3 RISK ASSESSMENT

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The foundation of the Kansas Hazard Mitigation Plan is the statewide risk assessment. In order to define effective mitigation actions to make Kansas more resilient to the impacts of future disasters, it is necessary to understand the hazards that threaten the State and how they disrupt Kansas communities. It is also necessary to understand how the communities are vulnerable to the impacts of the identified hazards and the scope or extent of that vulnerability. This chapter details the risk assessment process conducted by the Kansas Hazard Mitigation Team (KHMT). Its purpose is to provide, on a statewide basis, an understanding of the risks posed by the hazards that threaten Kansas. This allows the KHMT to focus its planning efforts on the hazards that pose the most risk to the people of Kansas, their property, and their communities.

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 is to reflect recent events, the availability of new information, and a reevaluation of the hazards that threaten Kansas. This chapter has been reorganized and is broken down into six sections:

- **Exposure and Analysis of State Development Trends** —This section looks at population changes, social vulnerability, land use and development trends and building exposure.
- **Hazard Identification**—This section identifies the hazards of greatest concern to Kansas and how and why they were identified.
- **Hazard Profiles and State Risk Assessment**—This section describes each hazard identified in the previous section, discusses where in the state the hazard is most likely to occur, gives examples of previous occurrences, states the probability of occurrence and analyzes the vulnerability and potential losses by jurisdiction (county), which includes discussions on development in hazard-prone areas.
- **Integration of Local Plans: Vulnerability and Loss Estimates**—This section includes an overview and analysis of potential losses to identified vulnerable structures based on estimates provided in local risk assessments.
- **State Owned or Operated Facilities: Vulnerability and Loss Estimates**—This section addresses the vulnerability and loss estimates to state owned or operated facilities located in the identified hazard areas.

- **References**—This section consolidates the hazard references used throughout chapter 3.

Like any other aspect of planning, hazard identification and vulnerability assessment is an ongoing, continually evolving process. This plan incorporates efforts to not only improve the knowledge of the KHMT, stakeholders and citizens regarding the hazards known to threaten the State but also to assess if previously unidentified natural, technological or manmade hazards need to be addressed by the Kansas Hazard Mitigation Plan.

3.1. Exposure and Analysis of State Development Trends

Requirement for Update §201.4(d): Plan must be reviewed and revised to reflect changes in development.

Development, demographic and land use trends along with building value exposure are important elements to consider in a risk assessment. This section will examine growth, social vulnerability, other demographics, land use and development trends and exposure of the built environment as inputs to the vulnerability discussions that will take place by hazard in **Section 3.3** Hazard Profiles and State Risk Assessment.

3.1.1. Growth

As part of the plan update process, the State looked at changes in growth and development and examined these changes in the context of the State's hazard-prone areas and how the changes in growth and development affect loss estimates and vulnerability. When the population in a hazardous area increases, so does the vulnerability of people and property associated with the hazards unless mitigation measures are taken. Recognizing both the population growth trends and the geographic locations of the growth patterns within the State is necessary to understand this issue. The discussion here focuses on population growth and increases in housing units and density by county, based on U.S. Census Bureau data.

3.1.2. Population

The U.S. Census Bureau lists the Kansas 2010 population at 2,853,118. This reflects an increase of 6.1 percent between 2000 and 2010. In 2010, Kansas ranked 33rd among the 50 states in population, 13th in land area and 40th in population density (based on 81,758.7 square miles as reported in the 2010 census). Decennial census findings from the last few decades illustrate growth in Kansas (see **Table 3.1**).

Table 3.1. Kansas' Decennial Census 1970–2010

Year	Population	% Change
1970	2,246,578	+3.1
1980	2,363,679	+5.2
1990	2,477,574	+4.8
2000	2,688,418	+8.5
2010	2,853,118	+6.1

Source: U.S. Census Bureau, http://quickfacts.census.gov/qfd/states/20000.html

Between 2000 and 2010, only 28 Kansas counties increased in population. The majority of the population growth was in the contiguous counties near the metropolitan areas of Kansas City and Lawrence (Johnson, Douglas, Miami, Leavenworth, and Franklin) and also around Manhattan and Fort Riley (Riley, Wabaunsee, Pottawatomie, Geary, Clay, and Dickinson). Johnson County, the largest county in Kansas, gained the most people and is growing the fastest (percent change). **Table 3.2**, **Table 3.3**, and **Table 3.4** show the top 10 Kansas counties ranked by census 2010 population and those with the greatest estimated population gains.

Figure 3.1 shows Kansas' percentage changes in population by county. Between 2000 and 2010, 77 counties in Kansas had a decrease in population (see **Table 3.5** and **Table 3.6**). **Table 3.7** shows the 10 least populous counties in Kansas. **Table 3.9** lists all the Kansas county populations in 2000, 2010, 2011 estimates and population changes categorized by their Mitigation Planning Region.

Table 3.2. Top 10 Counties Ranked by Population, 2010

County	Mitigation Planning Region	2010 Population
Johnson	L	544,179
Sedgwick	G	498,365
Shawnee	J	177,934
Wyandotte	L	157,505
Douglas	K	110,826
Leavenworth	L	76,227
Riley	I	71,115
Butler	G	65,880
Reno	G	64,511
Saline	F	55,606

Source: U.S. Census Bureau 2010, www.census.gov

Table 3.3. Ten Counties with Greatest Population Gains (Numerical), 2000–2010

County	Mitigation Planning Region	Population Gain 2000-2010
Johnson	L	93,093
Sedgwick	G	45,496
Douglas	K	10,864
Riley	I	8,272
Shawnee	J	8,063
Leavenworth	L	7,536
Geary	I	6,415
Butler	G	6,398
Miami	J	4,436
Pottawatomie	I	3,395

Source: U.S. Census Bureau 2010, www.census.gov

Table 3.4. Ten Counties with Greatest Population Gains (Percent), 2000–2010

County	Mitigation Planning Region	Population Gain (%) 2000-2010
Geary	I	22.95%
Johnson	L	20.64%
Pottawatomie	I	18.64%
Miami	J	15.65%
Riley	I	13.16%
Leavenworth	L	10.97%
Douglas	K	10.87%
Butler	G	10.76%
Sedgwick	G	10.05%
Jackson	K	6.36%

Source: U.S. Census Bureau 2010, www.census.gov

Figure 3.1. Percent Change in Population by County, 2000–2010

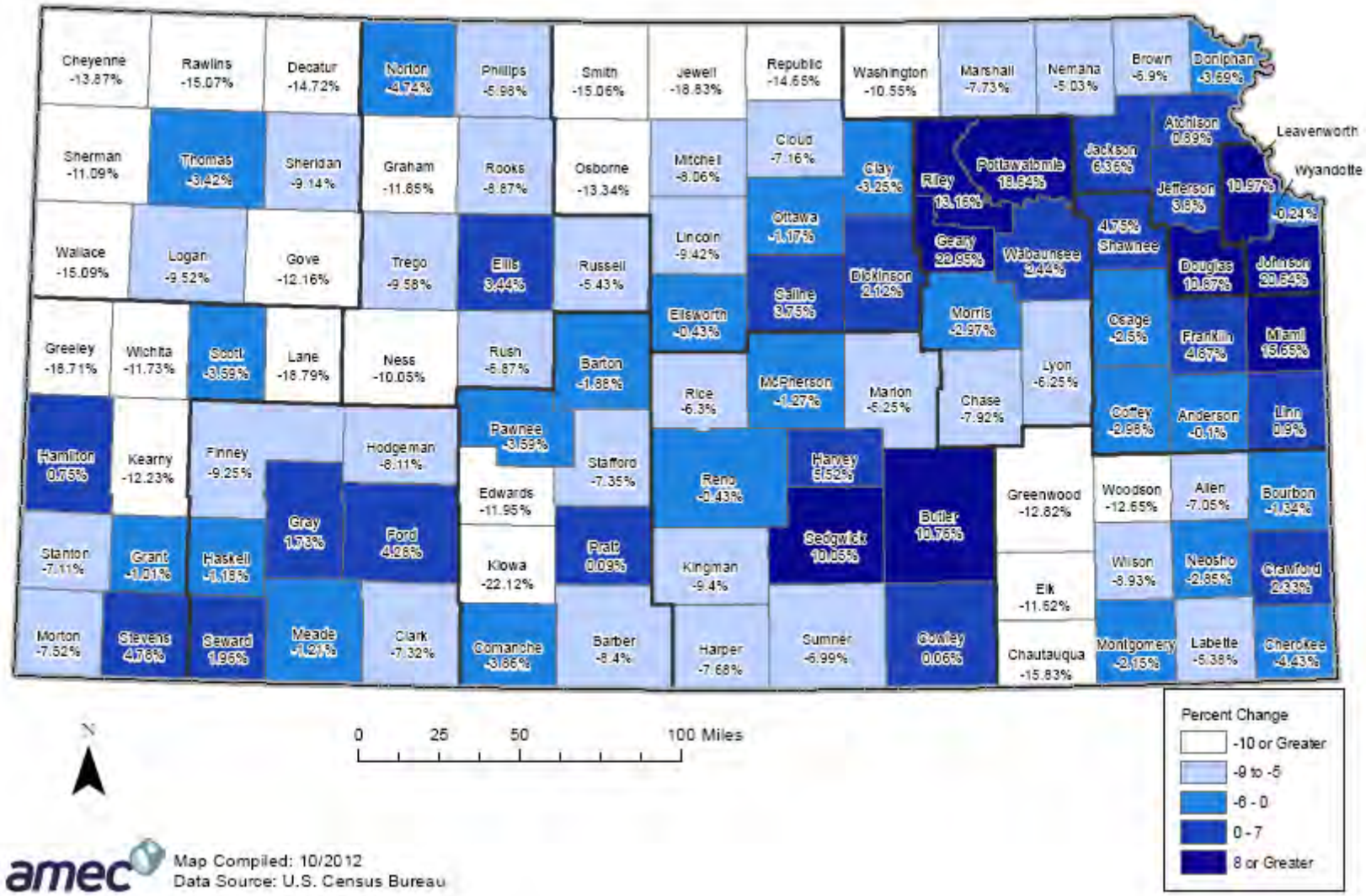


Table 3.5. Ten Counties with Greatest Population Losses (Numerical) 2000–2010

County	Mitigation Planning Region	Population Loss 2000-2010
Finney	D	-3,747
Lyon	I	-2,245
Sumner	G	-1,814
Labette	H	-1,228
Allen	H	-1,014
Cherokee	H	-1,002
Greenwood	H	-984
Wilson	H	-923
Republic	F	-855
Marshall	K	-848

Source: U.S. Census Bureau 2010, www.census.gov

Table 3.6. Ten Counties with Greatest Population Losses (Percent) 2000–2010

County	Mitigation Planning Region	Population Loss (%) 2000-2010
Kiowa	E	-22.12%
Jewell	F	-18.83%
Lane	C	-18.79%
Greeley	C	-18.71%
Chautauqua	H	-15.83%
Wallace	A	-15.09%
Rawlins	A	-15.07%
Smith	F	-15.06%
Decatur	A	-14.72%
Republic	F	-14.65%

Source: U.S. Census Bureau 2010, www.census.gov

Table 3.7. Ten Smallest Counties Ranked by Population

County	Mitigation Planning Region	2010 Population
Greeley	C	1,247
Wallace	A	1,485
Lane	C	1,750
Comanche	E	1,891
Hodgeman	D	1,916
Clark	D	2,215
Wichita	C	2,234
Stanton	C	2,235
Rawlins	A	2,519
Kiowa	E	2,553

Source: U.S. Census Bureau 2010, www.census.gov

Interim population projections issued by the U.S. Census suggest that state-wide Kansas' population will continue to grow, but percentage increase will drop, through 2030 (see **Table 3.8**).

Table 3.8. Interim Kansas Population Projections 2015–2030

Year	Projected Population	Percent Change
2010	2,688,418	
2015	2,852,690	6.11%
2020	2,890,566	1.33%
2025	2,919,002	0.98%
2030	2,940,084	0.72%

Source: U.S. Census, http://www.census.gov/population/projections/SummaryTabA1.pdf

Table 3.9. Kansas Counties Census Population for 2000, 2010, and 2011 Estimates

County	2000 Census Population	2010 Census Population	Population Change (Numerical) 2000-2010	Population Change (Percent) 2000-2010	2011 Population Estimates July 1, 2011
Mitigation Planning Region A					
Cheyenne	3,165	2,726	-439	-13.87%	2,718
Decatur	3,472	2,961	-511	-14.72%	2,915
Gove	3,068	2,695	-373	-12.16%	2,697
Logan	3,046	2,756	-290	-9.52%	2,783
Rawlins	2,966	2,519	-447	-15.07%	2,512
Sheridan	2,813	2,556	-257	-9.14%	2,552
Sherman	6,760	6,010	-750	-11.09%	6,054
Thomas	8,180	7,900	-280	-3.42%	7,977
Wallace	1,749	1,485	-264	-15.09%	1,527
Subtotal	**35,219**	**31,608**	**-3,611**	**-10.25%**	**31,735**
Mitigation Planning Region B					
Ellis	27,507	28,452	945	3.44%	28,742
Graham	2,946	2,597	-349	-11.85%	2,641
Ness	3,454	3,107	-347	-10.05%	3,120
Norton	5,953	5,671	-282	-4.74%	5,635
Phillips	6,001	5,642	-359	-5.98%	5,555
Rooks	5,685	5,181	-504	-8.87%	5,182
Rush	3,551	3,307	-244	-6.87%	3,238
Russell	7,370	6,970	-400	-5.43%	6,956
Trego	3,319	3,001	-318	-9.58%	2,930
Subtotal	**65,786**	**63,928**	**-1,858**	**-2.82%**	**63,999**
Mitigation Planning Region C					
Grant	7,909	7,829	-80	-1.01%	7,964
Greeley	1,534	1,247	-287	-18.71%	1,258

County	2000 Census Population	2010 Census Population	Population Change (Numerical) 2000-2010	Population Change (Percent) 2000-2010	2011 Population Estimates July 1, 2011
Hamilton	2,670	2,690	20	0.75%	2,666
Kearny	4,531	3,977	-554	-12.23%	3,987
Lane	2,155	1,750	-405	-18.79%	1,749
Morton	3,496	3,233	-263	-7.52%	3,198
Scott	5,120	4,936	-184	-3.59%	4,910
Stanton	2,406	2,235	-171	-7.11%	2,250
Stevens	5,463	5,724	261	4.78%	5,613
Wichita	2,531	2,234	-297	-11.73%	2,276
Subtotal	**37,815**	**35,855**	**-1,960**	**-5.18%**	**35,871**
Mitigation Planning Region D					
Clark	2,390	2,215	-175	-7.32%	2,143
Finney	40,523	36,776	-3,747	-9.25%	37,083
Ford	32,458	33,848	1,390	4.28%	34,568
Gray	5,904	6,006	102	1.73%	6,113
Haskell	4,307	4,256	-51	-1.18%	4,285
Hodgeman	2,085	1,916	-169	-8.11%	1,966
Meade	4,631	4,575	-56	-1.21%	4,531
Seward	22,510	22,952	442	1.96%	23,328
Subtotal	**114,808**	**112,544**	**-2,264**	**-1.97%**	**114,017**
Mitigation Planning Region E					
Barber	5,307	4,861	-446	-8.40%	4,888
Barton	28,205	27,674	-531	-1.88%	27,841
Comanche	1,967	1,891	-76	-3.86%	1,884
Edwards	3,449	3,037	-412	-11.95%	3,020
Kiowa	3,278	2,553	-725	-22.12%	2,549
Pawnee	7,233	6,973	-260	-3.59%	7,011
Pratt	9,647	9,656	9	0.09%	9,676
Stafford	4,789	4,437	-352	-7.35%	4,371
Subtotal	**63,875**	**61,082**	**-2,793**	**-4.37%**	**61,240**
Mitigation Planning Region F					
Clay	8,822	8,535	-287	-3.25%	8,573
Cloud	10,268	9,533	-735	-7.16%	9,365
Dickinson	19,344	19,754	410	2.12%	19,739
Ellsworth	6,525	6,497	-28	-0.43%	6,483
Jewell	3,791	3,077	-714	-18.83%	3,096
Lincoln	3,578	3,241	-337	-9.42%	3,215
Mitchell	6,932	6,373	-559	-8.06%	6,295
Osborne	4,452	3,858	-594	-13.34%	3,847
Ottawa	6,163	6,091	-72	-1.17%	6,119
Republic	5,835	4,980	-855	-14.65%	4,907
Saline	53,597	55,606	2,009	3.75%	55,844
Smith	4,536	3,853	-683	-15.06%	3,834
Subtotal	**133,843**	**131,398**	**-2,445**	**-1.83%**	**131,317**

County	2000 Census Population	2010 Census Population	Population Change (Numerical) 2000-2010	Population Change (Percent) 2000-2010	2011 Population Estimates July 1, 2011
Mitigation Planning Region G					
Butler	59,482	65,880	6,398	10.76%	65,817
Cowley	36,291	36,311	20	0.06%	36,272
Harper	6,536	6,034	-502	-7.68%	5,993
Harvey	32,869	34,684	1,815	5.52%	34,846
Kingman	8,673	7,858	-815	-9.40%	7,853
McPherson	29,554	29,180	-374	-1.27%	29,241
Marion	13,361	12,660	-701	-5.25%	12,538
Reno	64,790	64,511	-279	-0.43%	64,607
Rice	10,761	10,083	-678	-6.30%	10,076
Sedgwick	452,869	498,365	45,496	10.05%	501,076
Sumner	25,946	24,132	-1,814	-6.99%	23,787
Subtotal	**741,132**	**789,698**	**48,566**	**6.55%**	**792,106**
Mitigation Planning Region H					
Allen	14,385	13,371	-1,014	-7.05%	13,331
Bourbon	15,379	15,173	-206	-1.34%	14,985
Chautauqua	4,359	3,669	-690	-15.83%	3,584
Cherokee	22,605	21,603	-1,002	-4.43%	21,385
Crawford	38,242	39,134	892	2.33%	39,220
Elk	3,261	2,882	-379	-11.62%	2,811
Greenwood	7,673	6,689	-984	-12.82%	6,644
Labette	22,835	21,607	-1,228	-5.38%	21,511
Montgomery	36,252	35,471	-781	-2.15%	34,911
Neosho	16,997	16,512	-485	-2.85%	16,449
Wilson	10,332	9,409	-923	-8.93%	9,300
Woodson	3,788	3,309	-479	-12.65%	3,292
Subtotal	**196,108**	**188,829**	**-7,279**	**-3.71%**	**187,423**
Mitigation Planning Region I					
Chase	3,030	2,790	-240	-7.92%	2,817
Geary	27,947	34,362	6,415	22.95%	35,323
Lyon	35,935	33,690	-2,245	-6.25%	33,764
Morris	6,104	5,923	-181	-2.97%	5,888
Pottawatomie	18,209	21,604	3,395	18.64%	21,920
Riley	62,843	71,115	8,272	13.16%	72,997
Wabaunsee	6,885	7,053	168	2.44%	7,026
Subtotal	**160,953**	**176,537**	**15,584**	**9.68%**	**179,735**
Mitigation Planning Region J					
Anderson	8,110	8,102	-8	-0.10%	8,070
Coffey	8,865	8,601	-264	-2.98%	8,533

County	2000 Census Population	2010 Census Population	Population Change (Numerical) 2000-2010	Population Change (Percent) 2000-2010	2011 Population Estimates July 1, 2011
Franklin	24,784	25,992	1,208	4.87%	25,931
Linn	9,570	9,656	86	0.90%	9,612
Miami	28,351	32,787	4,436	15.65%	32,715
Osage	16,712	16,295	-417	-2.50%	16,306
Shawnee	169,871	177,934	8,063	4.75%	178,941
Subtotal	**266,263**	**279,367**	**13,104**	**4.92%**	**280,108**
Mitigation Planning Region K					
Atchison	16,774	16,924	150	0.89%	16,793
Brown	10,724	9,984	-740	-6.90%	10,010
Doniphan	8,249	7,945	-304	-3.69%	7,945
Douglas	99,962	110,826	10,864	10.87%	112,211
Jackson	12,657	13,462	805	6.36%	13,433
Jefferson	18,426	19,126	700	3.80%	18,941
Marshall	10,965	10,117	-848	-7.73%	10,005
Nemaha	10,717	10,178	-539	-5.03%	10,113
Washington	6,483	5,799	-684	-10.55%	5,845
Subtotal	**194,957**	**204,361**	**9,404**	**4.82%**	**205,296**
Mitigation Planning Region L					
Johnson	451,086	544,179	93,093	20.64%	552,991
Leavenworth	68,691	76,227	7,536	10.97%	77,176
Wyandotte	157,882	157,505	-377	-0.24%	158,224
Subtotal	**677,659**	**777,911**	**100,252**	**14.79%**	**788,391**
Statewide Total	**2,688,418**	**2,853,118**	**164,700**	**6.12%**	**2,871,238**

Source: U.S. Census Bureau 2010, www.census.govKansas Housing Units

Another indicator of growth is the number of housing units. The census defines a housing unit as: a house, an apartment, a mobile home or trailer, a group of rooms, or a single room that is occupied, or, if vacant, is intended for occupancy as separate living quarters. According to the U.S. Census Bureau, the number of housing units in Kansas increased only 3.97 percent (44,959 units) between 2000 and 2010. When comparing the number of housing units, the State of Kansas ranks 33rd amongst the 50 states. Johnson, Sedgwick and Douglas counties top the list for numerical gains, and the 10 counties with the greatest rate of population growth (percent change) also had the greatest growth in housing units. In terms of housing units by number and percent, **Table 3.10** and **Table 3.11** list the counties that have grown the most. Johnson County has the highest population of Kansas counties.

Table 3.10. Ten Counties with Greatest Housing Unit Gains (Numerical) 2000–2010

County	Mitigation Planning Region	Housing Unit Gains 2000-2010
Johnson	L	44,959
Sedgwick	G	20,460
Douglas	K	6,481
Shawnee	J	5,372
Riley	I	4,815
Leavenworth	L	4,296
Butler	G	2,882
Geary	I	2,558
Miami	J	2,206
Saline	F	1,406

Source: U.S. Census Bureau 2010, www.census.gov

Table 3.11. Ten Counties with Greatest Housing Unit Gains (Percent) 2000-2010

County	Mitigation Planning Region	Housing Unit Gains (%) 2000-2010
Geary	I	21.39%
Riley	I	20.58%
Miami	J	20.08%
Pottawatomie	I	17.99%
Leavenworth	L	17.61%
Douglas	K	16.10%
Linn	J	15.38%
Jackson	K	13.45%
Butler	G	12.44%
Sedgwick	G	10.70%

Source: U.S. Census Bureau 2010, www.census.gov

As illustrated in **Table 3.12**, the 10 most populous counties (**Table 3.2**) also have the most housing units.

