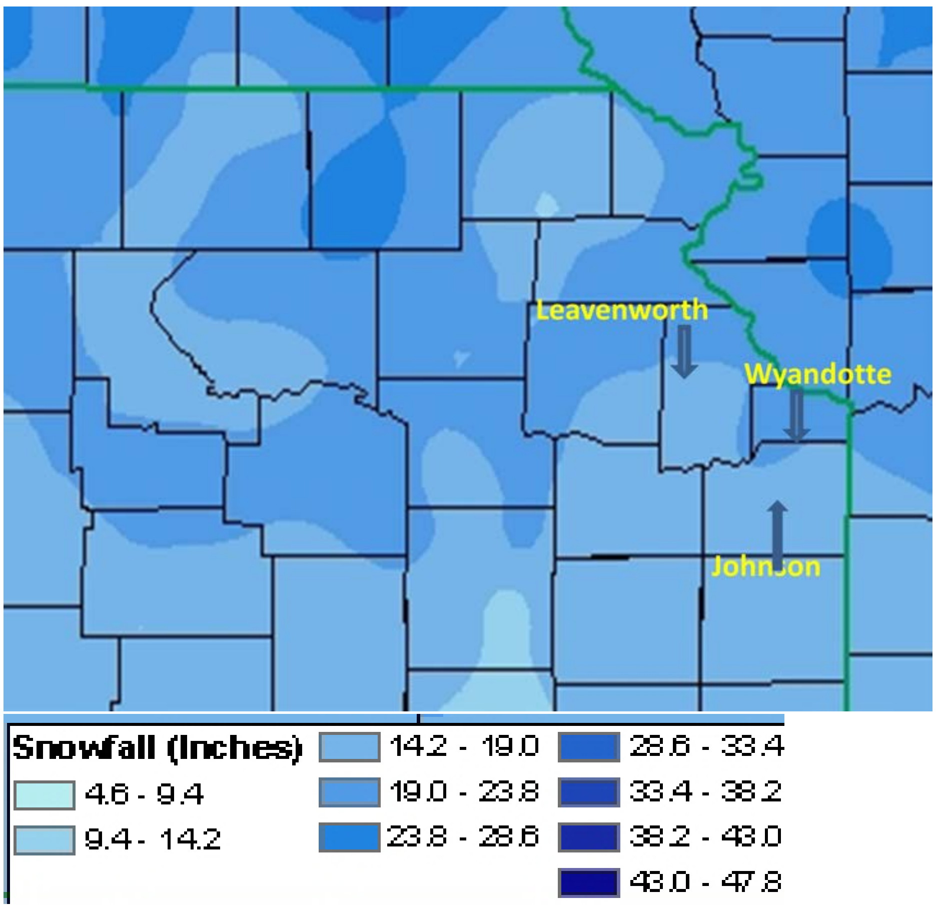
- **Blizzard**—Winds of 35 mph or more with snow and blowing snow reducing visibility to less than 1/4 mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, 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 with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

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.

Location

The entire planning area is susceptible to heavy snow and freezing rain. **Figure 3.83** shows the average snowfalls for the planning area.

Figure 3.83. Average Annual Snowfall for Region L.



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

The Region sees an average number of 8 – 9 hours per year with freezing rain.

Previous Occurrences

Region L has been in 4 out of eight Presidential Declarations that involved winter storms since 1955 (**see Table 3.185).**

Table 3.185. Region L's Inclusion in Presidential Declarations Involving Winter Storms