Table 3.12. Top 10 Counties Ranked by Number of Housing Units 2010

County	Mitigation Planning Region	Number of Housing Units, 2010
Johnson	L	226,571
Sedgwick	G	211,593
Shawnee	J	79,140
Wyandotte	L	66,747
Douglas	K	46,731
Leavenworth	L	28,697
Reno	G	28,274
Riley	I	28,212

County	Mitigation Planning Region	Number of Housing Units, 2010
Butler	G	26,058
Saline	F	24,101

Source: U.S. Census Bureau 2010, www.census.gov

Table 3.13 shows the Kansas county census housing units data from 2000 and 2010 along with the numerical and percent changes from 2000 to 2010. This information is categorized by the Mitigation Planning Regions.

Table 3.13. Kansas Counties Census Housing Units 2000 and 2010

County	2000 Census Housing Units	2010 Census Housing Units	Housing Unit Change (Numerical) 2000-2010	Housing Unit Change (Percent) 2000-2010
Mitigation Planning Region A				
Cheyenne	1,636	1,518	-118	-7.21%
Decatur	1,821	1,818	-3	-0.16%
Gove	1,423	1,373	-50	-3.51%
Logan	1,423	1,441	18	1.26%
Rawlins	1,565	1,458	-107	-6.84%
Sheridan	1,263	1,265	2	0.16%
Sherman	3,184	3,148	-36	-1.13%
Thomas	3,562	3,536	-26	-0.73%
Wallace	791	781	-10	-1.26%
Subtotal	**16,668**	**16,338**	**-330**	**-1.98%**
Mitigation Planning Region B				
Ellis	12,078	12,872	794	6.57%
Graham	1,553	1,484	-69	-4.44%
Ness	1,835	1,740	-95	-5.18%
Norton	2,673	2,542	-131	-4.90%
Phillips	3,088	3,049	-39	-1.26%
Rooks	2,758	2,768	10	0.36%
Rush	1,928	1,869	-59	-3.06%
Russell	3,871	3,910	39	1.01%
Trego	1,723	1,682	-41	-2.38%
Subtotal	**31,507**	**31,916**	**409**	**1.30%**
Mitigation Planning Region C				
Grant	3,027	2,945	-82	-2.71%
Greeley	712	629	-83	-11.66%
Hamilton	1,211	1,236	25	2.06%
Kearny	1,657	1,556	-101	-6.10%
Lane	1,065	990	-75	-7.04%
Morton	1,519	1,467	-52	-3.42%
Scott	2,291	2,193	-98	-4.28%
Stanton	1,007	990	-17	-1.69%
Stevens	2,265	2,306	41	1.81%
Wichita	1,119	1,054	-65	-5.81%

County	2000 Census Housing Units	2010 Census Housing Units	Housing Unit Change (Numerical) 2000-2010	Housing Unit Change (Percent) 2000-2010
Subtotal	**15,873**	**15,366**	**-507**	**-3.19%**
Mitigation Planning Region D				
Clark	1,111	1,135	24	2.16%
Finney	13,763	13,276	-487	-3.54%
Ford	11,650	12,005	355	3.05%
Gray	2,181	2,340	159	7.29%
Haskell	1,639	1,666	27	1.65%
Hodgeman	945	973	28	2.96%
Meade	1,968	1,998	30	1.52%
Seward	8,027	8,061	34	0.42%
Subtotal	**41,284**	**41,454**	**170**	**0.41%**
Mitigation Planning Region E				
Barber	2,740	2,765	25	0.91%
Barton	12,888	12,696	-192	-1.49%
Comanche	1,088	1,044	-44	-4.04%
Edwards	1,754	1,636	-118	-6.73%
Kiowa	1,643	1,220	-423	-25.75%
Pawnee	3,114	3,152	38	1.22%
Pratt	4,633	4,514	-119	-2.57%
Stafford	2,458	2,319	-139	-5.66%
Subtotal	**30,318**	**29,346**	**-972**	**-3.21%**
Mitigation Planning Region F				
Clay	4,084	4,042	-42	-1.03%
Cloud	4,838	4,659	-179	-3.70%
Dickinson	8,686	8,972	286	3.29%
Ellsworth	3,228	3,239	11	0.34%
Jewell	2,103	2,032	-71	-3.38%
Lincoln	1,853	1,864	11	0.59%
Mitchell	3,340	3,296	-44	-1.32%
Osborne	2,419	2,206	-213	-8.81%
Ottawa	2,755	2,779	24	0.87%
Republic	3,113	2,877	-236	-7.58%
Saline	22,695	24,101	1,406	6.20%
Smith	2,326	2,232	-94	-4.04%
Subtotal	**61,440**	**62,299**	**859**	**1.40%**
Mitigation Planning Region G				
Butler	23,176	26,058	2,882	12.44%
Cowley	15,673	16,030	357	2.28%
Harper	3,270	3,116	-154	-4.71%
Harvey	13,378	14,527	1,149	8.59%
Kingman	3,852	3,818	-34	-0.88%
McPherson	11,830	12,721	891	7.53%
Marion	5,882	5,946	64	1.09%
Reno	27,625	28,274	649	2.35%
Rice	4,609	4,548	-61	-1.32%

County	2000 Census Housing Units	2010 Census Housing Units	Housing Unit Change (Numerical) 2000-2010	Housing Unit Change (Percent) 2000-2010
Sedgwick	191,133	211,593	20,460	10.70%
Sumner	10,877	10,865	-12	-0.11%
Subtotal	**311,305**	**337,496**	**26,191**	**8.41%**
Mitigation Planning Region H				
Allen	6,449	6,226	-223	-3.46%
Bourbon	7,135	7,167	32	0.45%
Chautauqua	2,169	2,150	-19	-0.88%
Cherokee	10,031	9,890	-141	-1.41%
Crawford	17,221	17,801	580	3.37%
Elk	1,860	1,760	-100	-5.38%
Greenwood	4,273	4,068	-205	-4.80%
Labette	10,306	10,092	-214	-2.08%
Montgomery	17,207	16,578	-629	-3.66%
Neosho	7,461	7,513	52	0.70%
Wilson	4,937	4,682	-255	-5.17%
Woodson	2,076	2,022	-54	-2.60%
Subtotal	**91,125**	**89,949**	**-1,176**	**-1.29%**
Mitigation Planning Region I				
Chase	1,529	1,503	-26	-1.70%
Geary	11,959	14,517	2,558	21.39%
Lyon	14,757	15,237	480	3.25%
Morris	3,160	3,206	46	1.46%
Pottawatomie	7,311	8,626	1,315	17.99%
Riley	23,397	28,212	4,815	20.58%
Wabaunsee	3,033	3,227	194	6.40%
Subtotal	**65,146**	**74,528**	**9,382**	**14.40%**
Mitigation Planning Region J				
Anderson	3,596	3,720	124	3.45%
Coffey	3,876	3,964	88	2.27%
Franklin	10,229	11,147	918	8.97%
Linn	4,720	5,446	726	15.38%
Miami	10,984	13,190	2,206	20.08%
Osage	7,018	7,503	485	6.91%
Shawnee	73,768	79,140	5,372	7.28%
Subtotal	**114,191**	**124,110**	**9,919**	**8.69%**
Mitigation Planning Region K				
Atchison	6,818	6,990	172	2.52%
Brown	4,815	4,779	-36	-0.75%
Doniphan	3,489	3,576	87	2.49%
Douglas	40,250	46,731	6,481	16.10%
Jackson	5,094	5,779	685	13.45%
Jefferson	7,491	8,160	669	8.93%
Marshall	4,999	4,866	-133	-2.66%
Nemaha	4,340	4,562	222	5.12%
Washington	3,142	2,955	-187	-5.95%

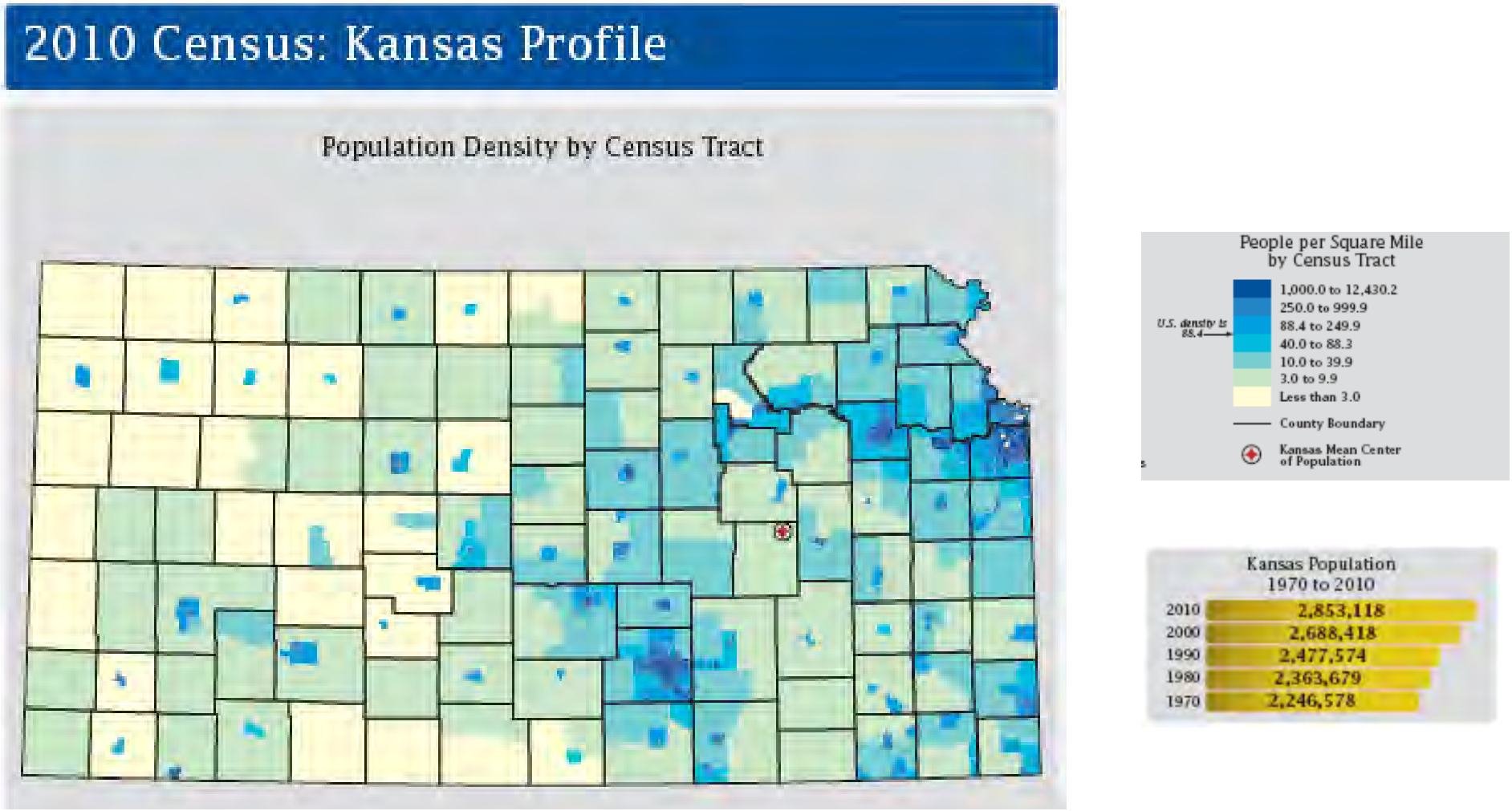
County	2000 Census Housing Units	2010 Census Housing Units	Housing Unit Change (Numerical) 2000-2010	Housing Unit Change (Percent) 2000-2010
Subtotal	**80,438**	**88,398**	**7,960**	**9.90%**
Mitigation Planning Region L				
Johnson	181,612	226,571	44,959	24.76%
Leavenworth	24,401	28,697	4,296	17.61%
Wyandotte	65,892	66,747	855	1.30%
Subtotal	**271,905**	**322,015**	**50,110**	**18.43%**
Statewide Total	**1,131,200**	**1,233,215**	**102,015**	**3.97%**

Source: U.S. Census Bureau 2010, www.census.gov

Density

Kansas has a surface land area of 82,278.36 square miles (2010 census), a population of 2,853,118 (2010 census), and a population density of 34.9 people per square mile. Based on the 2010 census, Kansas ranked 40th in population density among the 50 states. In 2010, 31 (29 percent) of Kansas‘ counties had population densities of less than five people per square mile. See **Figure 3.2** for Kansas‘ Population Density by Census Tract. Johnson and Wyandotte counties, with over 1,000 people per square mile, are by far the State‘s most densely populated counties. The same 10 counties ranked at the top in terms of both population density and housing density (see **Table 3.12**). Eight of these counties (excluding Crawford and Geary counties) also ranked among Kansas‘ top 10 most populous counties (see **Table 3.2**).

Figure 3.2. Kansas Population Density by Census Tract, 2010



Source: U.S. Census Bureau 2010, www.census.gov

Table 3.14. Top 10 Counties Ranked by Population Density*, 2010

County	Mitigation Planning Region	2010 Population Density	2010 Housing Density
Johnson	L	1,149.60	478.6
Wyandotte	L	1,039.00	440.3
Sedgwick	G	499.6	212.1
Shawnee	J	327.1	145.5
Douglas	K	243.1	102.5
Leavenworth	L	164.7	62
Riley	I	116.6	46.3
Geary	I	89.3	37.7
Saline	F	77.2	33.5
Crawford	H	66.4	30.2

Sources: U.S. Census Bureau 2010, www.census.gov
*Density is reported as people/housing units per square mile and is based on the square mileage of the counties in the 2010 census.

As should be expected, the percent change in population density largely tracks with the percent change in population growth (**Table 3.4)**. The fastest growing counties are also seeing their population density increase more rapidly than the other counties (see **Table 3.15**) with the exception of Shawnee, which were replaced in the population density top 10 by Jackson County.

Table 3.15. Ten Counties with Greatest Population Density* Gains (Percent), 2000-2010

County	Mitigation Planning Region	Population Density Gains (%) 2000-2010
Geary	I	23.00%
Johnson	L	21.51%
Pottawatomie	I	18.98%
Miami	J	15.85%
Riley	I	13.09%
Douglas	K	11.11%
Leavenworth	L	11.06%
Butler	G	10.55%
Sedgwick	G	10.24%
Jackson	K	6.22%

Sources: U.S. Census Bureau 2000, 2010, www.census.gov
* Density is reported as people/housing units per square mile and is based on the square mileage of the counties in the 2000 census.

Table 3.16 shows the Kansas county census housing units data from 2000 and 2010 along with the numerical and percent changes from 2000 to 2010. This information is categorized by the Mitigation Planning Regions.

Table 3.16. Kansas Counties Population Density Census for 2000 and 2010

County	2000 Census Population Density	2010 Census Population Density	Population Density Change (Numerical) 2000-2010	Population Density Change (Percent) 2000-2010
Mitigation Planning Region A				
Cheyenne	3.1	2.7	-0.4	-12.90%
Decatur	3.9	3.3	-0.6	-15.38%
Gove	2.9	2.5	-0.4	-13.79%
Logan	2.8	2.6	-0.2	-7.14%
Rawlins	2.8	2.4	-0.4	-14.29%
Sheridan	3.1	2.9	-0.2	-6.45%
Sherman	6.4	5.7	-0.7	-10.94%
Thomas	7.6	7.4	-0.2	-2.63%
Wallace	1.9	1.6	-0.3	-15.79%
Mitigation Planning Region B				
Ellis	30.6	31.6	1	3.27%
Graham	3.3	2.9	-0.4	-12.12%
Ness	3.2	2.9	-0.3	-9.38%
Norton	6.8	6.5	-0.3	-4.41%
Phillips	6.8	6.4	-0.4	-5.88%
Rooks	6.4	5.8	-0.6	-9.38%
Rush	4.9	4.6	-0.3	-6.12%
Russell	8.3	7.9	-0.4	-4.82%
Trego	3.7	3.4	-0.3	-8.11%
Mitigation Planning Region C				
Grant	13.8	13.6	-0.2	-1.45%
Greeley	2	1.6	-0.4	-20.00%
Hamilton	2.7	2.7	0	0.00%
Kearny	5.2	4.6	-0.6	-11.54%
Lane	3	2.4	-0.6	-20.00%
Morton	4.8	4.4	-0.4	-8.33%
Scott	7.1	6.9	-0.2	-2.82%
Stanton	3.5	3.3	-0.2	-5.71%
Stevens	7.5	7.9	0.4	5.33%
Wichita	3.5	3.1	-0.4	-11.43%
Mitigation Planning Region D				
Clark	2.5	2.3	-0.2	-8.00%
Finney	31.1	28.2	-2.9	-9.32%
Ford	29.5	30.8	1.3	4.41%
Gray	6.8	6.9	0.1	1.47%
Haskell	7.5	7.4	-0.1	-1.33%
Hodgeman	2.4	2.2	-0.2	-8.33%
Meade	4.7	4.7	0	0.00%
Seward	35.2	35.9	0.7	1.99%
Mitigation Planning Region E				
Barber	4.7	4.3	-0.4	-8.51%
Barton	31.5	30.9	-0.6	-1.90%

County	2000 Census Population Density	2010 Census Population Density	Population Density Change (Numerical) 2000-2010	Population Density Change (Percent) 2000-2010
Comanche	2.5	2.4	-0.1	-4.00%
Edwards	5.5	4.9	-0.6	-10.91%
Kiowa	4.5	3.5	-1	-22.22%
Pawnee	9.6	9.2	-0.4	-4.17%
Pratt	13.1	13.1	0	0.00%
Stafford	6	5.6	-0.4	-6.67%
Mitigation Planning Region F				
Clay	13.7	13.2	-0.5	-3.65%
Cloud	14.3	13.3	-1	-6.99%
Dickinson	22.8	23.3	0.5	2.19%
Ellsworth	9.1	9.1	0	0.00%
Jewell	4.2	3.4	-0.8	-19.05%
Lincoln	5	4.5	-0.5	-10.00%
Mitchell	9.9	9.1	-0.8	-8.08%
Osborne	5	4.3	-0.7	-14.00%
Ottawa	8.5	8.5	0	0.00%
Republic	8.1	6.9	-1.2	-14.81%
Saline	74.5	77.2	2.7	3.62%
Smith	5.1	4.3	-0.8	-15.69%
Mitigation Planning Region G				
Butler	41.7	46.1	4.4	10.55%
Cowley	32.2	32.3	0.1	0.31%
Harper	8.2	7.5	-0.7	-8.54%
Harvey	60.9	64.3	3.4	5.58%
Kingman	10	9.1	-0.9	-9.00%
McPherson	14.2	13.4	-0.8	-5.63%
Marion	32.8	32.5	-0.3	
Reno	51.6	51.4	-0.2	-0.39%
Rice	14.8	13.9	-0.9	-6.08%
Sedgwick	453.2	499.6	46.4	10.24%
Sumner	22	20.4	-1.6	-7.27%
Mitigation Planning Region H				
Allen	28.6	26.7	-1.9	-6.64%
Bourbon	24.1	23.9	-0.2	-0.83%
Chautauqua	6.8	5.7	-1.1	-16.18%
Cherokee	38.5	36.8	-1.7	-4.42%
Crawford	64.5	66.4	1.9	2.95%
Elk	5	4.5	-0.5	-10.00%
Greenwood	6.7	5.9	-0.8	-11.94%
Labette	35.2	33.5	-1.7	-4.83%
Montgomery	56.2	55.1	-1.1	-1.96%
Neosho	29.7	28.9	-0.8	-2.69%
Wilson	18	16.5	-1.5	-8.33%
Woodson	7.6	6.6	-1	-13.16%
Mitigation Planning Region I				

County	2000 Census Population Density	2010 Census Population Density	Population Density Change (Numerical) 2000-2010	Population Density Change (Percent) 2000-2010
Chase	3.9	3.6	-0.3	-7.69%
Geary	72.6	89.3	16.7	23.00%
Lyon	42.2	39.8	-2.4	-5.69%
Morris	8.8	8.5	-0.3	-3.41%
Pottawatomie	21.6	25.7	4.1	18.98%
Riley	103.1	116.6	13.5	13.09%
Wabaunsee	8.6	8.9	0.3	3.49%
Mitigation Planning Region J				
Anderson	13.9	14	0.1	0.72%
Coffey	14.1	13.7	-0.4	-2.84%
Franklin	43.2	45.5	2.3	5.32%
Linn	16	16.3	0.3	1.88%
Miami	49.2	57	7.8	15.85%
Osage	23.8	23.1	-0.7	-2.94%
Shawnee	309	327.1	18.1	5.86%
Mitigation Planning Region K				
Atchison	38.8	39.3	0.5	1.29%
Brown	18.8	17.5	-1.3	-6.91%
Doniphan	21	20.2	-0.8	-3.81%
Douglas	218.8	243.1	24.3	11.11%
Jackson	19.3	20.5	1.2	6.22%
Jefferson	34.4	35.9	1.5	4.36%
Marshall	12.1	11.2	-0.9	-7.44%
Nemaha	14.9	14.2	-0.7	-4.70%
Washington	7.2	6.5	-0.7	-9.72%
Mitigation Planning Region L				
Johnson	946.1	1,149.60	203.5	21.51%
Leavenworth	148.3	164.7	16.4	11.06%
Wyandotte	1,042.90	1,039.00	-3.9	-0.37%

3.1.3. Social Vulnerability

A Social Vulnerability Index compiled by the Hazards and Vulnerability Research Institute in the Department of Geography at the University of South Carolina measures the social vulnerability of U.S. counties to environmental hazards for the purpose of examining the differences in social vulnerability among counties. Based on national data sources, primarily the 2010 census, it synthesizes 42 socioeconomic and built environment variables that research literature suggests contribute to reduction in a community's ability to prepare for, respond to and recover from hazards (i.e., social vulnerability). Eleven composite factors were identified that differentiate counties according to their relative level of social vulnerability: personal wealth, age, density of the built environment, single-sector economic dependence, housing stock and tenancy, race (African American and Asian), ethnicity (Hispanic and Native American), occupation and infrastructure dependence.

At the time of the 2013 revision, the Social Vulnerability Index 2006-2010 is the most recent data. The index can be used by the State to help determine where social vulnerability and exposure to hazards overlaps and how and where mitigation resources might best be used. See **Figure 3.3** for a map that illustrates Kansas' geographic variation in social vulnerability with a county comparison within the State. According to the index, the following, listed in order, are Kansas' most vulnerable counties (i.e., they rank in the top 20 percent in the State):

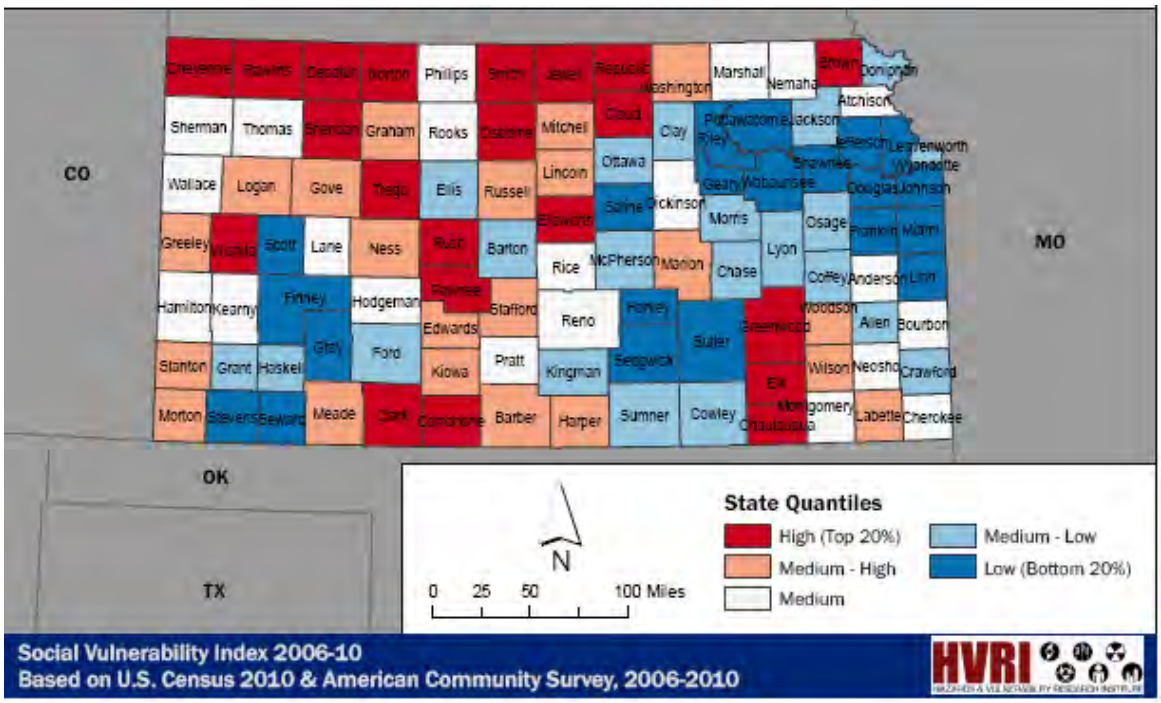
Table 3.17. Kansas' Most Vulnerable Counties, 2006-2010

	County
1.	Decatur
2.	Cheyenne
3.	Rawlins
4.	Osborne
5.	Pawnee
6.	Chautauqua
7.	Norton
8.	Cloud
9.	Clark
10.	Jewell
11.	Ellsworth
12.	Greenwood
13.	Comanche
14.	Sheridan
15.	Rush
16.	Wichita
17.	Smith
18.	Republic
19.	Brown
20.	Trego

Source: Hazards and Vulnerability Research Institute, University of South Carolina, http://webra.cas.sc.edu/hvri/products/sovi_data.aspx

The State can use this information as an indication of where post-disaster recovery needs may be greatest. The State is integrating this social vulnerability index data into the risk assessment of this plan.

Figure 3.3. Social Vulnerability to Environmental Hazards, County Comparison within the State, 2006-2010



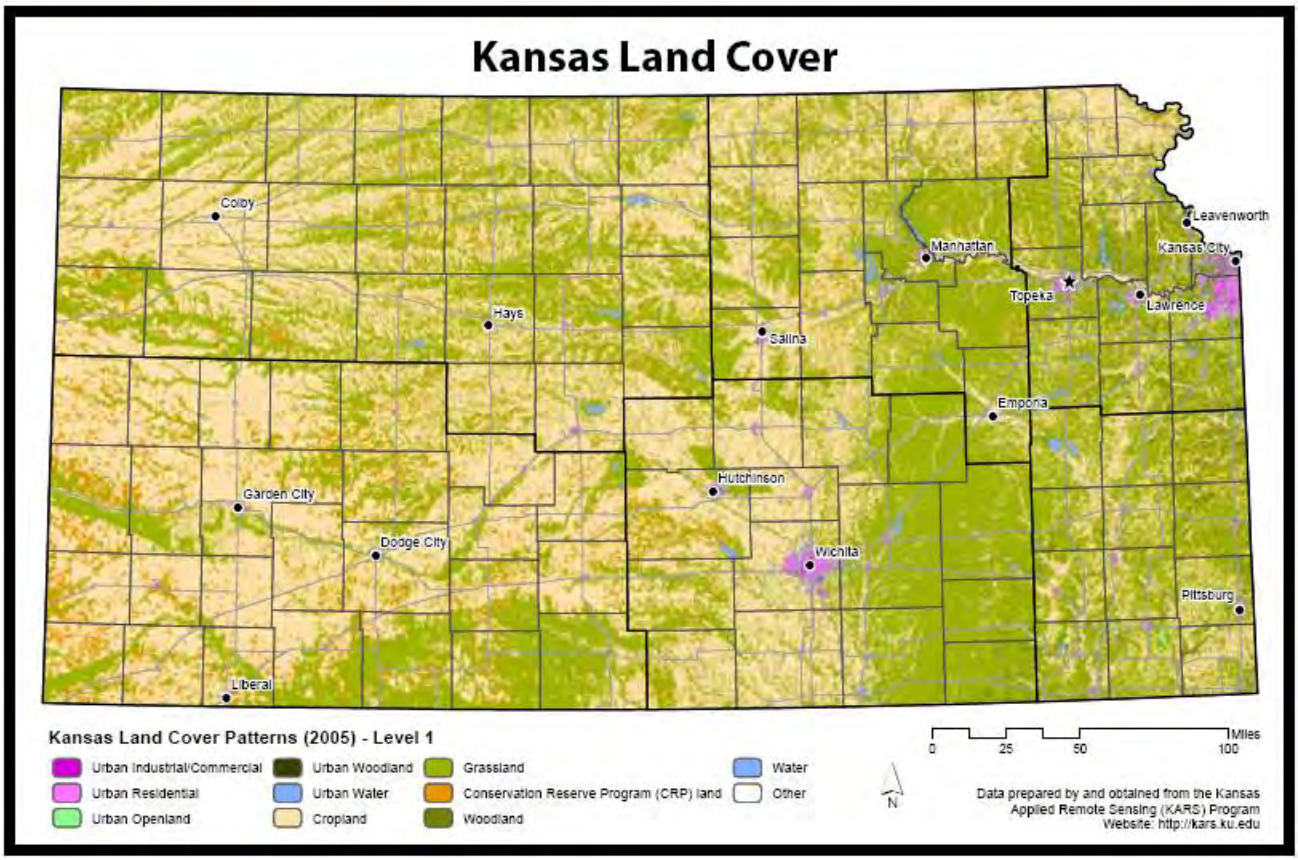
Source: Hazards and Vulnerability Research Institute, University of South Carolina, http://webra.cas.sc.edu/hvri/products/sovi2010_img/PDF/Kansas_0610.pdf

3.1.4. Land Use and Development Trends

General Land Use in Kansas

As indicated in **Figure 3.4**, the land cover in Kansas is predominantly agricultural. The central and western areas of the State are dominated by cropland and grassland. Overall, the State's land use is predominately rural. Urban and suburban uses of land are quite limited geographically and are confined primarily to the northeastern corner of the state in the Kansas City metropolitan area as well as around Topeka, and also in Wichita in south central Kansas.

Figure 3.4. Kansas Land Use/Land Cover



Kansas Forest Action Plan, Kansas Forest Service/ Kansas State University, Manhattan, Revised October 2011, http://www.kansasforests.org/assessment.shtml

Table 3.18 shows the decrease of cropland acres in Kansas from 1982 through 2007 and the increase of Conservation Reserve Program (CRP) land. One characteristic of local land use in Kansas, which must be considered in both state and local hazard mitigation planning, is how the land use patterns are changing at the community level. Identifying both the type and rate of change from existing land uses to future land uses, whether they are planned or unplanned, can help to identify the local jurisdictions most subject to development pressures and consequently help to focus the mitigation planning to minimize the vulnerability to future disasters of the newly constructed neighborhoods, facilities and infrastructure. Data from local plans can be used to identify the jurisdictions where planned land uses are significantly different from existing land uses.

Table 3.18. Land Cover/Use of Non-Federal Rural Land

Year	Cropland	CRP land	Pastureland	Rangeland	Forest Land	Other Rural Land	Total Rural Land
1982	29,097.4	0	2,113.5	16,528.2	1,491.0	685.4	49,915.5
1987	28,467.8	637.7	2,162.3	16,443.4	1,495.0	680.9	49,887.1
1992	26,483.5	2,875.8	2,322.2	15,831.5	1,575.8	688.7	49,777.5
1997	26,490.2	2,848.8	2,317.2	15,730.6	1,584.5	696.0	49,667.3
2002	26,397.3	2,663.7	2,383.0	15,810.0	1,609.6	721.1	49,584.7
2007	25,635.6	3,164.9	2,497.6	15,787.5	1,685.5	735.6	49,506.7

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, 2007 National Resources Inventory, dated December 2009; Note: Land measured in thousands of acres, with margins of error. (CPR) stands for Conservation Reserve Program land.

According to the Census of Agriculture estimates for 2009, more than 84 percent of Kansas land area is farmland (60.9 percent of farmland is cropland, 34.4 percent is pasture land, and 4.7 percent is other uses). This number was down from 90 percent in the 2005. One in five Kansans, rural and urban, work in jobs related to agriculture and food production. Agriculture and agribusiness are a major import to the Kansas economy.

According to the Kansas Department of Agriculture, Kansas produced more than $4.9 billion in agriculture exports in 2010. Kansas farmers provide food for Americans and people in 102 different counties around the world. At 28.2 million acres, Kansas has the second-most cropland of any state and the most cropland of any state by percentage.

In 2010, Kansas ranked first in wheat flour milling capacity and grain sorghum produced, second in wheat flour milled, wheat production cropland, sorghum silage produced and all cattle and calves on farm, and third in cattle slaughtered, cattle and calves on feed, red meat production by commercial slaughter plants, land in farms, commercial grain storage capacity and sunflowers produced.

Like other businesses, the size of farm enterprises will typically reflect the vulnerability of a farm to the impacts of disasters and is indicative of the availability of financial resources to recover in an event‘s aftermath. The average size of farms in 2010 is 705 acres.

Table 3.19 and **Figure 3.5** show the total farmland acreage by county; **Figure 3.6** and **Table 3.20** show the number of farms by county. The maps show that although there is more acreage of farmland in the western and south-central counties, there are more farms per county in the south-central and eastern counties. There are large parts of the State where agriculture is the mainstay of the local economy. Agriculture plays the largest role in local economies in central and western Kansas.

Table 3.19. Top 10 Kansas Counties Ranked by Farmland Acreage, USDA Agriculture Census, 2007

County	Total Land In Farms, Acres
Butler	787,290
Reno	780,893
Finney	760,110
Sumner	709,865

Sherman	657,942
Thomas	657,471
Ford	634,240
Ness	619,948
Barber	611,493
Hamilton	610,864

Source: http://www.nass.usda.gov/Statistics_by_State/Kansas/Publications/Annual_Statistical_Bulletin/ff2011.pdf

Figure 3.5. Total Kansas Farmland Acreage by County, USDA Agriculture Census, 2007

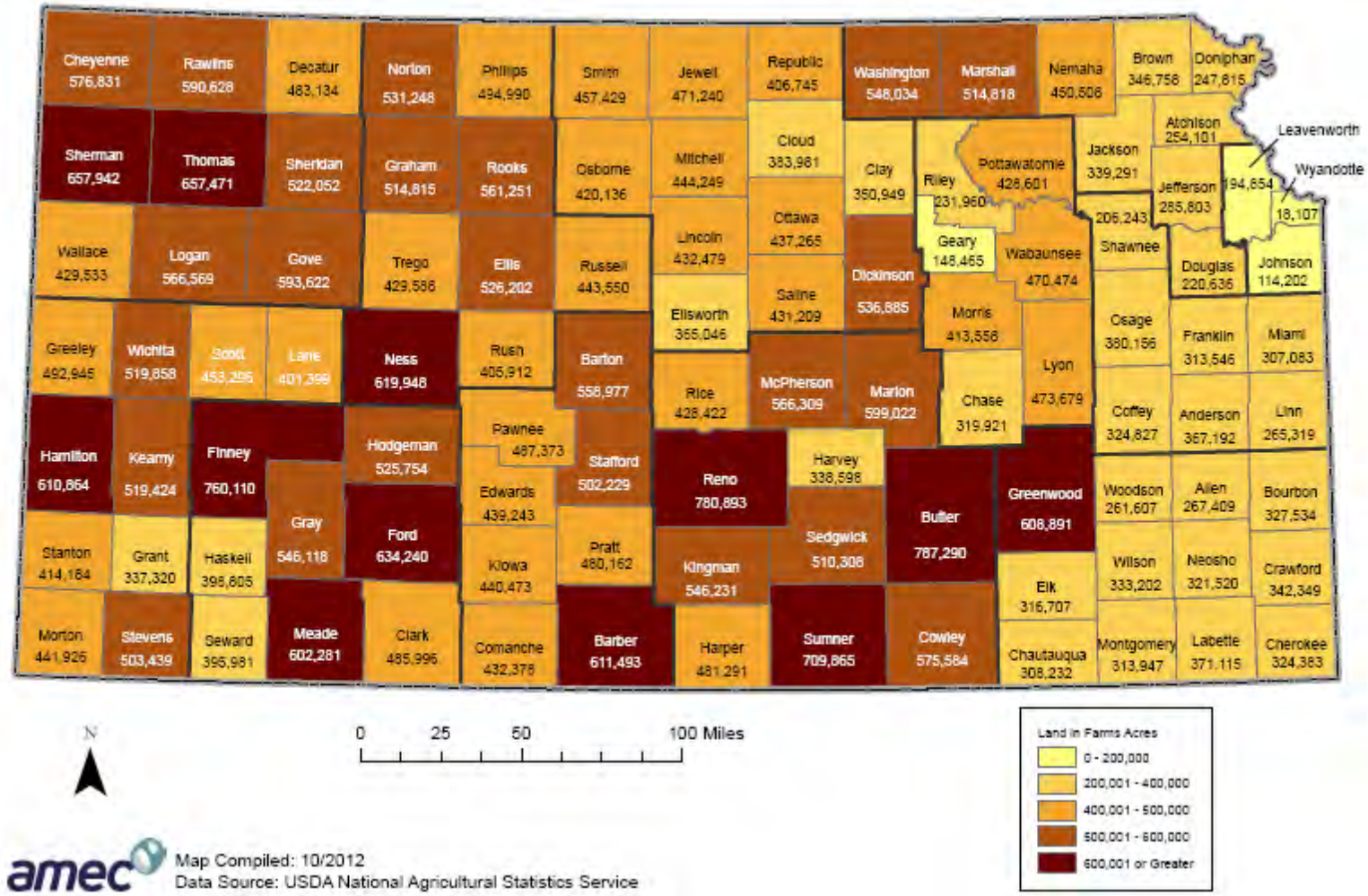


Figure 3.6. Number of Farms by County, USDA Agriculture Census, 2007

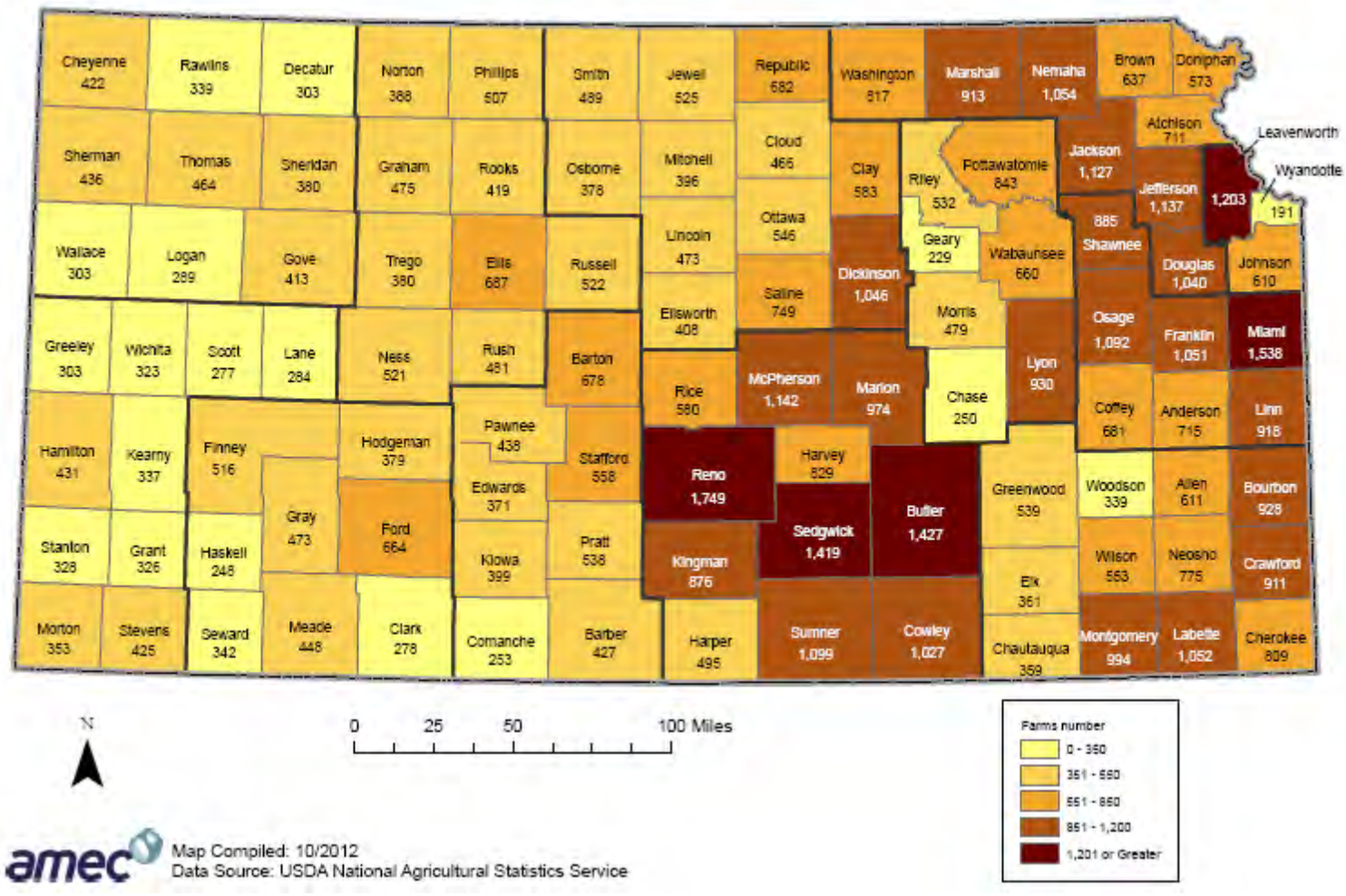


Table 3.20. Top 10 Counties Ranked by Number of Farms, USDA Agriculture Census, 2007

County	Number of Farms
Reno	1,749
Miami	1,538
Butler	1,427
Sedgwick	1,419
Leavenworth	1,203
McPherson	1,142
Jefferson	1,137
Jackson	1,127
Sumner	1,099
Osage	1,092

Source: http://www.nass.usda.gov/Statistics_by_State/Kansas/Publications/Annual_Statistical_Bulletin/ff2011.pdf

As mentioned previously, the percent of land dedicated to farming in Kansas dropped between 2005 and 2009. Nevertheless, while some areas converted more land to farming, some farmland was converted to other uses.

Changes from rural to urban land use, and vice versa, will continue to alter the type and scale of the vulnerability of local jurisdictions to future disasters. As local plans become available, especially those with significant land use changes, the State will review them to get a better understanding of the types of changes that are taking place and how they might affect the State‘s mitigation strategy.

3.1.5. Exposure of Built Environment/Cultural Resources

Built Environment

This section quantifies the buildings exposed to potential hazards, by county. **Table 3.21** and **Table 3.22** provide the value of the State‘s built environment and its contents, which in addition to the population information presented above, forms the basis of the vulnerability and risk assessment presented in this plan. **Figure 3.7** illustrates the statewide distribution of the building exposure, with both the structure and content values. This information was derived from inventory data associated with FEMA‘s loss estimation software HAZUS-MH 2.1 (February 2012). HAZUS-MH classifies building stock types into seven categories: residential, commercial, industrial, agriculture, religion, government, and education. Values associated with each of these categories reflect 2006 valuations, published by R.S. Means Company (Means Square foot Costs”, 2006) with replacement costs. According to the HAZUS-MH 2.1 inventory, the total estimated replacement value of buildings within the State is $193.2 billion and the total buildings content‘s estimated value within the State is $130.2 billion. The exposure value of buildings is incorporated as a factor in vulnerability assessments for hailstorm, tornado, windstorm, and winter storm hazards that are profiled later in this plan. Information about state facilities is in **Section 3.5** State Owned or Operated Facilities: Vulnerability and Loss Estimates.