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost**
Major Disaster Declarations				
1885	03/09/2010 (12/9/2009-1/8/2010)	Severe Winter Storms and Snowstorm	Allen, Anderson, Atchison, Bourbon, Brown, Butler, Cherokee, Cheyenne, Clay, Cowley, Crawford, Decatur, Doniphan, Elk, Franklin, Gove, Graham, Greenwood, Jackson, Jefferson, Jewell, Labette, Linn, Logan, Lyon, Marshall, Miami, Morris, Nemaha, Neosho, Norton, Osage, Phillips, Pottawatomie, Rawlins, Republic, Riley, Shawnee, Sheridan, Wabaunsee, Wallace, Washington, Wilson, Woodson and Wyandotte	$19,100,658
1741	02/01/2008 (12/6-12/19/2008)	Severe Winter Storms	Atchison, Barber, Barton, Brown, Butler, Chase, Cherokee, Clark, Clay, Cloud, Comanche, Crawford, Dickinson, Doniphan, Edwards, Ellis, Ellsworth, Ford, Geary, Graham, Gove, Harvey, Hodgeman, Jackson, Jefferson, Jewell, Kingman, Kiowa, Labette, Leavenworth, Lincoln, Logan, Lyon, Marion, Marshall, McPherson, Miami, Mitchell, Morris, Nemaha, Osage, Osborne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Republic, Rice, Riley, Rooks, Rush, Russell, Saline, Sedgwick, Shawnee, Sheridan, Smith, Stafford, Thomas, Wabaunsee, Wallace, Washington, and Woodson.	$359,557,345
1579	2/8/2005 (1/4-6/2005)	Severe Winter Storm, Heavy Rains, and Flooding	Anderson, Atchison, Barber, Brown, Butler, Chase, Chautauqua, Clark, Coffey, Comanche, Cowley, Crawford, Douglas, Elk, Franklin, Greenwood, Harper, Harvey, Jackson, Jefferson, Kingman, Kiowa, Leavenworth, Lyon, Marion, McPherson, Morris, Osage, Pratt, Reno, Rice, Sedgwick, Shawnee, Sumner, Wabaunsee, Woodson, Wyandotte	$106,873,672
1402	2/6/2002 (1/29-2/15/2002)	Ice Storm	Allen, Anderson, Barber, Bourbon, Butler, Chautauqua, Cherokee, Coffey, Comanche, Cowley, Crawford, Douglas, Elk, Franklin, Greenwood, Harper, Jefferson, Johnson, Kingman, Kiowa, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Pratt, Sedgwick, Shawnee, Sumner, Wilson, Woodson, Wyandotte	$60,185,754

Sources: http://www.fema.gov/disasters, and Kansas Division of Emergency Management
* Incident dates are in parentheses.
** Disaster costs include Public Assistance and Individual Assistance

Table 3.18a shows reported property damage for Region L for Disaster 1402. No other data is available for the other Disasters. This could be due to a reporting issue, or because all damages were insured and were not reported to the NOAA data base.

TABLE 3.185a. Property Damage for Region L Due to Storms, 1996 - 2012

Disaster	Year	County	Property Damage
1402	2002	Johnson	1.5M
1402	2002	Leavenworth	1.0M
1402	2002	Wyandotte	4.5M
Total	**2002**	**All**	**7M**

FEMA-1885-DR—March 9, 2010 (December 21, 2009—January 10, 2010): Beginning December 22nd a strong, slow moving storm moved into the western Kansas leaving heavy snow causing icy and snow packed roads in portions of northwestern Kansas. The storm system continued easterly and continued to significantly impact portions of north central, northeastern, and southeastern areas of the State. This storm system created blizzard conditions with dangerously high winds causing blowing/drifting snow, treacherous travel conditions, and impassable roads. Two fatalities and three injuries occurred in two of the more severe accidents.

FEMA-1741-DR—February, 2008 (December 6-19, 2007): Winter weather started across central and southeast Kansas with two different ice storms that moved across the area and produced significant accumulations. The ice caused numerous power outage and approximately 130,000 Kansas customers were without power. Specifically, Kansas Rural Electric Cooperatives reported 49,000 customers without power, Westar reported 76,000 customers, Kansas City Power & Light reported 4,300 customers, and Kansas City, Kansas Board of Public Utilities reported 800 customers without power. Then a major winter storm moved through Kansas during the evening hours of December 14th and the heaviest snow targeted areas still suffering from the ice storm that hit earlier in the week.

FEMA-1579-DR—February 8, 2005 (January 4-6): This was one of the worst ice storms on record to hit central, south central, and southeast Kansas. Although freezing rain was the primary culprit, sleet also played a vital role in coating nearly the entire region with one-two inches of ice, which caused incredible damage to trees, power lines, and power poles. Roads and highways were blocked by tree debris and downed power poles and lines. Many areas were without power for more than a week.

FEMA-1402-DR: Ice Storm—February 6, 2002 (January 29–February 15): Beginning on January 29, a three-day severe winter storm hit 35 Kansas counties in the southeast corner of the State with freezing rain, drizzle, sleet and snow. With one to two inches of ice accumulation, utility poles and power lines snapped, transportation was treacherous and fallen trees damaged many structures. The resulting power outages affected nearly the entire region and lasted nearly a week in some areas. Loss of power was particularly problematic for many nursing homes. There were seven fatalities. This was the worst ice storm in the metropolitan Kansas City area.

Extent

Winter Storms can severely affect people and property. Normally these storms are associated with extreme temperatures and wind, along with ice that can take down utility lines for days, weeks, even months. It is also very hard for people to be transit during these events and when they last a long time food can be in short supply. Another danger of a winter storm is if the electricity goes out, the heat normally follows, leaving people vulnerable to the cold.

- Johnson County had a reported 16 winter storm events between the years 2000 and 2012. While there were no deaths, injuries, the reported property damage during the 2002 storm was 1.5M. In addition, there were minor traffic accidents and school closings.

- Leavenworth County had 16 winter storms between the years 2000 and 2012, resulting in no deaths, injuries and property damage estimated at 1M. There were minor accidents and schools closings.

- Wyandotte County had 15 winter storms between the years 2000 and 2012, resulting in no deaths, injuries, and reported property damages at 4.5M. As with Johnson and Leavenworth Counties, there were minor accidents and school closings.

Because so many variables come into play during a winter storm the planning committee has determined that the magnitude is critical. Injuries and illnesses do not result in permanent disability (normally), a complete shutdown of facilities could last at least two weeks, and 25% – 50% of property could be severely damaged.

Probability

Johnson and Leavenworth County's had 16 winter storms in 12 years, resulting in a 100% chance of a winter storm in any given year.

Wyandotte County had 15 winter storms in the past 12 years, resulting in a 100% chance of a winter storm in any given year.

Because Kansas is in a unique position as it relates to the United States, in that the jet stream tends to be directly above it or right over it. This brings the potential for strong storms, including winter storms. Based on historical data, the probability for this hazard is **"Highly Likely"** within the next three years.

Impact and Vulnerability

Winter Storms, which include snow and ice, have caused significant damage to the planning area in recent years. To assess the vulnerability to this hazard the planning committee assigned ratings to pertinent factors that were examined and the county level. These factors are: social vulnerability index, prior events, prior annualized property damage, building exposure valuation, population density, crop exposure and annualized crop loss. A rating value of 2 – 20 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

Following are the data sources for the rating factors. Social Vulnerability Index for Region L counties from the Hazards and Vulnerability Research Institute at the University of South Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010), USDA's Census of Agriculture (2007), and USDA Risk Management Agency (2002-2011). In order to adequately describe the winter storm hazard, it was determined that winter storm historical events and property damages is needed back to 1993.

Table 3.186 below provides the factor's amount per county in Region L that are considered for winter storm vulnerability.

Table 3.186. Vulnerability of Region L Counties Factor Amounts for Winter Storm

To determine potential financial loss estimates to winter storms in the region, the available historical loss data was annualized to determine future potential losses. As discussed above in the vulnerability overview for winter storm, the planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (1993 – 2012). Most of the property damages that occur as a result of winter storms are a result of loss of power. For additional information regarding vulnerability to utility failure, see **Section 3.3.19**, Utility/Infrastructure Failure.

Table 3.186 provides the annualized property loss damages per county in the region from 1993 through 2012.