Table 3.21. Estimated Replacement Value of Buildings by Category for Kansas (2006 Valuations)

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Mitigation Planning Region A								
Cheyenne	$129,489	$31,383	$7,408	$10,225	$5,325	$858	$4,619	$189,307
Decatur	$170,374	$32,484	$4,791	$10,168	$8,433	$2,334	$3,451	$232,035
Gove	$147,551	$32,635	$10,701	$15,767	$5,585	$2,118	$10,305	$224,662
Logan	$150,202	$44,080	$3,908	$11,317	$5,999	$2,216	$5,627	$223,349
Rawlins	$137,112	$38,066	$5,156	$11,713	$5,198	$4,000	$4,217	$205,462
Sheridan	$141,246	$34,630	$3,401	$10,160	$4,729	$1,647	$4,848	$200,661
Sherman	$308,732	$93,459	$11,611	$15,148	$15,114	$3,676	$13,445	$461,185
Thomas	$401,387	$110,382	$13,797	$19,871	$16,745	$4,653	$33,138	$599,973
Wallace	$82,095	$17,219	$1,386	$6,671	$4,345	$2,298	$3,407	$117,421
Subtotal	**$1,668,188**	**$434,338**	**$62,159**	**$111,040**	**$71,473**	**$23,800**	**$83,057**	**$2,454,055**
Mitigation Planning Region B								
Ellis	$1,193,260	$342,837	$95,639	$19,098	$30,953	$12,650	$41,037	$1,735,474
Graham	$142,669	$38,437	$5,376	$4,260	$4,378	$1,470	$5,262	$201,852
Ness	$156,153	$50,340	$9,011	$8,082	$10,631	$1,747	$5,830	$241,794
Norton	$257,361	$61,011	$18,075	$13,507	$8,685	$5,752	$7,100	$371,491
Phillips	$316,072	$61,648	$18,029	$14,045	$12,934	$5,470	$11,246	$439,444
Rooks	$241,270	$79,598	$17,497	$236,588	$13,666	$5,739	$7,488	$601,846
Rush	$136,147	$31,616	$12,823	$7,590	$5,584	$2,542	$6,055	$202,357
Russell	$349,756	$80,961	$24,187	$10,067	$11,882	$3,999	$8,142	$488,994
Trego	$154,545	$33,377	$5,664	$5,539	$7,295	$4,677	$4,679	$215,776
Subtotal	**$2,947,233**	**$779,825**	**$206,301**	**$318,776**	**$106,008**	**$44,046**	**$96,839**	**$4,499,028**
Mitigation Planning Region C								
Grant	$296,646	$107,493	$23,136	$16,008	$12,507	$3,786	$10,273	$469,849
Greeley	$92,970	$21,763	$2,857	$7,276	$2,648	$857	$3,295	$131,666
Hamilton	$127,214	$32,434	$2,669	$14,454	$5,106	$3,206	$2,786	$187,869
Kearny	$172,175	$26,119	$4,082	$11,821	$4,854	$2,898	$6,774	$228,723
Lane	$115,133	$26,846	$1,550	$9,501	$3,082	$2,584	$3,666	$162,362
Morton	$161,922	$35,720	$5,309	$8,167	$9,536	$3,565	$5,933	$230,152
Scott	$244,650	$59,907	$7,995	$23,265	$11,356	$2,350	$991	$350,514

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Stanton	$103,798	$25,539	$2,546	$9,933	$3,634	$3,753	$2,455	$151,658
Stevens	$226,033	$36,862	$6,874	$6,260	$10,432	$1,822	$5,479	$293,762
Wichita	$118,412	$22,470	$2,182	$12,613	$12,724	$3,479	$3,799	$175,679
Subtotal	**$1,658,953**	**$395,153**	**$59,200**	**$119,298**	**$75,879**	**$28,300**	**$45,451**	**$2,382,234**
Mitigation Planning Region D								
Clark	$136,255	$19,073	$8,190	$4,626	$6,303	$1,631	$6,404	$182,482
Finney	$1,448,370	$397,989	$76,068	$36,285	$36,389	$14,053	$33,438	$2,042,592
Ford	$1,225,745	$316,801	$85,441	$27,732	$37,736	$13,919	$24,289	$1,731,663
Gray	$249,558	$51,466	$8,165	$25,738	$7,999	$6,209	$11,006	$360,141
Haskell	$174,354	$42,108	$6,767	$12,299	$7,338	$4,618	$5,319	$252,803
Hodgeman	$104,866	$12,269	$1,087	$7,550	$1,975	$1,746	$1,662	$131,155
Meade	$217,126	$32,850	$6,312	$16,940	$8,578	$2,859	$11,271	$295,936
Seward	$731,205	$209,738	$30,240	$4,310	$24,587	$7,853	$13,538	$1,021,471
Subtotal	**$4,287,479**	**$1,082,294**	**$222,270**	**$135,480**	**$130,905**	**$52,888**	**$106,927**	**$6,018,243**
Mitigation Planning Region E								
Barber	$266,528	$72,098	$13,008	$13,267	$11,273	$5,034	$6,928	$388,136
Barton	$1,151,374	$331,999	$172,749	$29,202	$47,319	$13,122	$26,353	$1,772,118
Comanche	$92,396	$18,993	$3,414	$6,385	$4,222	$1,175	$8,553	$135,138
Edwards	$160,455	$37,428	$10,718	$7,531	$4,962	$5,398	$5,890	$232,382
Kiowa	$170,579	$35,317	$4,938	$9,171	$9,614	$2,307	$5,729	$237,655
Pawnee	$360,996	$52,604	$4,303	$8,340	$13,861	$3,513	$5,975	$449,592
Pratt	$477,623	$119,524	$18,891	$14,891	$14,291	$7,428	$36,591	$689,239
Stafford	$206,392	$47,655	$5,707	$14,240	$10,567	$1,933	$8,837	$295,331
Subtotal	**$2,886,343**	**$715,618**	**$233,728**	**$103,027**	**$116,109**	**$39,910**	**$104,856**	**$4,199,591**
Mitigation Planning Region F								
Clay	$427,252	$87,337	$31,525	$21,304	$16,544	$5,112	$10,749	$599,823
Cloud	$491,148	$105,969	$20,481	$13,451	$29,116	$5,748	$25,870	$691,783
Dickinson	$904,729	$216,077	$43,190	$29,217	$40,490	$9,575	$19,587	$1,262,865
Ellsworth	$331,204	$56,845	$24,601	$13,666	$13,631	$7,515	$12,162	$459,624
Jewell	$181,789	$28,958	$12,668	$10,936	$6,019	$4,545	$9,900	$254,815
Lincoln	$169,064	$30,708	$7,161	$11,808	$6,609	$4,114	$5,282	$234,746

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Mitchell	$347,437	$83,622	$32,824	$17,051	$15,360	$3,307	$11,396	$510,997
Osborne	$207,049	$55,890	$47,453	$13,597	$11,786	$2,572	$4,657	$343,004
Ottawa	$307,419	$47,906	$13,793	$12,930	$23,102	$3,392	$9,774	$418,316
Republic	$307,309	$57,092	$10,608	$19,341	$10,756	$4,805	$7,305	$417,216
Saline	$2,478,096	$685,910	$227,147	$25,942	$86,397	$30,251	$58,129	$3,591,872
Smith	$194,083	$40,141	$14,725	$12,475	$8,755	$2,342	$5,775	$278,296
Subtotal	**$6,346,579**	**$1,496,455**	**$486,176**	**$201,718**	**$268,565**	**$83,278**	**$180,586**	**$9,063,357**
Mitigation Planning Region G								
Butler	$2,804,879	$409,913	$123,653	$31,605	$73,219	$21,505	$44,369	$3,509,143
Cowley	$1,650,317	$324,288	$59,020	$19,303	$47,301	$12,509	$67,899	$2,180,637
Harper	$304,168	$77,756	$31,669	$12,420	$14,814	$5,068	$9,377	$455,272
Harvey	$1,528,230	$336,010	$136,494	$24,914	$60,650	$17,615	$39,177	$2,143,090
Kingman	$445,655	$65,135	$49,734	$15,297	$15,077	$6,601	$9,099	$606,598
McPherson	$1,430,714	$308,239	$186,223	$38,330	$56,308	$12,256	$22,533	$2,054,603
Marion	$625,563	$106,019	$41,568	$23,448	$26,862	$15,105	$16,344	$854,909
Reno	$2,936,532	$673,941	$272,505	$43,331	$90,201	$44,174	$60,022	$4,120,706
Rice	$485,600	$97,983	$23,972	$17,845	$17,110	$5,846	$20,055	$668,411
Sedgwick	$22,273,136	$5,886,388	$2,209,049	$81,213	$584,172	$129,534	$365,407	$31,528,899
Sumner	$1,180,166	$193,068	$82,348	$33,557	$43,772	$12,321	$29,010	$1,574,242
Subtotal	**$35,664,960**	**$8,478,740**	**$3,216,235**	**$341,263**	**$1,029,486**	**$282,534**	**$683,292**	**$49,696,510**
Mitigation Planning Region H								
Allen	$701,522	$148,407	$60,217	$11,273	$29,083	$6,382	$26,894	$983,778
Bourbon	$767,220	$168,356	$107,198	$10,217	$30,164	$6,970	$12,363	$1,102,488
Chautauqua	$193,474	$35,226	$7,131	$32,499	$8,514	$3,039	$5,555	$285,438
Cherokee	$962,249	$158,649	$90,630	$19,757	$29,268	$8,177	$25,023	$1,293,753
Crawford	$1,840,563	$439,540	$168,664	$22,743	$53,594	$18,124	$45,589	$2,588,817
Elk	$152,928	$17,704	$2,115	$2,964	$3,402	$3,122	$5,056	$187,291
Greenwood	$386,754	$55,505	$16,046	$8,890	$12,789	$2,580	$8,848	$491,412
Labette	$1,081,414	$207,539	$79,040	$15,976	$33,147	$13,710	$23,024	$1,453,850
Montgomery	$1,724,172	$379,203	$182,182	$12,813	$71,150	$15,148	$47,515	$2,432,183
Neosho	$809,459	$186,576	$92,952	$17,176	$31,563	$15,514	$20,910	$1,174,150
Wilson	$446,126	$84,941	$79,574	$12,879	$27,804	$6,897	$12,838	$671,059

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Woodson	$161,245	$21,209	$5,858	$6,278	$4,097	$3,093	$6,125	$207,905
Subtotal	**$9,227,126**	**$1,902,855**	**$891,607**	**$173,465**	**$334,575**	**$102,756**	**$239,740**	**$12,872,124**
Mitigation Planning Region I								
Chase	$148,794	$17,497	$3,318	$5,561	$3,232	$1,919	$3,005	$183,326
Geary	$1,064,170	$244,281	$50,238	$9,490	$35,242	$20,634	$29,457	$1,453,512
Lyon	$1,468,776	$461,482	$104,797	$20,135	$45,373	$27,038	$238,907	$2,366,508
Morris	$288,356	$60,466	$25,086	$23,773	$11,388	$5,696	$7,189	$421,954
Pottawatomie	$813,561	$209,811	$59,004	$22,245	$24,438	$8,983	$19,138	$1,157,180
Riley	$2,921,993	$531,821	$61,387	$30,001	$82,450	$38,207	$148,158	$3,814,017
Wabaunsee	$350,238	$28,361	$13,049	$10,240	$9,364	$4,038	$23,889	$439,179
Subtotal	**$7,055,888**	**$1,553,719**	**$316,879**	**$121,445**	**$211,487**	**$106,515**	**$469,743**	**$9,835,676**
Mitigation Planning Region J								
Anderson	$374,936	$80,463	$26,248	$13,788	$8,577	$5,810	$8,579	$518,401
Coffey	$467,667	$100,314	$17,202	$17,164	$12,467	$7,897	$48,242	$670,953
Franklin	$1,187,525	$225,030	$91,924	$20,991	$37,711	$12,642	$22,181	$1,598,004
Linn	$511,695	$86,859	$22,767	$9,621	$12,173	$7,807	$8,204	$659,126
Miami	$1,638,010	$251,249	$90,307	$22,057	$41,539	$8,617	$54,487	$2,106,266
Osage	$783,384	$110,509	$12,490	$17,345	$25,749	$9,628	$18,005	$977,110
Shawnee	$8,607,175	$2,087,339	$408,573	$39,816	$281,705	$235,600	$168,033	$11,828,241
Subtotal	**$13,570,392**	**$2,941,763**	**$669,511**	**$140,782**	**$419,921**	**$288,001**	**$327,731**	**$18,358,101**
Mitigation Planning Region K								
Atchison	$922,586	$215,344	$120,042	$18,748	$31,437	$7,159	$18,047	$1,333,363
Brown	$491,108	$132,926	$31,985	$18,467	$18,445	$7,781	$12,513	$713,225
Doniphan	$386,334	$70,233	$22,395	$18,514	$9,006	$5,215	$45,412	$557,109
Douglas	$4,984,505	$1,021,552	$282,104	$34,900	$120,529	$38,161	$132,518	$6,614,269
Jackson	$612,772	$92,004	$25,943	$15,510	$17,712	$11,439	$12,943	$788,323
Jefferson	$917,944	$105,391	$37,231	$15,249	$24,020	$12,020	$18,997	$1,130,852
Marshall	$509,777	$115,403	$61,303	$30,922	$22,783	$6,957	$15,232	$762,377
Nemaha	$489,512	$113,121	$38,057	$32,775	$15,788	$6,466	$16,177	$711,896
Washington	$265,449	$66,867	$8,953	$27,159	$14,036	$4,136	$10,056	$396,656
Subtotal	**$9,579,987**	**$1,932,841**	**$628,013**	**$212,244**	**$273,756**	**$99,334**	**$281,895**	**$13,008,070**

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Mitigation Planning Region L								
Johnson	$32,813,492	$8,111,879	$1,699,112	$112,125	$612,676	$143,472	$378,712	$43,871,468
Leavenworth	$3,928,203	$578,117	$104,793	$27,384	$81,685	$41,955	$115,646	$4,877,783
Wyandotte	$8,317,902	$2,408,512	$739,055	$22,467	$346,313	$68,468	$163,949	$12,066,666
Subtotal	**$45,059,597**	**$11,098,508**	**$2,542,960**	**$161,976**	**$1,040,674**	**$253,895**	**$658,307**	**$60,815,917**
Statewide Total	**$139,952,725**	**$32,812,109**	**$9,535,039**	**$2,140,514**	**$4,078,838**	**$1,405,257**	**$3,278,424**	**$193,202,906**

Table 3.22. Estimated Replacement Value of Building's Contents by Category for Kansas (2006 Valuations)

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Mitigation Planning Region A								
Cheyenne	$65,084	$33,506	$10,563	$10,225	$5,325	$858	$4,619	$130,180
Decatur	$85,636	$33,524	$5,970	$10,168	$8,433	$2,444	$3,451	$149,626
Gove	$74,173	$35,975	$14,242	$15,767	$5,585	$2,366	$10,305	$158,413
Logan	$75,412	$47,299	$4,518	$11,317	$5,999	$2,319	$5,627	$152,491
Rawlins	$68,996	$41,646	$7,211	$11,713	$5,198	$4,000	$4,217	$142,981
Sheridan	$70,829	$36,565	$4,308	$10,160	$4,729	$1,647	$4,848	$133,086
Sherman	$154,751	$101,852	$15,358	$15,148	$15,114	$3,784	$13,445	$319,452
Thomas	$201,238	$116,708	$18,257	$19,871	$16,745	$4,653	$35,894	$413,366
Wallace	$41,306	$17,552	$1,786	$6,671	$4,345	$3,106	$3,407	$78,173
Subtotal	**$837,425**	**$464,627**	**$82,213**	**$111,040**	**$71,473**	**$25,177**	**$85,813**	**$1,677,768**
Mitigation Planning Region B								
Ellis	$597,633	$370,984	$135,062	$19,098	$30,953	$14,236	$49,883	$1,217,849
Graham	$71,553	$44,192	$7,601	$4,260	$4,378	$1,470	$5,262	$138,716
Ness	$78,567	$58,599	$12,813	$8,082	$10,631	$2,030	$5,830	$176,552
Norton	$129,096	$64,765	$25,274	$13,507	$8,685	$5,999	$7,335	$254,661
Phillips	$158,442	$62,972	$25,549	$14,045	$12,934	$5,819	$11,246	$291,007
Rooks	$121,138	$83,143	$24,566	$236,588	$13,666	$6,107	$7,488	$492,696
Rush	$68,451	$35,281	$18,779	$7,590	$5,584	$2,929	$6,055	$144,669
Russell	$175,446	$84,611	$34,282	$10,067	$11,882	$4,742	$8,142	$329,172
Trego	$77,525	$33,780	$7,213	$5,539	$7,295	$6,319	$4,679	$142,350
Subtotal	**$1,477,851**	**$838,327**	**$291,139**	**$318,776**	**$106,008**	**$49,651**	**$105,920**	**$3,187,672**
Mitigation Planning Region C								
Grant	$148,657	$119,357	$31,474	$16,008	$12,507	$4,166	$10,273	$342,442
Greeley	$46,586	$26,152	$3,749	$7,276	$2,648	$1,100	$3,295	$90,806
Hamilton	$63,920	$34,515	$3,507	$14,454	$5,106	$3,877	$2,786	$128,165
Kearny	$86,579	$27,026	$5,840	$11,821	$4,854	$3,228	$6,774	$146,122
Lane	$57,734	$31,428	$2,191	$9,501	$3,082	$2,786	$3,666	$110,388
Morton	$81,306	$40,877	$7,411	$8,167	$9,536	$3,899	$5,933	$157,129
Scott	$122,536	$60,527	$10,491	$23,265	$11,356	$2,350	$991	$231,516

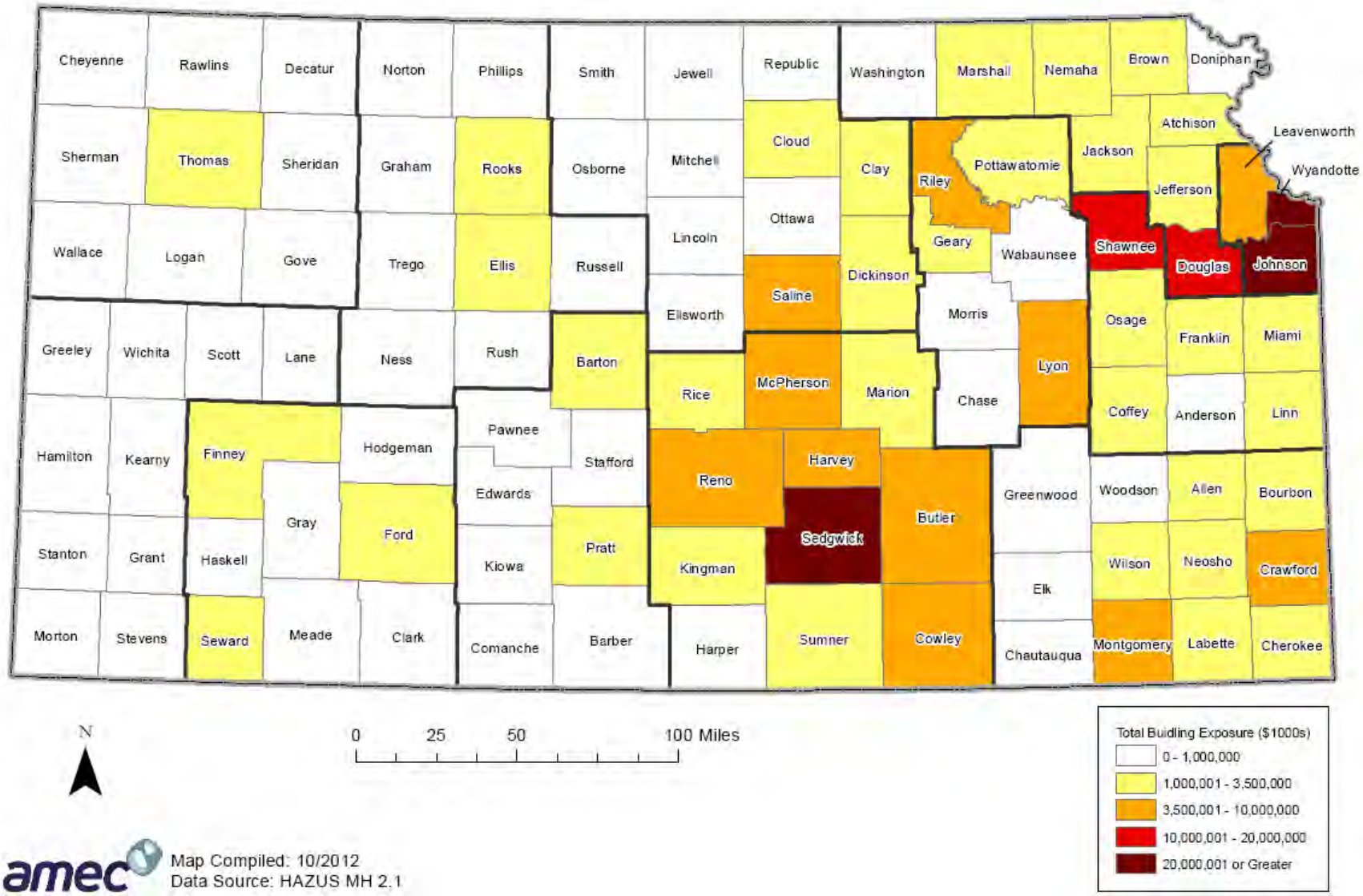
County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Stanton	$52,029	$28,879	$3,338	$9,933	$3,634	$3,753	$2,455	$104,021
Stevens	$113,476	$37,963	$8,867	$6,260	$10,432	$1,822	$5,479	$184,299
Wichita	$59,367	$24,688	$2,965	$12,613	$12,724	$4,606	$3,799	$120,762
Subtotal	**$832,190**	**$431,412**	**$79,833**	**$119,298**	**$75,879**	**$31,587**	**$45,451**	**$1,615,650**
Mitigation Planning Region D								
Clark	$68,462	$20,625	$11,675	$4,626	$6,303	$1,784	$6,804	$120,279
Finney	$725,345	$427,145	$103,021	$36,285	$36,389	$15,496	$34,372	$1,378,053
Ford	$613,934	$336,600	$121,601	$27,732	$37,736	$15,340	$26,092	$1,179,035
Gray	$125,109	$51,861	$10,794	$25,738	$7,999	$7,115	$11,006	$239,622
Haskell	$87,514	$48,710	$9,649	$12,299	$7,338	$5,768	$5,319	$176,597
Hodgeman	$52,629	$12,978	$1,360	$7,550	$1,975	$1,746	$1,662	$79,900
Meade	$109,114	$33,779	$8,569	$16,940	$8,578	$3,005	$11,271	$191,256
Seward	$366,170	$231,881	$40,394	$4,310	$24,587	$7,853	$14,050	$689,245
Subtotal	**$2,148,277**	**$1,163,579**	**$307,063**	**$135,480**	**$130,905**	**$58,107**	**$110,576**	**$4,053,987**
Mitigation Planning Region E								
Barber	$133,698	$79,348	$17,854	$13,267	$11,273	$5,216	$7,074	$267,730
Barton	$576,757	$358,032	$248,874	$29,202	$47,319	$14,623	$27,504	$1,302,311
Comanche	$46,361	$20,796	$4,876	$6,385	$4,222	$1,213	$8,553	$92,406
Edwards	$80,505	$40,323	$15,381	$7,531	$4,962	$6,335	$6,014	$161,051
Kiowa	$85,629	$37,648	$6,639	$9,171	$9,614	$2,640	$5,743	$157,084
Pawnee	$180,910	$55,825	$5,145	$8,340	$13,861	$3,869	$5,975	$273,925
Pratt	$239,416	$123,775	$25,218	$14,891	$14,291	$8,413	$50,692	$476,696
Stafford	$103,523	$50,964	$7,694	$14,240	$10,567	$1,933	$8,837	$197,758
Subtotal	**$1,446,799**	**$766,711**	**$331,681**	**$103,027**	**$116,109**	**$44,242**	**$120,392**	**$2,928,961**
Mitigation Planning Region F								
Clay	$214,140	$89,266	$44,176	$21,304	$16,544	$5,977	$10,749	$402,156
Cloud	$246,175	$116,093	$26,373	$13,451	$29,116	$6,007	$33,286	$470,501
Dickinson	$453,626	$229,887	$59,974	$29,217	$40,490	$10,766	$19,587	$843,547
Ellsworth	$166,126	$60,723	$35,686	$13,666	$13,631	$8,464	$12,162	$310,458
Jewell	$91,268	$30,410	$18,496	$10,936	$6,019	$4,545	$9,900	$171,574
Lincoln	$84,778	$31,849	$9,786	$11,808	$6,609	$4,834	$5,282	$154,946

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Mitchell	$174,370	$85,578	$43,875	$17,051	$15,360	$3,307	$13,025	$352,566
Osborne	$104,193	$57,887	$70,002	$13,597	$11,786	$3,008	$4,657	$265,130
Ottawa	$154,217	$50,742	$18,961	$12,930	$23,102	$4,022	$9,774	$273,748
Republic	$154,313	$60,598	$14,498	$19,341	$10,756	$5,647	$7,305	$272,458
Saline	$1,240,503	$736,381	$317,162	$25,942	$86,397	$33,009	$61,875	$2,501,269
Smith	$97,785	$43,366	$21,435	$12,475	$8,755	$2,557	$5,775	$192,148
Subtotal	**$3,181,494**	**$1,592,780**	**$680,424**	**$201,718**	**$268,565**	**$92,143**	**$193,377**	**$6,210,501**
Mitigation Planning Region G								
Butler	$1,404,552	$439,787	$163,676	$31,605	$73,219	$24,854	$46,458	$2,184,151
Cowley	$826,753	$348,587	$81,655	$19,303	$47,301	$13,832	$90,548	$1,427,979
Harper	$152,630	$84,506	$46,396	$12,420	$14,814	$5,201	$9,377	$325,344
Harvey	$765,368	$368,695	$191,164	$24,914	$60,650	$18,516	$43,208	$1,472,515
Kingman	$223,355	$69,099	$72,760	$15,297	$15,077	$7,819	$9,099	$412,506
Marion	$313,823	$108,705	$58,409	$23,448	$26,862	$18,304	$16,828	$566,379
McPherson	$716,434	$340,242	$270,675	$38,330	$56,308	$14,214	$23,462	$1,459,665
Reno	$1,470,400	$703,264	$386,211	$43,331	$90,201	$46,239	$63,503	$2,803,149
Rice	$243,454	$103,213	$33,691	$17,845	$17,110	$6,825	$20,539	$442,677
Sedgwick	$11,144,058	$6,612,111	$3,178,432	$81,213	$584,172	$141,262	$383,762	$22,125,010
Sumner	$591,431	$207,861	$117,677	$33,557	$43,772	$13,591	$29,137	$1,037,026
Subtotal	**$17,852,258**	**$9,386,070**	**$4,600,746**	**$341,263**	**$1,029,486**	**$310,657**	**$735,921**	**$34,256,401**
Mitigation Planning Region H								
Allen	$352,109	$156,635	$86,967	$11,273	$29,083	$6,382	$32,220	$674,669
Bourbon	$384,413	$184,017	$156,819	$10,217	$30,164	$7,154	$13,029	$785,813
Chautauqua	$96,970	$40,473	$9,903	$32,499	$8,514	$3,253	$5,555	$197,167
Cherokee	$482,340	$164,087	$130,146	$19,757	$29,268	$8,973	$25,438	$860,009
Crawford	$922,065	$481,518	$240,745	$22,743	$53,594	$19,793	$51,813	$1,792,271
Elk	$76,791	$18,969	$2,651	$2,964	$3,402	$3,521	$5,056	$113,354
Greenwood	$194,060	$59,227	$21,527	$8,890	$12,789	$2,931	$8,848	$308,272
Labette	$541,840	$229,768	$113,476	$15,976	$33,147	$15,860	$23,643	$973,710
Montgomery	$863,799	$412,325	$261,208	$12,813	$71,150	$16,791	$56,121	$1,694,207
Neosho	$405,581	$191,302	$132,997	$17,176	$31,563	$17,071	$22,551	$818,241
Wilson	$223,657	$90,980	$114,750	$12,879	$27,804	$7,467	$12,838	$490,375

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Woodson	$80,983	$21,761	$8,216	$6,278	$4,097	$3,443	$6,125	$130,903
Subtotal	**$4,624,608**	**$2,051,062**	**$1,279,405**	**$173,465**	**$334,575**	**$112,639**	**$263,237**	**$8,838,991**
Mitigation Planning Region I								
Chase	$74,635	$17,855	$4,144	$5,561	$3,232	$1,919	$3,005	$110,351
Geary	$532,780	$260,008	$70,187	$9,490	$35,242	$22,034	$31,184	$960,925
Lyon	$735,647	$511,304	$148,542	$20,135	$45,373	$29,318	$338,427	$1,828,746
Morris	$144,602	$61,774	$34,674	$23,773	$11,388	$6,605	$8,245	$291,061
Pottawatomie	$407,652	$229,240	$81,431	$22,245	$24,438	$10,828	$20,271	$796,105
Riley	$1,462,299	$560,996	$79,649	$30,001	$82,450	$39,537	$198,384	$2,453,316
Wabaunsee	$175,765	$28,725	$17,653	$10,240	$9,364	$4,467	$23,889	$270,103
Subtotal	**$3,533,380**	**$1,669,902**	**$436,280**	**$121,445**	**$211,487**	**$114,708**	**$623,405**	**$6,710,607**
Mitigation Planning Region J								
Anderson	$187,967	$87,455	$37,016	$13,788	$8,577	$6,561	$8,579	$349,943
Coffey	$234,811	$105,379	$23,446	$17,164	$12,467	$8,484	$48,242	$449,993
Franklin	$594,591	$235,059	$127,047	$20,991	$37,711	$14,819	$24,559	$1,054,777
Linn	$256,791	$87,877	$30,312	$9,621	$12,173	$9,885	$8,204	$414,863
Miami	$819,770	$265,233	$116,486	$22,057	$41,539	$10,309	$54,570	$1,329,964
Osage	$392,611	$111,968	$15,414	$17,345	$25,749	$10,770	$18,559	$592,416
Shawnee	$4,306,889	$2,237,525	$546,253	$39,816	$281,705	$240,146	$175,003	$7,827,337
Subtotal	**$6,793,430**	**$3,130,496**	**$895,974**	**$140,782**	**$419,921**	**$300,974**	**$337,716**	**$12,019,293**
Mitigation Planning Region K								
Atchison	$461,919	$234,893	$173,580	$18,748	$31,437	$8,163	$18,263	$947,003
Brown	$246,314	$142,548	$45,063	$18,467	$18,445	$8,968	$12,588	$492,393
Doniphan	$193,822	$73,843	$31,080	$18,514	$9,006	$6,047	$58,976	$391,288
Douglas	$2,494,254	$1,089,023	$392,086	$34,900	$120,529	$43,856	$170,631	$4,345,279
Jackson	$307,165	$98,273	$34,270	$15,510	$17,712	$13,452	$12,943	$499,325
Jefferson	$459,870	$114,889	$48,033	$15,249	$24,020	$15,011	$18,997	$696,069
Marshall	$255,546	$119,682	$89,444	$30,922	$22,783	$7,518	$15,232	$541,127
Nemaha	$245,437	$120,599	$54,566	$32,775	$15,788	$7,786	$16,177	$493,128
Washington	$133,484	$69,033	$11,540	$27,159	$14,036	$5,404	$10,056	$270,712
Subtotal	**$4,797,811**	**$2,062,783**	**$879,662**	**$212,244**	**$273,756**	**$116,205**	**$333,863**	**$8,676,324**

County	Residential ($1,000s)	Commercial ($1,000s)	Industrial ($1,000s)	Agriculture ($1,000s)	Religion ($1,000s)	Government ($1,000s)	Education ($1,000s)	Total ($1,000s)
Mitigation Planning Region L								
Johnson	$16,411,492	$8,556,170	$2,361,961	$112,125	$612,676	$160,661	$428,039	$28,643,124
Leavenworth	$1,965,410	$622,375	$130,698	$27,384	$81,685	$46,187	$119,213	$2,992,952
Wyandotte	$4,161,308	$2,573,106	$1,049,118	$22,467	$346,313	$72,009	$196,832	$8,421,153
Subtotal	**$22,538,210**	**$11,751,651**	**$3,541,777**	**$161,976**	**$1,040,674**	**$278,857**	**$744,084**	**$40,057,229**
Statewide Total	**$70,063,733**	**$35,309,400**	**$13,406,197**	**$2,140,514**	**$4,078,838**	**$1,534,947**	**$3,699,755**	**$130,233,384**

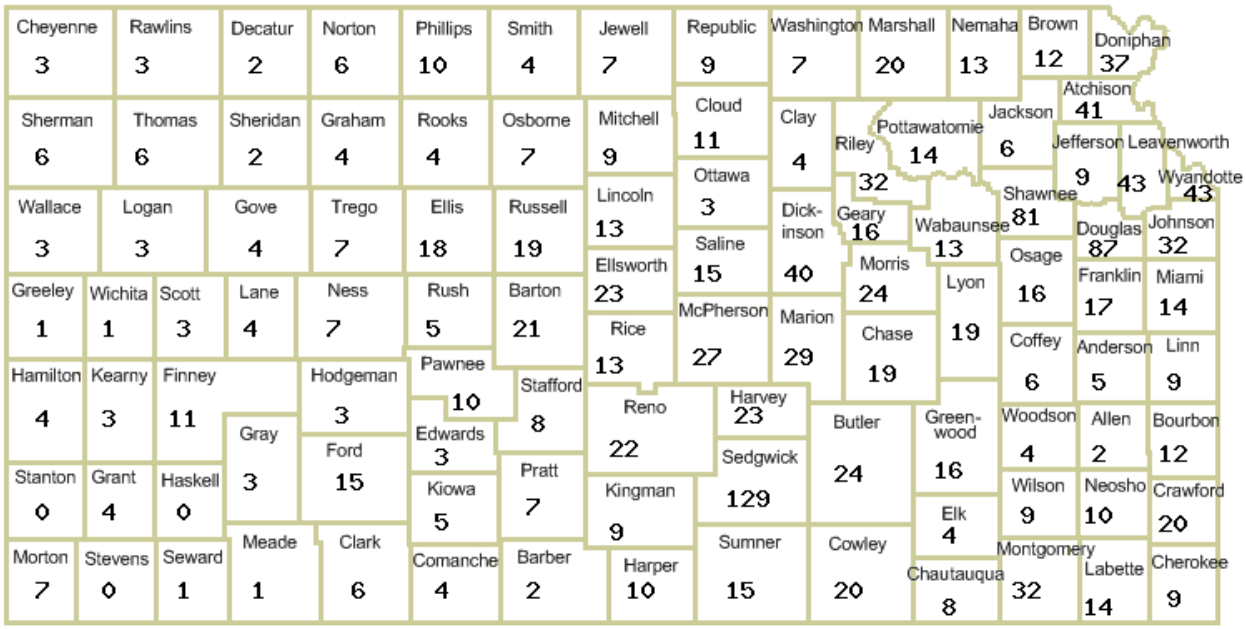
Figure 3.7. Total Building Exposure (Structure and Content Values)



Cultural Resources

In addition to information on the number and values of buildings exposed to potential hazards by county, the State has also included data on the number of historic resources in each county. The State and local jurisdictions should consider historic and cultural resources when developing mitigation strategies. **Figure 3.8** provides the number of National and State Historic Register Listings in Kansas, by County.

Figure 3.8. National and State Register Listings in Kansas, by County



Source: Kansas Historical Society, http://www.kshs.org/natreg/natreg_listings/map

3.2. Hazard Identification

Requirement §201.4(c)(2)(i): The state risk assessment shall include an] overview of the type…of all natural hazards that can affect the State.

This section identifies the natural, technological and manmade hazards that pose a threat to Kansas and defines the current priority for attention assigned to each by the KHMT based on the profiles and vulnerability assessments. In presenting these decisions, it is first important to recognize how the decisions were formulated.

As an interagency state level committee, the KHMT represents a broad range of expertise and interest related to hazard mitigation. When considering the human, economic and environmental impacts of disasters and emergencies, the origin of the event is not as significant as its effect. Therefore, the KHMT chose to address natural, technological and manmade hazards, recognizing that mitigation efforts for one may be beneficial for the others. In its initial process to identify and categorize the hazards threatening Kansas, the KHMT worked as a single group, exchanging information and viewpoints during a facilitated consensus process to reach decisions on the hazards to be addressed and the priority for each. The intent of the analysis was an objective assessment of the vulnerability of the State of Kansas to each hazard under discussion.

In deciding to discuss hazards as individual hazards, it must be emphasized that this division is somewhat artificial and used only to facilitate analyses. That is, one hazard event can result in another different hazard event. For example, drought can lead to wildfire, soil erosion and dust; severe winter storms and high wind events often cause utility and infrastructure failures. Similarly, some hazards can occur simultaneously, as the result of the same storm (e.g., tornado, hailstorm, lightning, flood and windstorm).

Methodology

Based on the experience of the representatives of the participating agencies of the KHMT, the hazards identified in the previous plans have been revisited, reevaluated, reorganized and reprioritized to reflect the hazards environment in Kansas at the time of the 2013 plan update. Twenty-two hazards have been identified as threatening to all or significant portions of the state of Kansas, and pose a sufficient level of human, economic and/or environmental risk to the communities of the State that they warrant incorporation into the Kansas Hazard Mitigation Plan.

Listed alphabetically, these hazards are:

Agricultural Infestation	Hailstorm	Soil Erosion and Dust
Civil Disorder	Hazardous Materials	Terrorism/Agri-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.

In the previous plan and in this plan, the State used the methodology from the MitigationPlan.com planning tool to prioritize the 22 hazards. This prioritization was based on a Calculated Priority Risk Index (CPRI) that considered four elements of risk: probability, magnitude/severity, warning time and duration. **Table 3.23** defines the levels for each element of risk.

For the 2013 Mitigation Plan update, the committee determined that Fog would be excluded from the new plan. Many local plans chose to eliminate fog from consideration in their mitigation planning efforts. Although when the right conditions are present, fog can present a hazard, the KHMT determined that due to the many variables associated with fog, it is difficult to evaluate this hazard it terms of probability and duration. In addition, it is difficult to mitigate damages from fog in Kansas. Another change to the list of hazard is that the KHMT decided that Civil Disorder should be evaluated as a hazard separate from Terrorism/Agri-terrorism. So, with the removal of Fog and the separation of Civil Disorder as a stand-alone hazard, there are still 22 hazards identified by the KHMT as being relevant for Hazard Mitigation Planning in Kansas.

Table 3.23. Calculated Priority Risk Index (CPRI) Element Definitions

Element/Level	Characteristics
Probability*	
4 - Highly Likely	Event is probable within the calendar year Event has up to 1 in 1 year chance of occurring (1/1=100%) History of events is greater than 33% likely per year Event is "Highly Likely" to occur
3 - Likely	Event is probable within the next three years Event has up to 1 in 3 years chance of occurring (1/3=33%) History of events is greater than 20% but less than or equal to 33% likely per year Event is "Likely" to occur
2 - Possible	Event is probable within the next five years Event has up to 1 in 5 years chance of occurring (1/5=20%) History of events is greater than 10% but less than or equal to 20% likely per year Event could "Possibly" occur
1 - Unlikely	Event is possible within the next 10 years Event has up to 1 in 10 years chance of occurring (1/10=10%) History of events is less than or equal to 10% likely per year Event is "Unlikely" but 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
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	Less Than 6 Hours
3	6-12 Hours
2	12-24 Hours
1	24+ Hours
Duration	
4	More Than 1 Week
3	Less Than 1 Week
2	Less Than 1 Day
1	Less Than 6 Hours

* Based on history, using the definitions given, the likelihood of future events is quantified.
** According to the severity associated with past events or the probable worst case scenario possible in the state.

Using the levels described in **Table 3.23**, the following formula was 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) The CPRI does have some limitations as the number of fatalities and injuries are not a calculated element, and thus cannot alter the rating.

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

All listed hazards, and their corresponding CPRI ranking methodology was reviewed and verified by all members of the KHMT during recorded mitigation meetings. The CPRI index was approved for the 2013 State mitigation planning update during the September 2012 KHMT meeting.

In addition to CPRI, the mitigation plan also incorporated hazard rankings from all approved Kansas Local Mitigation Plans into its Risk Assessment strategy.

The hazard ranking was based on the CPRI for the State as a whole. When examining various regions of the State, the same ranking does not always apply. **Table 3.24** indicates the ranking established by the State using the method described above.

Table 3.24. Kansas Hazard Rankings

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Flood	4	3	3	3	3.45	High
Tornado	4	3	4	1	3.40	High
Windstorm	4	3	3	2	3.35	High
Winter Storm	4	3	2	3	3.30	High
Wildfire	4	2	4	2	3.20	High
Agricultural Infestation	4	2	1	4	2.95	Moderate
Hailstorm	4	2	3	1	2.95	Moderate
Hazardous Materials	4	1	4	2	2.90	Moderate
Utility/Infrastructure Failure	3	2	4	3	2.85	Moderate
Drought	3	3	1	4	2.80	Moderate
Civil Disorder	1	4	4	4	2.65	Moderate
Expansive Soils	4	1	1	4	2.65	Moderate
Land Subsidence	4	1	1	4	2.65	Moderate
Major Disease Outbreak	2	4	1	4	2.65	Moderate
Terrorism/Agri-terrorism	1	4	4	4	2.65	Moderate

Hazard Type	Probability	Magnitude	Warning Time	Duration	CPRI	Planning Significance
Lightning	4	1	2	1	2.50	Moderate
Extreme Temperatures	3	2	1	3	2.40	Moderate
Dam and Levee Failure	1	4	2	4	2.35	Moderate
Landslide	3	1	3	1	2.20	Moderate
Radiological	1	3	2	3	1.95	Low
Soil Erosion and Dust	2	1	1	4	1.75	Low
Earthquake	1	2	4	1	1.75	Low

Beneficial to the identification process was information about historical hazard events in Kansas. This information came largely from state and federal agencies. One of the most useful resources was FEMA's list of presidential disaster declarations for the State of Kansas. This list, which also indicates the increased number of disaster declarations in recent years, is presented in **Table 3.25**.