Table 3.186. Annualized Property Loss Damages, 1993 – 2012

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region L									
Johnson	1	40	$10,010,000	$500,500	$43,871,468	1,149.60	$29,472,000	$197,938	$19,794
Leavenworth	1	35	$9,770,000	$488,500	$4,877,783	164.7	$20,983,000	$162,813	$16,281
Wyandotte	3	32	$9,760,000	$488,000	$12,066,666	1,039.00	$0	$0	$0
Total		**107**	**$29,540,000**	**$1,477,000**	**$60,815,917**		**$50,455,000**	**$360,751**	**$36,075**

Source: State Hazard Mitigation Plan 2013

Table 3.187 provides the 1 – 10 ranges for the winter storm vulnerability factor ratings. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.187. Ranges for Winter Storm Vulnerability Factor Ratings

Ratings	Social Vulnerability	Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss Insurance Paid
1		14 - 21	$2,000 - $50,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	0 - $200,000
2	1	21 - 29	$50,001 - $100,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$200,001 - $400,000
3		30 - 36	$100,001 - $300,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$400,000 - $600,000
4	2	37 - 44	$300,001 - $500,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$600,001 - $800,000
5		45 - 52	$500,001 - $700,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$800,001 - $1,000,000
6	3	53 - 60	$700,001 - $900,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$1,100,001 - $1,300,000
7		61 - 69	$900,001 - $1,100,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$1,300,001 - $1,500,000
8	4	70 - 77	$1,100,001 - $1,700,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$1,500,001 - $1,700,000
9		78 - 85	$1,700,001 - $2,200,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$1,700,001 - $2,700,000
10	5	86 - 93	$2,200,001 - $2,800,000	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$2,700,001 - $3,700,000

* Population density is the number of people per square mile.

Source: State Hazard Mitigation Plan 2013

Table 3.188 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and **Table 3.189** provides the rating values determined for each factor that was considered in determining overall vulnerability to winter storm.

Table 3.188. Ranges for Overall Winter Storm Vulnerability

Ranges	Low	Medium-Low	Medium	Medium-High	High
	13 - 17	18 - 22	23 - 27	28 - 32	33 - 37

Source: State Hazard Mitigation Plan 2013

Table 3.189. Vulnerability of Region L Counties to Winter Storm

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Winter Storm Vulnerability
Mitigation Planning Region L									
Johnson	2	4	5	10	10	2	1	34	High
Leavenworth	2	3	4	2	2	2	1	16	Low
Wyandotte	6	3	4	3	10	0	1	27	Medium

Source: State Hazard Mitigation Plan 2013

Table 3.190 lists the top vulnerable counties in Kansas relative to each other concerning winter storm events.

Table 3.190. Top Counties Vulnerable to Winter Storm

Mitigation Planning Region	County	Overall Vulnerability Rating	Winter Storm Vulnerability
G	Sedgwick	37	High
G	Reno	36	High
F	Republic	35	High
K	Marshall	34	High
L	Johnson	34	High
A	Thomas	32	Medium-High
F	Cloud	32	Medium-High
F	Dickinson	32	Medium-High
A	Sheridan	31	Medium-High
A	Sherman	31	Medium-High
K	Brown	31	Medium-High
K	Washington	31	Medium-High

Source: State Hazard Mitigation Plan 2013

To determine potential financial loss estimates to winter storms in Kansas, the historical loss data was annualized to determine future potential losses. Loss data was obtained from the NCDC storm events (1993 – 2012). **Table 3.191** shows the annualized property loss for Region L by county..

Table 3.191. Annualized Property Loss for Region L

County	Property loss ($)
Johnson	$500,500
Leavenworth	$488,500
Wyandotte	$488,000
Total	**1,477,000**

Source: State Hazard Mitigation Plan 2013

Mitigation Concerns:

- Region L has a huge diverse population of mature trees, which during a winter storm can see limbs breaking and downing power lines. This, in turn, takes out the electricity which puts the population in peril of extremely cold temperatures. If the roads are not accessible this population runs the risk of perishing.
- Heavy snowfall and ice conditions can cause roads to become impassable which results in the population being cut off from emergency services. Medical conditions can be exasperated without medicine or treatment or access to either. Should a fire ensue due to downed power lines, fire trucks could have a hard time reaching the source, again putting the population at risk.
- In the planning area, specifically Johnson County, record storms in the past five years have created traffic issues. Lack of early warning and communication to residents is an area that needs improvement. The lack of early warning and communication to the people of the planning area hampers emergency response for fire rescue, building failures, etc.