Table 3.25. Kansas Presidential Declarations May 1955 – May 2013

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
Major Disaster Declarations				
4112	04/26/2013 (02/20-02/23/2013)	Snowstorm	Barber, Barton, Dickinson, Ellis, Franklin, Harper, Harvey, Hodgeman, Kingman, Marion, McPherson, Ness, Osage, Osborne, Pawnee, Phillips, Pratt, Rice, Rooks, Rush, Russell, Smith and Stafford.	$1,102,861 (Estimate)
4063	05/24/2012 (4/14-4/15/2012)	Severe Storms, Tornadoes, Straight-line Winds and Flooding	Edwards, Ellsworth, Harper, Hodgeman, Jewell, Kiowa, Mitchell, Osborne, Rice, Rush, Russell, Sedgwick, Stafford and Sumner	$6,923,919
4035	09/23/2011 (6/1-8/1/2011)	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	$7,462,881
4010	07/29/2011 (5/19-6/4/2011)	Severe Storms, Straight-line Winds, Tornadoes and Flooding	Barton, Clay, Cloud, Hamilton, Jewell, Lincoln, Logan, Lyon, Marion, Mitchell, Morton, Osage, Osborne, Ottawa, Pottawatomie, Republic, Riley, Rooks, Rush, Russell, Sherman, Smith, Stafford, Stanton and Washington	$8,259,620
1932	08/10/2010 (6/7-7/21/2010)	Severe Storms, Flooding and Tornadoes	Atchison, Brown, Butler, Chase, Cheyenne, Clay, Cloud, Comanche, Decatur, Doniphan, Elk, Ellis, Franklin, Greenwood, Harvey, Jackson, Jewell, Kiowa, Lyon, Marion, Marshall, McPherson, Miami, Mitchell, Morris, Norton, Osage, Osborne, Pawnee, Phillips, Pottawatomie, Republic, Riley, Rooks, Rush, Sheridan, Smith, Wabaunsee, Washington, Wilson and Woodson	$9,279,257

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
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
1868	12/23/2009 (11/14-11/16/2009)	Severe Winter Storm	Marshall, Republic and Washington	$43,217,690
1860	09/30/2009 (7/8-7/14/2009)	Severe Storms and Flooding	Anderson, Bourbon, Franklin, Linn and Sedgwick	$3,347,662
1849	06/25/2009 (4/25-5/16/2009)	Severe Storms, Flooding, Straight-line Winds, and Tornadoes	Anderson, Barber, Bourbon, Butler, Chase, Cherokee, Coffey, Cowley, Crawford, Elk, Finney, Greenwood, Harper, Harvey, Kingman, Labette, Linn, Lyon, Marion, Marshall, Montgomery, Morris, Neosho, Reno, Rice, Sumner, Wabaunsee and Wilson	$15,013,488
1848	06/24/2009 (3/26-29/2009)	Severe Winter Storm and Record and Near Record Snow	Butler, Chase, Chautauqua, Coffey, Cowley, Dickinson, Elk, Grant, Greenwood, Harvey, Lyon, Marion, Morris, Sumner, and Woodson	$20,174,657
1808	10/31/2008	Severe Storms, Flooding, and Tornadoes	Anderson, Butler, Chase, Cowley, Greenwood, Harper, Harvey, Russell, and Sumner	$4,167,044
1776	07/09/2008	Severe Storms, Flooding, and Tornadoes	Barber, Barton, Bourbon, Brown, Butler, Chautauqua, Cherokee, Clark, Clay, Comanche, Cowley, Crawford, Decatur, Dickinson, Edwards, Elk, Ellis, Ellsworth, Franklin, Gove, Graham, Harper, Haskell, Hodgeman, Jackson, Jewell, Kingman, Kiowa, Lane, Linn, Logan, Mitchell, Montgomery, Ness, Norton, Osborne, Pawnee, Phillips, Pratt, Reno, Republic, Riley, Rooks, Rush, Saline, Seward, Sheridan, Smith, Stafford, Sumner, Thomas, Trego, Wallace and Wilson	$70,629,544
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

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
1711	7/2/2007 (6/26-30/2007)	Severe Storms and Flooding	Allen, Anderson, Bourbon, Butler, Chautauqua, Cherokee, Coffey, Cowley, Crawford, Edwards, Elk, Franklin, Greenwood, Harper, Labette, Linn, Miami, Montgomery, Neosho, Osage, Pawnee, Wilson, Woodson	$40,238,600
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
1675	1/7/2007 (12/28-30/2006)	Severe Winter Storm	Cheyenne, Clark, Comanche, Decatur, Edwards, Ellis, Finney, Ford, Gove, Graham, Grant, Gray, Greeley, Hamilton, Haskell, Hodgeman, Jewell, Kearny, Kiowa, Lane, Logan, Meade, Morton, Ness, Norton, Osborne, Pawnee, Phillips, Rawlins, Rooks, Rush, Russell, Scott, Seward, Sheridan, Sherman, Smith, Stafford, Stanton, Stevens, Thomas, Trego, Wallace, Wichita	$315,201,639
1638	4/14/2006 (3/12-13/2006)	Severe Storms, Tornadoes, and Straight-Line Winds	Douglas, Wyandotte	$6,233,044
1626	1/26/2006 (11/27-28/2005)	Severe Winter Storm	Cheyenne, Decatur, Edwards, Gove, Graham, Hodgeman, Ness, Norton, Pawnee, Phillips, Rawlins, Rooks, Rush, Sheridan, Sherman, Thomas, Trego	$50,281,517
1615	11/21/2005 (10/1-2/2005)	Severe Storms and Flooding	Atchison, Jackson, Jefferson, Leavenworth, Shawnee	$10,286,064
1600	8/23/2005 (6/30-7/1/2005)	Severe Storms and Flooding	Cherokee, Crawford, Neosho	$4,344,569
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

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
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
1366	4/27/2001 (4/21/2001)	Severe Storms and Tornado	Barton	$4,730,957
1327	5/3/2000 (4/19/2000)	Severe Storms and Tornadoes	Crawford, Labette, Neosho	$2,542,209
1273	5/4/1999 (5/3/1999)	Tornadoes and Severe Storms	Reno, Sedgwick, Sumner	$9,121,870
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	$16,688,650
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	$9,770,769
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
903	4/29/1991 4/26-5/19/1991)	Severe Storm, Tornado	Butler, Cowley, Jefferson, Sedgwick, Wabaunsee, Washington	$4,862,790
780	10/22/1986 (10/2-10/4/1986)	Severe Storms, Flooding	Allen, Bourbon, Chautauqua, Cherokee, Cowley, Elk, Labette, Montgomery, Neosho, Wilson	$2,344,121
714	6/22/1984 (6/7-6/9/1984)	Severe Storms, Tornadoes, Flooding	Atchison, Brown, Doniphan, Jackson, Nemaha, Pottawatomie	$5,002,299
663	6/28/1982	Severe Storms, Flooding	Jackson, Shawnee	$804,048
644	7/18/1981	Severe Storms, Flooding, Tornadoes	Barton, Douglas	$670,436
588	6/15/1979	Severe Storms, Flooding	Butler, Cowley	$1,056,090
539	9/20/1977	Severe Storms, Flooding	Atchison, Brown, Doniphan, Jackson, Jefferson, Johnson, Leavenworth, Nemaha, Shawnee, Wyandotte	$4,041,566

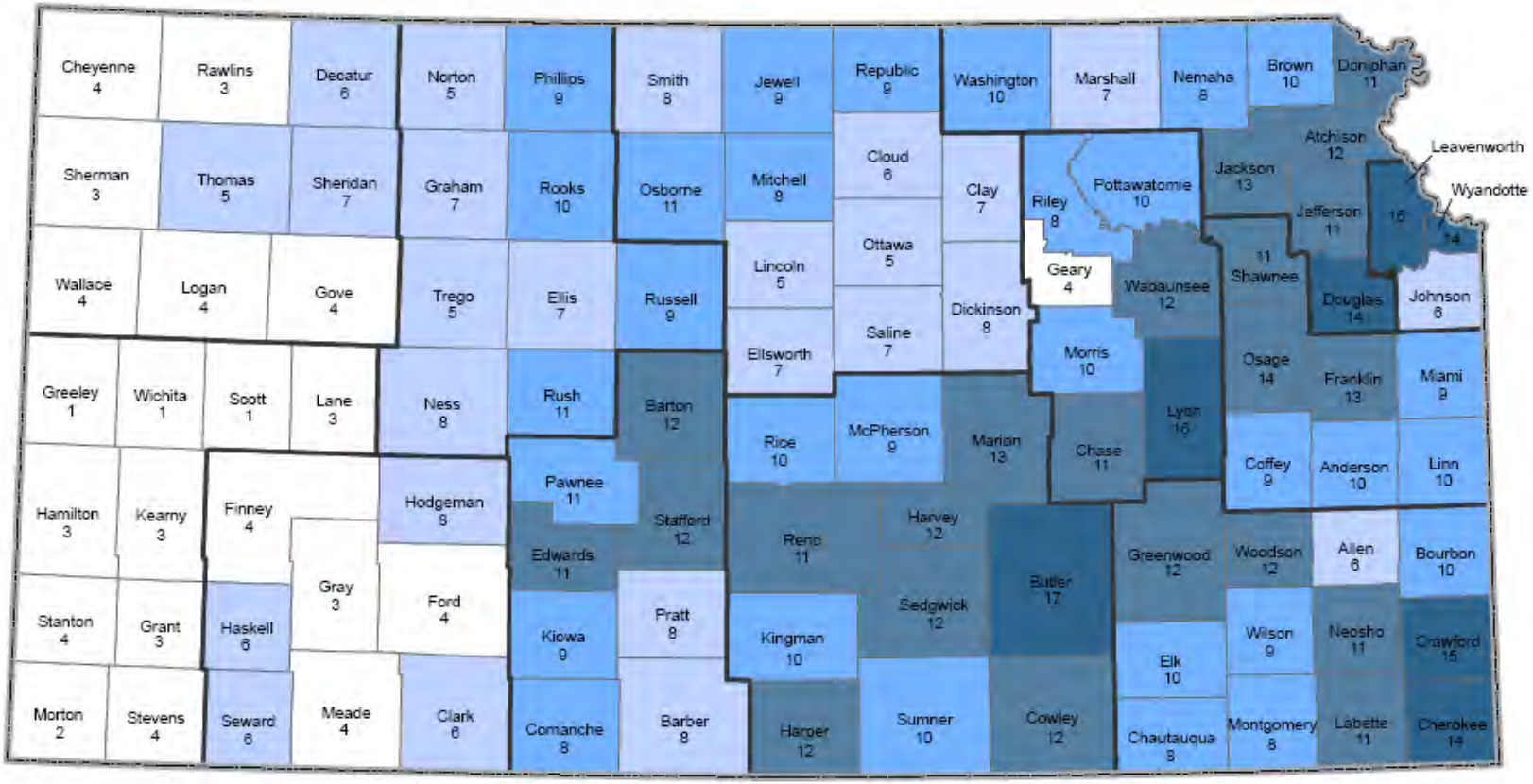
Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
514	7/13/1976	Severe Storms, High Winds, Flooding	Butler, Cherokee, Crawford, Cowley, Elk, Greenwood, Labette, Neosho, Montgomery, Wilson	$1,794,942
442	6/10/1974	Severe Storms, Flooding	Lyon	$298,560
403	9/28/1973	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
219	6/10/1966	Tornadoes, Severe Storms	Riley, Shawnee	$2,856,131
201	6/23/1965	Flooding	Barton, Butler, Chase, Edwards, Finney, Ford, Grant, Gray, Greenwood, Hamilton, Harvey, Kearny, Lyon, Marion, McPherson, Pawnee, Reno, Rice, Sedgwick, Stafford, Stanton	$1,046,450
88	11/6/1958	Floods	Atchison, Clay, Cloud, Nemaha, Republic, Washington	$121,504
81	9/5/1957	Floods	n/a	$66,816
34	5/27/1955	Tornado	Cowley	$294,167

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
Emergency Declarations				
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
3126	6/9/1998	Grain Elevator Explosion	Harvey, Sedgwick	$972,216
Fire Management Assistance Declarations				
2878	4/3/2011	Haskell County Fire	Haskell and Stevens	n/a
2632	3/30/2006	Obee Fire	Reno	n/a

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

Figure 3.9 and **Figure 3.10** are maps of Kansas showing the number of times every county in Kansas has been declared in Federal Disaster Occurrences which includes Presidential Declarations, Emergency Declarations, and Fire Management Assistance Declarations and State Disaster Occurrences.

Figure 3.9. Federal Disaster Occurrences 1998 through June 2013



Note: This map includes DR-4112-KS declared April 26, 2013

Figure 3.10. State Disaster Occurrences, 1991 through June 2013

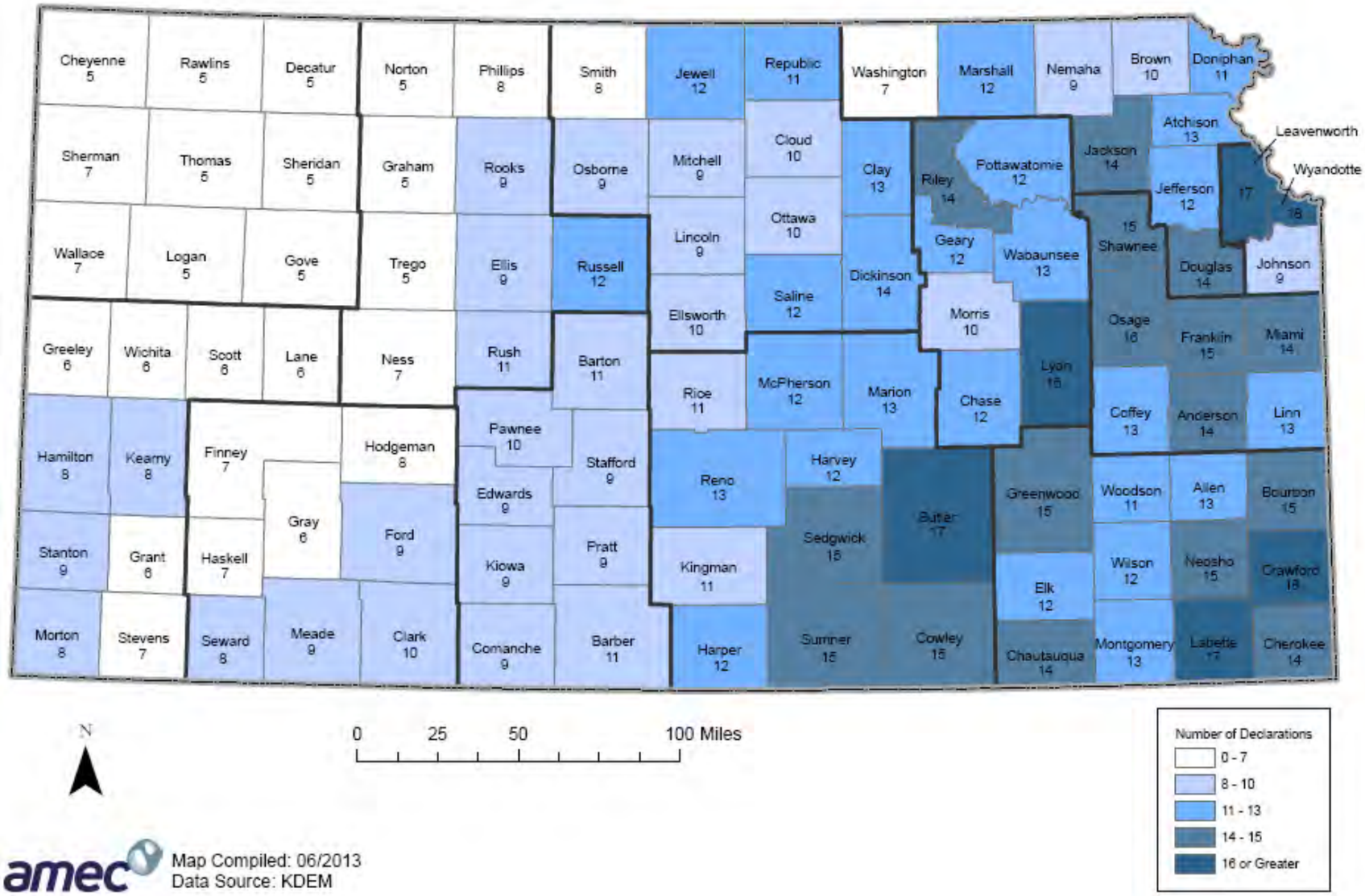


Table 3.26 lists the U.S. Department of Agriculture Secretarial Disaster Declarations and the disaster description for the State of Kansas for the period 2010-2012. Secretarial Disasters are designated from a natural disaster and have a minimum of 30 percent production loss of at least one crop in the county must have occurred.

Table 3.26. USDA Disaster Declarations in Kansas 2010-2012

Declaration Number	Declaration Date	Disaster Description	Counties Involved
S3339	08/7/2012	Drought-Fast Track	Primary: Nemaha, Contiguous: Brown, Jackson, Marshall, Pottawatomie
S3333	07/31/2012	Drought-Fast Track	Primary: Cherokee
S3330	07/31/2012	Drought-Fast Track	Primary: Jewell and Smith
S3315	07/24/2012	Drought-Fast Track	Primary: Norton, Phillips, Smith
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,
S3326	06/12/2012	Drought-Fast Track	Primary: Cherokee, Clay, Cloud, Jewell, Pottawatomie, Republic, Riley, Washington, Contiguous: Crawford, Dickinson, Geary, Jackson, Labette, Marshall, Mitchell, Nemaha, Osborne, Ottawa, Shawnee, Smith, Wabaunsee
S3299	04/1/2012	Drought and Heat	Primary: Missouri counties, Contiguous: Atchison, Bourbon, Cherokee, Crawford, Doniphan, Johnson, Leavenworth, Linn, Miami, Wyandotte
S3260	01/1/2012	Drought, High Winds, & Heat	Primary: Colorado counties, Contiguous: Cheyenne, Greeley, Hamilton, Morton, Sherman, Stanton, Wallace
S3281	01/1/2012	Drought-Fast Track	Primary: Nebraska counties, Contiguous: Cheyenne, Decatur, Norton, Phillips, Rawlins
S3358	01/1/2012	Drought, Heat, High Winds	Primary: Marshall, Contiguous: Nemaha, Pottawatomie, Riley, Washington
S3359	01/1/2012	Drought, Heat, High Winds	Primary: Nebraska counties, Contiguous: Brown, Doniphan, Jewell, Marshall, Nemaha, Republic, Washington
S3284	01/1/2012	Drought-Fast Track	Primary: Oklahoma counties, Contiguous: Barber, Chautauqua, Cherokee, Clark, Comanche, Cowley, Harper, Labette, Meade, Montgomery, Morton, Seward, Stevens, Sumner
S3279	01/1/2012	Drought-Fast Track	Primary: Missouri counties, Contiguous: Linn and Miami
S3276	01/1/2012	Drought-Fast Track	Primary: Allen, Anderson, Barber, Barton, Bourbon, Butler, Chautauqua, Cheyenne, Clark, Coffey, Comanche, Cowley, Crawford, Decatur, Edwards, Elk, Finney, Ford, Gove, Graham, Grant, Gray,

Declaration Number	Declaration Date	Disaster Description	Counties Involved
			Greeley, Greenwood, Hamilton, Harper, Harvey, Haskell, Hodgeman, Kearny, Kingman, Kiowa, Labette, Lane, Linn, Logan, McPherson, Meade, Montgomery, Morton, Neosho, Ness, Norton, Pawnee, Phillips, Pratt, Rawlins, Reno, Rice, Rooks, Scott, Sedgwick, Seward, Sheridan, Sherman, Stafford, Stanton, Stevens, Sumner, Thomas, Trego, Wallace, Wichita, Wilson, Woodson Contiguous: Chase, Cherokee, Dickson, Ellis, Ellsworth, Franklin, Marion, Miami, Morris, Osage, Osborne, Rush, Russell, Saline, Smith, Wabaunsee
S3209	12/08/2011	Severe Storms, Thunderstorms, Hail & High Winds	Primary: Missouri counties: Contiguous: Atchison, Doniphan, Leavenworth, Wyandotte
S3198	11/09/2011	Drought & Excessive Heat	Primary: Oklahoma counties; Contiguous: Chautauqua, Cherokee, Labette, Montgomery
S3196	11/09/2011	Flood, Excessive Rain, Severe Storms, Hail and High Winds	Primary: Nebraska counties; Contiguous: Rawlins
S3190	10/27/2011	Excessive Rain, High Winds & Lightning	Primary: Cheyenne; Contiguous: Barton, Ellsworth, McPherson, Rawlins, Reno, Rice, Sherman, Stafford,
S3186	10/14/2011	Drought & excessive heat	Primary: Missouri counties; Contiguous: Atchison, Bourbon, Cherokee, Crawford, Johnson, Leavenworth, Linn, Miami, Wyandotte
S3176	10/14/2011	Hail, High Winds, Tornadoes	Primary: Nebraska counties; Contiguous: Cheyenne
S3167	09/20/2011	Drought, High Winds & Excessive Heat	Primary: Allen, Anderson, Barton, Bourbon, Chase, Chautauqua, Cherokee, Coffey, Cowley, Crawford,, Elk, Ellsworth, Franklin, Greenwood, Labette, Linn, Lyon, Montgomery, Neosho, Pawnee, Rush, Wilson, Woodson; Contiguous: Barton, Cowley, Edwards, Ellis, Hodgeman, Lincoln, McPherson, Marion, Miami, Morris, Ness, Osage, Rice, Russell, Saline, Stafford, Wabaunsee
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
S2983	03/18/2010	Flood, Excessive Rain, Frost	Primary: Chautauqua, Cherokee, Crawford, Elk, Greenwood, Labette, Montgomery, Neosho; Contiguous: Allen, Bourbon, Butler, Chase, Coffey, Cowley, Lyon, Wilson, Woodson
S2989	04/11/2010	Excessive Rain	Primary: Allen, Linn; Contiguous: Anderson, Bourbon, Coffey, Franklin, Miami, Neosho, Wilson, Woodson
S3019	08/20/2010	Flood, Excessive Rain, Hail, High Winds, Tornadoes, Lightning	Primary: Chase, Cloud, Gove, Jewell, Lyon, Marshall, Rooks, Smith, Trego; Contiguous: Butler, Clay, Coffey, Ellie, Graham, Greenwood, Lane, Logan, Marion, Mitchell, Morris, Nemaha, Ness, Osage, Osborne, Ottawa, Phillips, Pottawatomie, Republic, Riley, Scott, Sheridan, Thomas, Wabaunsee, Washington
S3020	08/20/2010	Flood, Excessive Rain,	Primary: Missouri counties; Contiguous: Atchison,

Declaration Number	Declaration Date	Disaster Description	Counties Involved
		High Winds	Bourbon, Crawford, Doniphan, Johnson, Leavenworth, Linn, Wyandotte
S3030	09/07/2010	Flood, Excessive Rain, Hail, High Winds	Primary: Osborne, Republic; Contiguous: Cloud, Ellie, Jewell, Lincoln, Mitchell, Rooks, Russell, Smith, Washington
S3041	09/30/2010	Severe Storms, Hail, Tornadoes	Contiguous: Cheyenne
S3050	11/04/2010	Flood, Excessive Rain, Hail, High Winds	Primary: Greeley, Thomas; Contiguous: Decatur, Gove, Hamilton, Logan, Rawlins, Sheridan, Sherman, Wallace, Wichita
S3054	11/12/2010	Drought	Primary: Missouri counties; Contiguous: Linn, Miami
S3061	11/26/2010	Drought. Excessive Heat	Primary: Rooks; Contiguous: Ellis, Graham, Osborne, Phillips, Smith, Trego
S3080	12/27/2010	Drought, High Winds, Excessive Heat	Primary: Oklahoma counties; Contiguous: Barber, Clark, Comanche, Harper, Morton

Source: U.S. Department of Agriculture

3.3. Hazard Profiles and State Risk Assessment

Requirement §201.4(c)(2)(i): [The state risk assessment shall include an overview of the] location of all natural hazards that can affect the state, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate.

Requirements §201.4(c)(2)(ii) and §201.4(c)(2)(iii): The state risk assessment shall include an] overview and analysis of the state's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The state shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events.

[The state risk assessment shall include an] overview and analysis of potential losses to identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment.

Requirement for Update §201.4(d): Plan must be reviewed and revised to reflect changes in development.

The risks posed by the hazards identified in **Section 3.2**, Hazard Identification are considered sufficient by the Kansas Hazard Mitigation Team. The general level of risk posed to the people, property, and the environment and economy of the affected communities should be evaluated as part of the statewide mitigation planning effort. General profiles for each of these hazards were compiled for the previous plans. These profiles have been updated for the 2013 plan update.

Each profile describes the hazard and its potential impacts, its location in the State, previous occurrences, and its probability of future hazard events. Profiles then go on to explore state vulnerability analysis, state estimates of potential losses, development in hazard prone areas and the hazard impact overview. The magnitude of the impact caused by a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment. This is a function of when the event occurs, the jurisdictions and community sectors affected, the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

The level of information presented in the profiles varies by hazard based on the amount of information available. Resources used to compile these profiles can be found at the end of the chapter. With each update of this plan, new information will be incorporated to provide an improvement in evaluation and prioritization of the hazards that affect Kansas.

General 2013 Update Changes

For this 2013 Hazard Mitigation update, each profile was updated with more historical impact information and there is a new section, Consequence Analysis, which is the result of the Emergency Management Accreditation Program (EMAP) hazard impact analysis. Where data is presented by county, the Mitigation Planning Region is indicated. For most of the tables, the counties are sorted by Mitigation Planning Region and then alphabetically within the planning region. The vulnerability assessment and state estimates of potential losses have been

expanded for all hazards addressed in the plan where sufficient data is available. In addition, statewide flood and earthquake losses have been quantified using HAZUS-MH. There are no appendices of vulnerability analysis. For a more detailed summary of revisions in this update, see Chapter 2.

Data Presented by Mitigation Planning Region

Where data is presented by county, the Mitigation Planning Region is indicated. For most of the tables, the counties are sorted by Mitigation Planning Region and then alphabetically within each planning region. This organization was done to facilitate use of data within regional plans.

EMAP Consequence Analysis

A consequence analysis of the potential for detrimental impacts of hazard was conducted for the Emergency Management Accreditation Program (EMAP) and added as Appendix Z to the 2010 State Hazard Mitigation Plan. The Consequence Analysis, or Hazard Impacts, was not originally included in the 2010 State Hazard Mitigation Plan (SHMP). Since that plan‘s review and approval by FEMA, the State completed the Consequence Analysis as this amended appendix based on the EMAP standard Published in September 2010. The results of the EMAP consequence analysis are presented in each hazard profile‘s Consequence Analysis Section.

In this analysis all 22 of the State of Kansas‘ hazards have been addressed, with the impacts that each will have on the following:

- 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 State 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 Kansas City 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 3.27** presents the methodology for determination of the ranking level (minimal, moderate, or severe)

Table 3.27. 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 on 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, lightning 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 State Risk Assessment that follow in are in alphabetical order by hazard title for ease of reference.

3.3.1. Agricultural Infestation

Calculated Priority Risk Index	Planning Significance
2.95	Moderate

Description/Location

Agricultural infestation is the naturally occurring infection of vegetation, crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption or use. Because of Kansas's overall substantial agricultural industry and related facilities and locations, the potential for infestation of crops or livestock poses a significant risk to the economy of the State. Kansas cropland is vulnerable to disease and other agricultural pests. Kansas farmers harvested an estimated 8.5 million acres of wheat, 3.6 million acres of corn, 2.8 million acres of hay and grass silage, 2.6 million acres of sorghum and 2.5 million acres of soybeans according to USDA figures in 2007. Kansas's total agricultural output reached $14.4 billion in 2007, with crops contributing $4.8 billion and livestock sales contributing $9.5 billion to that total (USDA National Agricultural Statistics Service, 2007 Census of Agriculture, (Note 2012 Census of Agriculture data will be available in early 2014)). Kansas was ranked #1 in wheat production in the U.S.

Kansas also has growers of sensitive and organic crops such as blueberries, grapes, fruit and nut trees, strawberries, tomatoes and cotton that are concerned about drift damage from commonly used pesticides. To help reduce the risk of pesticide drift damage, the Kansas Department of Agriculture hosts a sensitive crop registry at http://www.ksda.gov/pesticides_fertilizer/content/177 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.

A certain level of agricultural infestation is normal in Kansas. The concern is when the level of an infestation escalates suddenly, or a new infestation appears, overwhelming normal control efforts. The levels and types of agricultural infestation appear to vary by many factors, including cycles of heavy rains and drought.

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

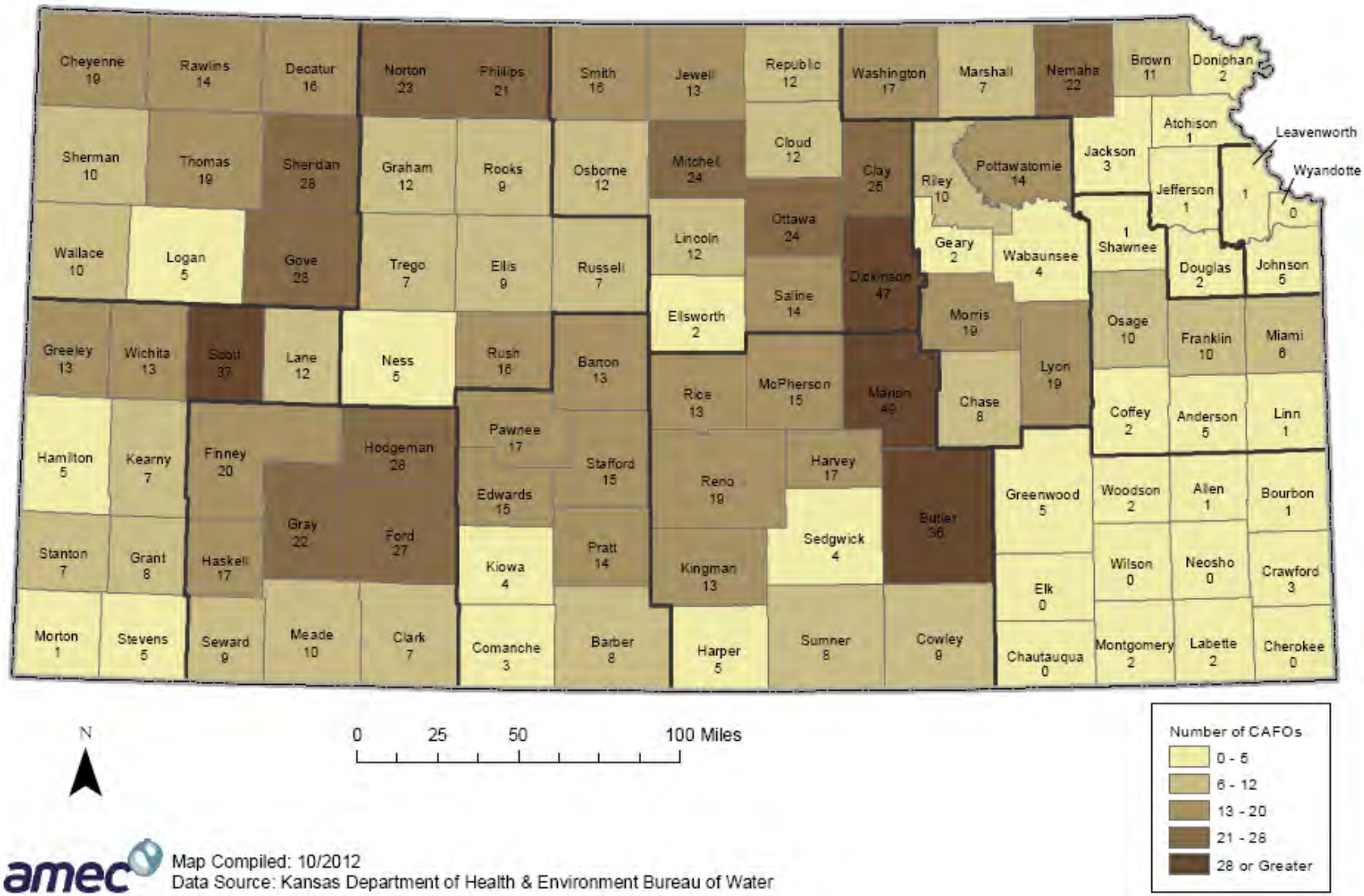
Agricultural incidents are naturally occurring infection of livestock with insects, vermin, or diseases that render the livestock unfit for consumption or use. Kansas continues to be a ~~free~~" state, which means it is Brucellosis, Tuberculosis and Pseudorabies free.

In 2007, the State of Kansas ranked second in the U.S. for cattle and calves livestock inventory with 6.6 million and the hogs and pig‘s inventory was 1.8 million. With this substantial agricultural industry and related facilities throughout the State, the potential for infestation of livestock poses a significant risk to the Kansas economy.

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 Kansas. 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

Figure 3.11 shows the number of active beef Confined Animal Feeding Operations (CAFO) facilities with 300 or more animal units per county in Kansas. The CAFO facilities are regulated by the Kansas Department of Health & Environment, Bureau of Water, Livestock Waste Management. The counties with the most active beef CAFO facilities with 300 or more animals are Marion with 49 facilities, Dickinson with 47 facilities, Scott with 37 facilities, and Butler with 36 facilities.

Figure 3.11. Active Number of Beef Confined Animal Feeding Operations (CAFO) Facilities



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

A plant disease outbreak or a pest infestation could negatively impact crop production and agriculturally dependent businesses. An extreme outbreak or infestation could potentially result in billions of dollars in production losses. The cascading net negative economic effects could result in wide-spread business failures, reduction of tax revenues, harm to other state economies, and diminished capability for this country to compete in the global market.

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 Kansas are also subject to various types of infestation. Significant wheat crop losses because of these diseases are well documented in various areas of Kansas. Sorghum losses can occur when a crop is infected with sooty stripe early in the growing season. 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 Kansas:

- **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. It has not been detected in Kansas yet.

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.

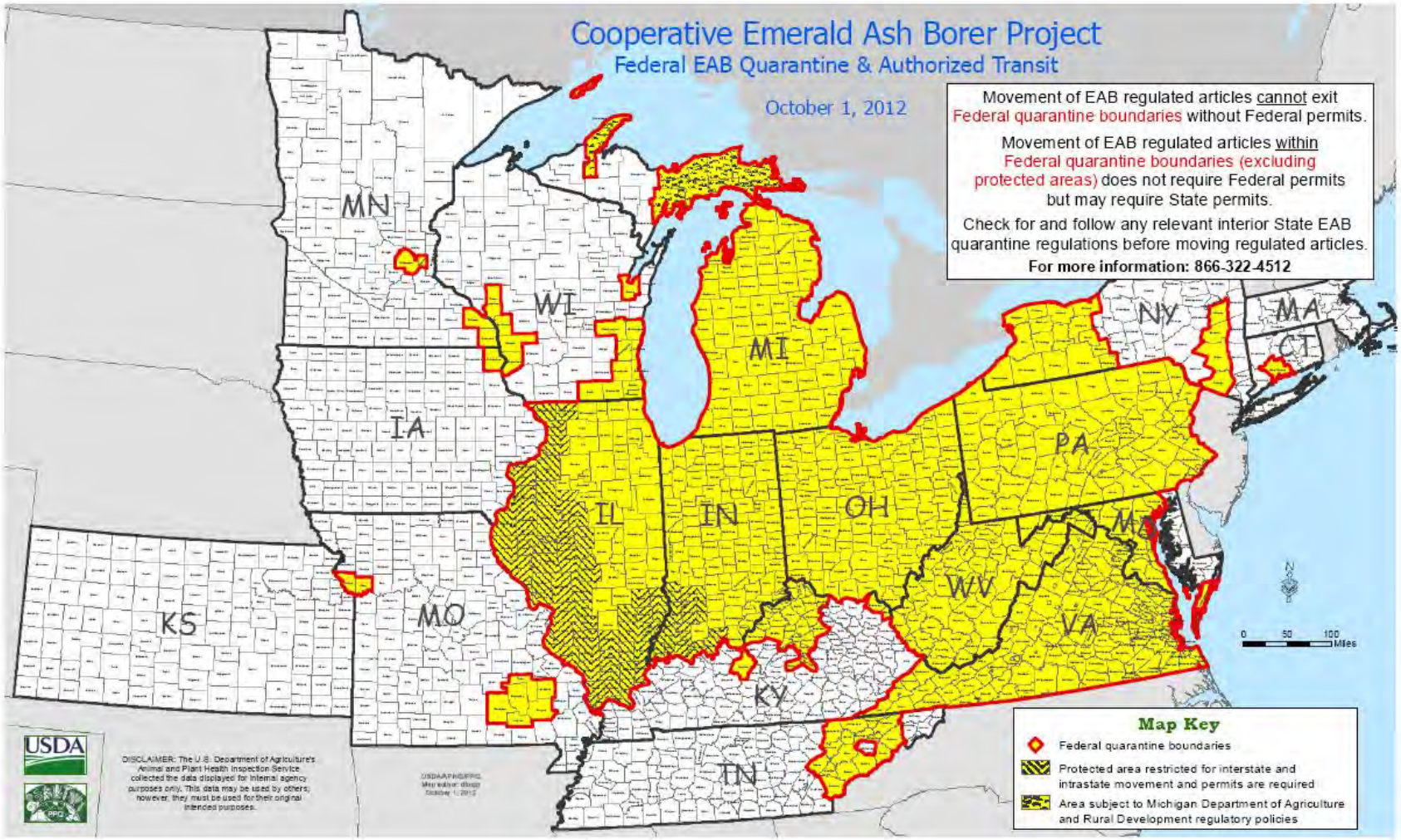
Emerald ash borer is a pest of ash trees native to Asia. This pest is a slender, emerald green beetle that is ½ inch long, and responsible for the destruction of approximately 20 million ash trees in Indiana, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, 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 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 3.12 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 3.12. 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

Kansas 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.

All agricultural and urban areas in Kansas are subject to agricultural infestations. The central and western parts of the State are more susceptible to crop and livestock infestation. This corresponds with the areas of the State with heavier utilization of the land for crops and rangeland.

In addition, there are several aspects of agricultural infestation that are directly parallel to the risk of agri-terrorism. Many experts fear that intentional, criminal introduction of a disease such as foot and mouth to one or more of Kansas stockyards would result in very rapid spread of the disease throughout the nation and could have very severe economic consequences to the industry. Additional information is provided about Agri-terrorism in **Section 3.3.17** Terrorism/Agri-Terrorism.

Previous Occurrences

The Kansas Department of Agriculture's *Kansas Cooperative Plant Disease Survey Report*, dated August 2012, reports annual wheat disease loss estimates starting from 1976 through 2012**. Figure 3.13** is the loss estimate percentages that began in 1976 and that have many peaks and valleys over the years that are associated with disease epidemics and weather conditions. The trend is a steady decline in the wheat disease losses, though the losses in 2012 were above average of 10.7 percent. Stripe rust was the dominant disease of 2012 with a loss

estimate of 5.7 percent and then barley yellow dwarf virus and root infesting nematodes as the top three diseases of importance.

Figure 3.13. Annual Wheat Disease Loss Estimate Percentages from 1976 through 2012

Source: *Kansas Cooperative Plant Disease Survey Report*, http://www.ksda.gov/includes/document_center/plant_protection/Plant_Disease_Reports/2012KSWheatDiseaseLossEstimates.pdf, dated August 2012

Other Infestations

- **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.
- **Summer 2012:** Scrapie was found in two sheep at a regulatory slaughter test in Kansas. The sheep were from two unrelated flocks. There had not been any cases in Kansas for more than two years. In 2011, there had been no positive Scrapie cases on sheep slaughter surveillance.
- **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.

According to the USDA Risk Management Agency, insured crop losses through the State of Kansas as a result of insects, Aflatoxin, plant disease and wildlife foraging for the ten year period of 2002-2011 totaled $30,593,140. In **Table 3.28,** the USDA Risk Management Agency insured crop losses through the State of Kansas are shown by year, 2002-2011. It shows the

highest year of crop losses as 2006 in this 10-year period, then the years of 2008, 2011, and 2007. This information is also reported and annualized by county in **Table 3.31** in the State Estimates of Potential Losses Section. 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.

Table 3.28. Total Insured Crop Insurance Paid by Year, 2002-2011

Year	Crop Insurance Paid
2011	$2,501,308
2010	$1,905,403
2009	$1,766,449
2008	$4,648,900
2007	$2,399,839
2006	$13,655,542
2005	$1,268,425
2004	$1,044,862
2003	$754,677
2002	$647,736
Total	**$30,593,140**

Source: USDA Risk Management Agency, 2012

Probability of Future Hazard Events

The State experiences agricultural losses every year as a result of naturally-occurring diseases that impact animals/livestock. This hazard's CPRI probability is "Highly Likely".

Even though the probability of the hazard is "Highly Likely", it is also known that the acres of land in farms in decreasing in Kansas as see in **Table 3.29** and that trend is expected to continue in the future in Kansas. The decreased acres of land would decrease the acres of crops and number of livestock animals that could be infected with an infestation.

Table 3.29. Kansas Land in Farms

	2002	2007	2010	Percent change from 2002-2010
Land in Farms (acres)	47,227,944	46,345,827	46,200,000	-2.22%

Source: USDA, National Agricultural Statistics Service, 2007 and 2010

There is the possibility of the Thousand Cankers Disease, Asian Longhorned Beetle and Emerald Ash Borer pest spreading in Kansas. The State will ask for cooperation from the public, firewood dealers, arborists and the nursery industry to prevent further spreading. Preventing its introduction is far more cost-effective than trying to contain it as an established pest. The 1.5 million ash trees that occur in Kansas towns and cities will pose a great cost to Kansans in removal, stump grinding and replacement if the pest is found throughout the State.

State Vulnerability Analysis

According to the Kansas Department of Agriculture, Plant Protection and Weed Control Division, **Table 3.30** lists the highest risk plant pests to Kansas, their crop or host plant, the global

distribution of the pest, the Kansas acreage at significant risk and the type of loss. Several pests are capable of destroying the entire State's crop or plant.

Table 3.30. Highest Risk Plant Pests To Kansas

Pest (Disease Insect, or weed)	Crop or Host Plant	Distribution	Kansas Acreage at Significant Risk	Type of Loss
Rust, Austro-Asian	Soybean	Australia, Japan, Pacific, Gulf of Mexico	2 million acres in the eastern regions of Kansas	Direct Loss to production
Aspergillus ear rot (Alfatoxin)	Corn	Worldwide, endemic to Kansas	4-5 million acres	Toxin renders the grain unusable for human and animal feed
Black Stem Rust UG99 strain	Wheat	Africa, Asia	Entire state 9-10 million acres	Direct Loss to production
Blast – South American strains	Wheat	South America	Entire state 9-10 million acres	Direct Loss to production
Stripe Rust (new races)	Wheat	North America	Entire state 9-10 million acres	Direct Loss to production
Leaf Rust (new races)	Wheat	North America	Entire state 9-10 million acres	Direct Loss to production
Karnal Bunt	Wheat	Asia, Mexico, Arizona	Entire state 9-10 million acres	International export quarantines, flour quality
Thousand Cankers	Walnut	Western US states and PA, VA, Tenn	Entire state for logging trees and municipal shade trees	Death of municipal trees, loss of nut crop, loss of the most valuable timber tree
Emerald Ash Borer	Ash	North Central and North Eastern U.S., including Kansas (Wyandotte County)	Entire state. Urban corridors will be significantly impacted due to the high percentage of Ash planted.	Death of native and municipal trees. Cost of removal and revegetation. If tree is deemed important to keep, the cost of pesticide treatment.
Asian Longhorned Beetle	Maples, Birches, Willows, Mimosa, Ash, Sycamore, Poplar.	Small parts of Ohio, New York, and Massachusetts	Entire State	Death of native and municipal trees. Cost of removal and revegetation. Currently, no viable pesticide options.
Hydrilla	Water Bodies	Southern U.S. and one park pond in Olathe	All state water bodies	Economic and environmental. Large mats of vegetation cause problems with recreation, water intakes, etc. Easily spread through fragmentation.

Source: Kansas Department of Agriculture, Plant Protection and Weed Control Division, 2012

State Estimates of Potential Losses

Kansas has experienced $3,059,314 annually in USDA Risk Management Agency's insured crop losses as a result of agricultural infestation conditions during the ten-year period of 2002-2011. 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 3.31** is a list of the annualized crop insurance paid per county for

agricultural infestation. It also shows the State‘s concentration of the Top Livestock Inventory and Top Crop in Acres from USDA Census of Agriculture, 2007.

Figure 3.14 shows the Annualized Agricultural Infestation Crop Loss Damages per county. The counties of Grant, Haskell, Stanton, Stevens and Gray in southwestern Kansas have the highest annualized crop losses followed by Sumner, Washington and Marshall Counties.

There is a data limitation for the value of livestock animals that have been killed or euthanized from disease infestation. That data is not available for this planning effort and it is not summarized in this potential losses section.

Also the Kansas Forest Service has completed estimated samplings of the number of Ash trees in some counties in Kansas. There is no state-wide data on the number of ash trees that could be affected by the Emerald Ash Borer pest and thus there is no summarized data in this potential losses section.