Development in Hazard Prone Areas

Structural development is not considered to be an issue for future development in the planning area. The biggest vulnerability comes from downed utility lines, transportation accidents, and exposure of aging infrastructure.

Johnson County

Table 3.192. Johnson County CPRI: Winter Storm

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Johnson County						
Winter Storm	4	3	1	3	3.15	High

Leavenworth County

Table 3.193. Leavenworth County CPRI: Winter Storm

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Leavenworth County						
Winter Storm	3	3	2	3	2.85	Moderate

Wyandotte County

Table 3.194. Wyandotte County CPRI: Winter Storm

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Wyandotte County						
Winter Storm	3	3	2	3	2.85	Moderate

Consequence Analysis

People, animals and agriculture are adversely affected by winter storms especially when accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, severe drifting and dangerous wind chill. Strong winds with these intense storms and cold fronts can knock down trees, utility poles and power lines. The information contained in Table 3.195 provides the Consequence Analysis of Potential for Detrimental Impact of Hazard done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.195. Consequence (Impact) Analysis: Winter Storm

Subject	Ranking	Impacts/Winter Storm
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas.
Responders	Minimal	Impact to responders could be severe for unprotected personnel and moderate to light for prepared personnel.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact to facilities and infrastructure in the incident area. Utility lines most affected. (minimal to severe).
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained. (Minimal to severe)
Environment	Severe	Greatest impact will be to trees, bushes, foliage, crops, and wildlife, which could be severe.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the severity of the winter storm, longevity of the storm, and any damages sustained such as utilities and roads. (Minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Utility failure could be called in to question if outages are persistent. (minimal to severe).

3.24. Summary of Key Issues

Table 3.196 shows the results of the Hazard Ranking from High to Low Planning significance based on the methodology described at the beginning of this section.

Table 3.196. Region L Hazard Ranking-High to Low Planning Significance

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Regional CPRI						
Tornado	4	4	4	1	3.70	High
Flood	4	3	3	4	3.55	High
Winter Storm	4	3	2	3	3.30	High
Windstorm	4	2	3	2	3.05	High
Utility/Infrastructure Failure	4	1	4	3	3.00	High
Drought	4	2	3	4	2.95	Moderate
Hazardous Materials	4	1	4	2	2.90	Moderate
Lightning	4	2	2	1	2.80	Moderate
Wildfire	4	1	4	1	2.80	Moderate
Civil Disorder	2	4	4	1	2.80	Moderate
Major Disease Outbreak	2	4	1	4	2.75	Moderate
Hailstorm	4	1	2	1	2.65	Moderate
Terrorism/Agro-terrorism	1	4	4	4	2.65	Moderate
Extreme Temperatures	3	2	1	4	2.50	Moderate
Agricultural Infestation	3	2	1	4	2.50	Moderate
Expansive Soils	3	1	1	4	2.20	Moderate
Dam and Levee Failure	1	3	3	3	2.10	Moderate
Radiological	1	3	3	3	2.10	Moderate
Landslide	1	2	4	1	1.75	Low
Soil Erosion and Dust	2	1	1	4	1.75	Low
Earthquake	1	2	4	1	1.75	Low
Land Subsidence	1	1	3	2	1.40	Low

The planning committee will focus efforts for the mitigation strategy on the hazards with a ranking of a moderate and high planning significance. Some of the key issues brought out via the risk assessment are as follows (this list is not all-inclusive, but highlights some of the planning committee's concerns).

- Continued public education for all hazards needs to continue, expand, and improve.
- Utility/Infrastructure is ranked with a high planning significance and the planning committee will pursue mitigation efforts with the major utility companies to help reduce outages.
- Continue compliance with the NFIP to include floodplain management and mitigation of repetitive loss and severe repetitive loss properties.
- Encourage lake Quivira to address NFIP suspension.
- Continue finding funding outlets for safe rooms in schools and public facilities.
- With the large population base in Region L, all hazards need required vigilance so that mitigation efforts can be accomplished to preserve life, and prevent the destruction of property.

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