Table 3.31. Total Insured Crop Insurance Paid per County from 2002-2011, Top Livestock Inventory Number and Top Crop in Acres from USDA Census 2007

County	Annualized Crop Insurance Paid for Agricultural Infestation Damages	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lambs, 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 A											
Cheyenne	$15,223	89	55,190	319	304	(D)	50,162	11,128	0	0	123,384
Decatur	$11,847	143	59,982	(D)	356	(D)	71,967	12,862	12,319	1,077	96,209
Gove	$21,936	72	78,555	22	601	6,789	63,730	14,997	50,513	3,914	106,086
Logan	$12,570	70	24,494	(D)	543	278	50,270	6,008	28,309	1,831	105,438
Rawlins	$19,884	635	29,966	85	301	none	37,494	15,180	30,565	2,437	132,645
Sheridan	$23,761	14	104,705	286	226	(D)	129,128	11,600	29,966	6,731	109,213
Sherman	$15,727	259	36,546	(D)	429	(D)	114,687	13,546	11,941	3,425	164,014
Thomas	$20,273	19	60,638	340	568	683	161,173	7,214	42,945	9,961	198,700
Wallace	$23,801	35	25,212	(D)	459	401	54,154	6,178	9,743	0	76,360
Subtotal	**$165,023**	**1,336**	**475,288**	**1,052**	**3,787**	**8,151**	**732,765**	**98,713**	**216,301**	**29,376**	**1,112,049**
Mitigation Planning Region B											
Ellis	$15,559	262	62,646	129	618	336	2,294	23,333	36,503	2,688	87,042
Graham	$23,831	263	29,734	2,776	251	(D)	32,846	15,770	46,379	7,973	75,731
Ness	$89,875	(D)	33,126	(D)	200	(D)	5,964	15,230	40,577	844	126,744
Norton	$22,940	407	44,196	110,982	624	483	68,879	16,365	19,719	9,370	84,278
Phillips	$12,440	177	47,260	36,925	705	407	32,708	25,017	33,036	7,925	82,805
Rooks	$19,598	96	62,914	50	430	(D)	5,897	27,940	55,742	10,058	116,488
Rush	$21,615	(D)	30,306	(D)	233	(D)	5,749	21,779	43,970	4,181	92,870
Russell	$10,397	81	27,998	353	580	294	(D)	17,752	33,857	3,429	80,097
Trego	$41,520	(D)	21,514	(D)	216	30	15,342	13,253	47,950	897	66,477
Subtotal	**$257,775**	**1,286**	**359,694**	**151,165**	**3,857**	**1,550**	**169,679**	**176,439**	**357,733**	**47,365**	**812,532**

County	Annualized Crop Insurance Paid for Agricultural Infestation Damages	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lambs, 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 C											
Grant	$210,633	145	197,047	(D)	264	(D)	46,597	9,408	25,983	0	85,385
Greeley	$22,902	(D)	26,359	(D)	67	(D)	55,382	1,260	29,821	1,710	164,006
Hamilton	$43,668	216	105,572	110	376	40	26,466	15,775	33,661	0	135,155
Kearny	$33,203	(D)	81,235	(D)	395	(D)	36,013	26,697	28,140	960	94,725
Lane	$39,003	224	61,420	(D)	207	59	8,745	4,210	33,005	2,853	86,131
Morton	$90,920	29	15,625	(D)	169	(D)	38,772	3,244	60,469	1,708	76,899
Scott	$33,080	165	246,339	190,559	294	237	48,600	4,563	60,912	1,331	116,608
Stanton	$187,712	(D)	40,542	(D)	121	472	56,883	7,827	24,534	0	113,442
Stevens	$173,377	322	51,469	(D)	486	0	140,774	6,116	31,554	7,276	84,186
Wichita	$32,252	(D)	142,254	(D)	345	(D)	44,059	4,286	40,350	963	129,773
Subtotal	**$866,750**	**1,101**	**967,862**	**190,669**	**2,724**	**808**	**502,291**	**83,386**	**368,429**	**16,801**	**1,086,310**
Mitigation Planning Region D											
Clark	$8,361	99	60,780	(D)	338	(D)	1,387	11,252	12,581	417	56,554
Finney	$84,722	301	264,133	(D)	674	165	91,219	46,465	62,229	7,137	154,103
Ford	$96,122	79	183,757	109	829	(D)	47,614	23,441	61,491	9,516	149,049
Gray	$105,166	81	260,414	(D)	584	575	68,839	30,760	58,891	7,665	109,443
Haskell	$196,757	0	350,395	52	165	(D)	91,605	17,515	31,027	7,974	92,395
Hodgeman	$50,512	234	103,161	(D)	196	(D)	16,993	12,212	32,373	649	117,918
Meade	$25,849	271	69,689	(D)	336	(D)	81,714	9,950	36,642	9,638	96,918
Seward	$48,500	132	149,058	100	436	0	64,884	12,308	39,826	7,591	68,967
Subtotal	**$615,989**	**1,197**	**1,441,387**	**261**	**3,558**	**740**	**464,255**	**163,903**	**335,060**	**50,587**	**845,347**
Mitigation Planning Region E											
Barber	$8,039	670	62,949	10	1,095	109	7,907	22,185	7,901	4,138	64,507
Barton	$13,085	118	120,851	(D)	650	(D)	32,238	57,796	48,944	21,046	159,491

County	Annualized Crop Insurance Paid for Agricultural Infestation Damages	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lambs, 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
Comanche	$5,803	47	37,748	(D)	484	0	1,374	19,867	7,636	0	51,062
Edwards	$55,867	17	75,672	(D)	148	0	70,216	16,633	26,319	17,335	103,291
Kiowa	$19,551	246	27,249	(D)	355	(D)	25,257	10,187	18,615	5,821	72,936
Pawnee	$17,111	20	109,574	17	167	128	31,432	31,164	46,974	16,028	135,502
Pratt	$20,612	151	68,429	(D)	630	2,919	60,734	12,105	22,566	12,343	123,149
Stafford	$19,765	483	96,994	7,715	603	657	77,680	28,008	27,327	23,397	155,734
Subtotal	**$159,832**	**1,752**	**599,466**	**7,742**	**4,132**	**3,813**	**306,838**	**197,945**	**206,282**	**100,108**	**865,672**
Mitigation Planning Region F											
Clay	$15,376	416	35,053	35,486	396	(D)	15,421	20,413	33,209	52,389	80,987
Cloud	$15,803	282	33,234	3,071	403	93	20,329	17,668	46,198	28,656	111,633
Dickinson	$8,364	550	76,813	13,244	1,333	1,746	9,082	49,668	50,709	51,697	151,946
Ellsworth	$17,026	275	25,566	(D)	260	840	(D)	22,643	25,270	5,217	79,059
Jewell	$25,446	486	39,295	4,364	241	3,773	15,357	26,561	51,239	33,158	131,157
Lincoln	$8,621	93	45,610	143	467	450	565	24,209	38,917	13,032	110,966
Mitchell	$17,224	7	44,839	39,993	230	495	7,496	15,828	50,636	21,320	177,691
Osborne	$10,987	0	25,218	(D)	188	536	5,409	16,976	35,068	11,041	104,147
Ottawa	$5,636	1,028	48,787	1,231	658	281	3,101	27,645	29,982	21,426	135,135
Republic	$42,325	348	45,092	94	286	3,069	57,257	27,360	33,016	57,641	91,752
Saline	$7,657	678	34,581	806	1,086	2,020	1,766	27,391	25,954	27,033	132,483
Smith	$6,225	705	35,953	6,573	354	1,190	11,734	17,903	51,643	16,124	127,194
Subtotal	**$180,690**	**4,868**	**490,041**	**105,005**	**5,902**	**14,493**	**147,517**	**294,265**	**471,841**	**338,734**	**1,434,150**
Mitigation Planning Region G											
Butler	$8,483	1,269	120,852	65,477	3,594	2,689	51,606	90,630	33,199	48,229	56,713
Cowley	$4,677	872	58,170	5,742	1,748	678	6,594	0	0	0	45,429
Harper	$36,394	523	73,087	82	267	524	2,599	20,830	8,748	3,555	93,152
Harvey	$8,601	687	39,773	22,775	1,115	767	32,532	18,699	44,031	47,146	114,175

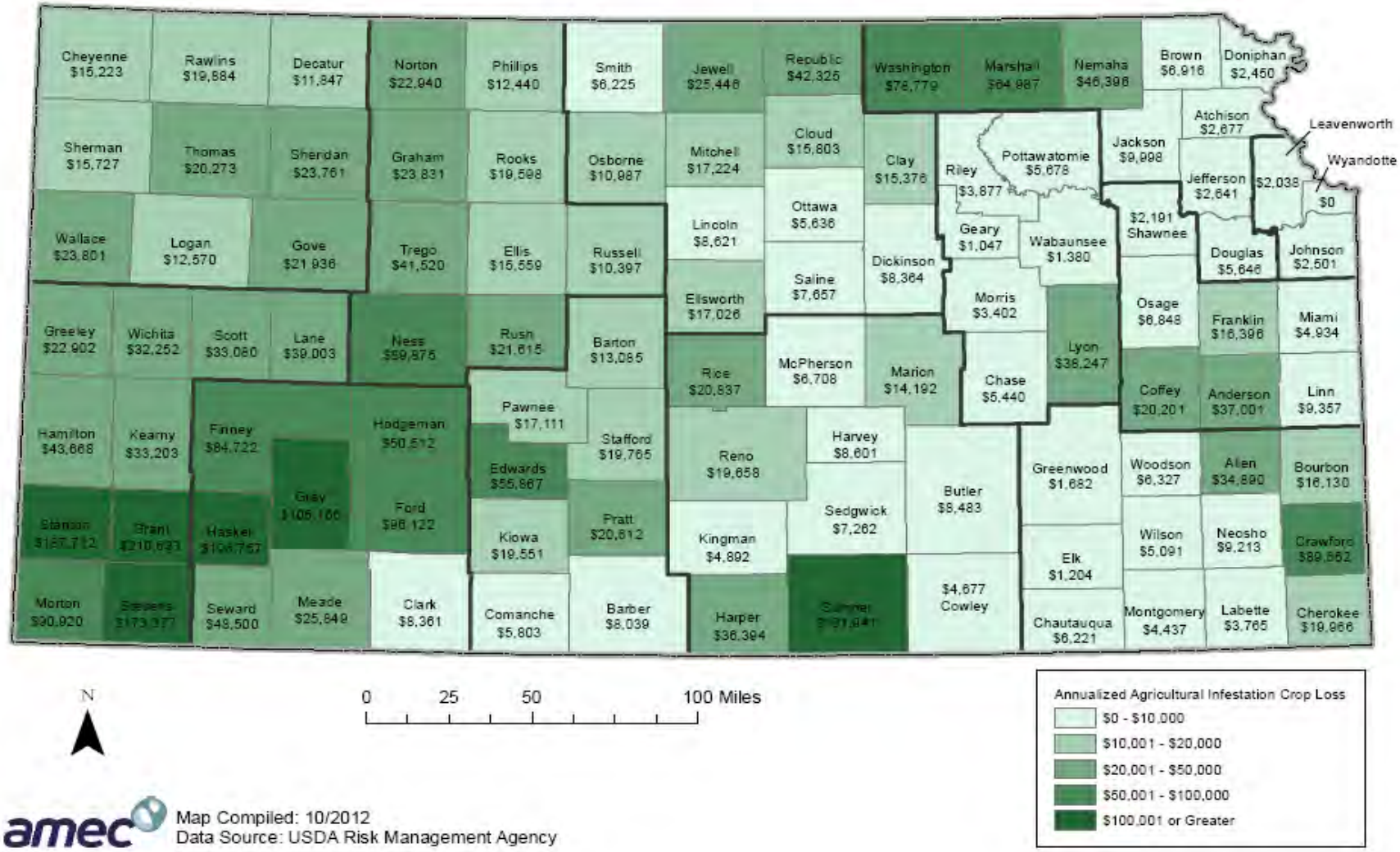
County	Annualized Crop Insurance Paid for Agricultural Infestation Damages	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lambs, Inventory, Wool Production	Corn Harvested in Acres	Forage Harvested in Acres	Sorghum for Grain Harvested in Acres	Soybeans for Beans Harvested in Acres	Wheat Harvested in Acres
Kingman	$4,892	593	47,487	21,124	1,226	2,281	9,801	35,623	17,448	17,641	124,286
McPherson	$14,192	660	54,503	25,497	1,347	5,668	25,289	34,752	53,323	43,352	212,115
Marion	$6,708	449	77,076	15,692	841	3,162	18,637	57,220	48,313	45,487	132,921
Reno	$19,658	1,670	86,582	17,129	3,024	4,345	35,317	49,071	57,523	46,271	232,736
Rice	$20,837	324	57,799	11,020	816	324	30,845	20,609	47,398	35,254	161,148
Sedgwick	$7,262	1,219	34,551	3,336	2,359	1,471	31,656	40,179	54,073	46,857	159,192
Sumner	$101,941	503	39,499	4,060	1,070	1,858	15,997	35,394	58,440	42,498	182,524
Subtotal	**$233,644**	**8,769**	**689,379**	**191,934**	**17,407**	**23,767**	**260,873**	**403,007**	**422,496**	**376,290**	**1,514,391**
Mitigation Planning Region H											
Allen	$34,890	1,011	30,306	497	442	137	18,197	33,887	2,735	36,443	24,399
Bourbon	$16,130	560	59,770	(D)	1,300	173	5,945	51,807	2,143	28,055	11,076
Chautauqua	$6,221	940	39,559	(D)	973	849	1,926	21,620	0	2,125	(D)
Cherokee	$19,966	467	36,191	(D)	1,253	85	53,046	0	0	0	64,450
Crawford	$89,662	657	60,668	345	922	311	39,707	38,748	3,714	59,148	31,538
Elk	$1,204	267	40,114	100	872	86	4,065	21,917	602	6,991	3,962
Greenwood	$1,682	586	64,269	1,783	5,542	133	8,551	45,254	1,076	13,681	7,591
Labette	$3,765	2,598	77,106	950	1,974	2,268	26,421	52,132	6,816	30,519	34,830
Montgomery	$4,437	1,359	35,619	36,961	1,666	430	24,245	35,218	3,472	21,534	23,355
Neosho	$9,213	1,219	58,334	2,208	985	458	25,138	34,955	4,384	27,782	26,943
Wilson	$5,091	1,051	32,762	(D)	433	34	28,302	39,958	7,719	47,562	28,255
Woodson	$6,327	159	48,760	77	349	396	15,855	43,824	4,663	18,229	15,829
Subtotal	**$198,587**	**10,874**	**583,458**	**42,921**	**16,711**	**5,360**	**251,398**	**419,320**	**37,324**	**292,069**	**272,228**
Mitigation Planning Region I											
Chase	$5,440	41	56,994	(D)	824	(D)	3,749	18,866	774	13,300	8,581
Geary	$1,047	196	12,810	(D)	340	85	6,799	14,533	4,883	12,929	15,731
Lyon	$38,247	2,004	69,465	5,515	1,215	357	18,581	64,621	2,612	63,007	27,744

County	Annualized Crop Insurance Paid for Agricultural Infestation Damages	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lambs, 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
Morris	$3,402	256	64,152	381	768	186	14,914	36,288	11,131	39,804	37,437
Pottawatomie	$5,678	534	70,469	21,630	1,776	1,211	29,665	52,607	6,094	34,575	15,023
Riley	$3,877	291	25,927	18,845	684	1,280	8,694	20,764	11,750	23,179	25,126
Wabaunsee	$1,380	176	49,716	1,336	1,349	3,633	16,746	43,777	2,588	22,934	9,811
Subtotal	**$59,069**	**3,498**	**349,533**	**47,707**	**6,956**	**6,752**	**99,148**	**251,456**	**39,832**	**209,728**	**139,453**
Mitigation Planning Region J											
Anderson	$37,001	1,568	47,714	3,806	943	452	40,350	44,492	5,292	69,383	37,954
Coffey	$20,201	977	46,132	(D)	1,363	1,448	22,845	41,435	6,805	54,720	25,801
Franklin	$16,396	577	41,293	22,662	1,882	444	21,933	41,017	4,546	53,685	21,098
Linn	$9,357	3,890	34,826	2,060	1,331	79	8,281	35,958	3,299	36,233	14,957
Miami	$4,934	715	43,635	1,657	3,416	379	20,693	54,025	2,856	41,969	11,574
Osage	$6,848	612	36,693	1,363	1,599	275	32,132	51,173	9,106	61,974	23,179
Shawnee	$2,191	720	13,692	195	1,601	266	36,332	28,003	3,476	37,426	9,681
Subtotal	**$96,928**	**9,059**	**263,985**	**31,743**	**12,135**	**3,343**	**182,566**	**296,103**	**35,380**	**355,390**	**144,244**
Mitigation Planning Region K											
Atchison	$2,677	32	35,656	4,442	607	(D)	62,099	25,495	1,188	59,821	10,541
Brown	$6,916	197	29,122	6,663	552	1,664	111,058	17,426	1,175	98,331	13,163
Doniphan	$2,450	194	14,563	1,067	583	385	85,285	10,154	750	62,421	2,536
Douglas	$5,646	466	22,642	(D)	1,946	629	29,564	33,488	3,500	43,188	11,002
Jackson	$9,998	694	50,453	1,949	1,723	284	23,091	53,175	2,354	28,456	10,118
Jefferson	$2,641	948	49,569	2,128	1,374	612	38,278	46,448	2,295	38,227	13,423
Marshall	$64,987	364	60,831	9,994	384	635	63,002	28,401	29,975	108,888	82,740
Nemaha	$46,396	89	66,730	121,191	429	607	84,560	39,783	6,451	78,657	39,314
Washington	$78,779	220	75,725	125,191	664	807	35,372	29,441	50,340	72,683	103,820
Subtotal	**$220,490**	**3,204**	**405,291**	**272,625**	**8,262**	**5,623**	**532,309**	**283,811**	**98,028**	**590,672**	**286,657**

County	Annualized Crop Insurance Paid for Agricultural Infestation Damages	All Goats Inventory	Cattle & Calves Inventory	Hogs & Pigs Inventory	Horses & Ponies Inventory	Sheep & Lambs, 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	$2,038	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)
Subtotal	**$4,538**	**1,251**	**43,779**	**4,673**	**4,467**	**3,095**	**29,691**	**59,545**	**941**	**52,693**	**12,559**
Statewide Total	**$3,059,314**	**48,195**	**6,669,163**	**1,047,497**	**89,898**	**77,495**	**3,679,330**	**2,727,893**	**2,589,647**	**2,459,813**	**8,525,592**

Source: USDA Risk Management Agency, 2012; USDA Census of Agriculture, 2007.
Note: (D) is cannot be disclosed.

Figure 3.14. Annualized Agricultural Infestation Crop Loss Damages



Development in Hazard Prone Areas

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

Consequence Analysis

The threat of foreign animal disease is analyzed in KDEM's Threat/Hazard Identification & Risk Assessment (THIRA), 2012. This hazard of concern was identified as such because it poses one of the worst, yet most plausible in risk to Kansas communities requiring a comprehensive application of Core Capabilities across the five mission areas of Prevention, Protection, Mitigation Response, and Recovery.

The information in **Table 3.32** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.32. 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.

3.3.2. Civil Disorder

Calculated Priority Risk Index	Planning Significance
2.65	Moderate

Description/Location

In the United States, civil disorder has been most commonly associated with urban areas and college campuses, particularly in the 1960s around the issues of civil rights and the Vietnam War. 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. In the 1990s, abortion clinics, for example, were targets for these disruptive-type activities.

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.

Previous Occurrences

Notable previous occurrences in Kansas which could be described as Civil Disorder are listed below.

- **1920 Independence, Kansas Riots:** A grocer had been murdered in his store early Thursday morning, presumably by an African-American man, who was caught in the act of robbing the cash register within the store, by a passing citizen, who immediately gave the alarm and notified local police authorities. Several suspects were arrested, and one was identified as the man seen within the store of the murdered man. Soon after the identity had been established crowds began to gather within the vicinity of the jail, and threats of violence were heard. Armed African-Americans, who claimed they came to offer their services to the police officials in the protection of the prisoner from mob violence, were present, as were armed whites who had been engaged in the hunt for the murderer, or were attracted by the threats of violence. The police officials, with the aid of the man who identified the prisoner, attempted to pacify the crowd and induce them to disperse. During the parley a shot was fired by parties unknown, and immediately a fusillade of shots were exchanged between the Caucasians and African-Americans, resulting in the killing of one

African-American, two Caucasians, and the serious wounding of three other Caucasians, whose recovery was doubtful. After the first exchange of shots the African-Americans retired to cover, with the whites gathering force, and it looked like a race war was on. The local peace officers quickly realized that they were unable to successfully cope with the situation, and thereupon called for volunteers to assist in restoring order and upholding the law. Many members of the American Legion from Independence and near-by towns responded to the call for assistance, and a force approximating 450 men was organized and controlled the situation, under Legion officers, until the arrival of National Guard troops. During this period National Guard troops were ordered into active service to suppress lawlessness and assist civil authorities in upholding the law upon two different occasions. At Independence, KS, on December 17, 1920, after a clash between Caucasians and African-Americans in which several persons were killed or injured. The sheriff of Montgomery County called for military aid. Nine officers and 104 enlisted men of the Fourth Infantry were dispatched to Independence, arriving there at 3:45 a.m., December 18, 1920. The situation was quickly in hand, and all troops returned to their home stations the following day. The near race riot which caused troops to be called to Independence resulted from the murder of an Independence citizen by an African-American

- **1984 and 1986 Aggieville Riots:** These riots occurred in Manhattan, Kansas, following football games between Kansas State University and the University of Kansas. They were some of the earliest collegiate sports-related riots in the United States. On October 13, 1984, Kansas State defeated KU 24-7 in football. That evening, Kansas State students and townspeople gathered to celebrate the victory in Aggieville, a student entertainment district in Manhattan filled with bars. An estimated 6,000 to 8,000 people jammed the main street outside the bars. As night fell, the revelers turned violent, smashing windows and signs, overturning a car, and uprooting street signs. Police who attempted to intervene were chased by students who hurled obscenities and bottles at them. Five police officers were cornered for a time and pelted with rocks and bottles. http://en.wikipedia.org/wiki/Aggieville_Riots - cite_note-Collegian-3 At one point, the Kansas Highway Patrol called Governor John W. Carlin's office to request that he declare a state of emergency and send Kansas National Guard troops to Aggieville – ultimately, this was not done. Ten people were injured in the riot, including six police officers. Twenty-four arrests were made. Two years later, despite a number of precautions, Aggieville was the site of another riot after Kansas State again defeated Kansas University 29-12 on October 18, 1986. Students wearing t-shirts that said "Riotville" and "Riot II" mingled amongst 4,000 to 6,000 people that again filled the main street outside the bars. As night fell, the crowd again turned violent. Almost every building in Aggieville had its windows smashed, people climbed to the tops of several buildings, and a 1968 Volkswagen Beetle was rolled over and torched. Eighteen arrests were made. Although the property damage was greater in 1986, injuries were limited. In 1987, Manhattan was again the site of the KSU-KU football game, but this time the town completely cordoned-off Aggieville and brought in police officers from all over the State of Kansas to control entry points and patrol the streets inside. This ended the cycle of violence. A 17-17 tie in what became known as the "Toilet Bowl" left little cause for celebration on either side.
- **1991 Summer of Mercy Wichita:** Operation Rescue National's activities gained attention again in 1991 during the —Summer of Mercy" in Wichita, Kansas, led by Keith Tucci. Thousands of anti-abortion protesters flocked to Wichita and were arrested at sit-in protests

and blockades of clinic entrances and adjacent streets. The protests were held at three different clinic locations in Wichita but focused on George Tiller's abortion clinic. Over 1,600 arrests took place during the first three weeks, with thousands of locals gathering and dozens of clergy people becoming involved. The event lasted six weeks, with over 2,600 arrests accomplished by the Wichita Police Department. The protests culminated in a rally that filled Cessna Stadium, featuring Pat Robertson. *The New York Times* ran an article on August 4, 1991, quoting John Snow, a retired accountant who sat on the sidewalk across from Tiller's clinic in Wichita, dispensing Kool-Aid and saying the rosary. Despite the large numbers of arrests, Operation Rescue founder Randall Terry was quoted as saying "The Wichita Police handled the Operation Rescue event better than almost any police department in history." As a result, Wichita Police Chief Rick Stone received the United States Department of Justice Marshal's Service "Law Enforcement Officer of the Year Award" for his "outstanding professionalism and law enforcement leadership".

Probability of Future Hazard Events

Nationwide, riots are likely to be a feature of life. Without question, Kansas will continue to experience marches, protests, demonstrations, and gatherings in various cities and communities that could lead to some type of civil disorder. However, based on the State's general history of civil disturbance and the various human factors noted above, the probability that such incidents will develop into full-scale riots is considered "Unlikely".

State Vulnerability Analysis

Although it is a rare event, when rioting or civil disorders do occur, they generally prove extremely difficult for law enforcement authorities to control. Initial law enforcement presence is often staffed below the peak loads needed to bring things back under control. As a result, the civil disorder continues until sufficient state police or National Guard units arrive to bolster the arrest process and subsequently restore order. In some cases, damage to life and property may already be extensive. Therefore, this Hazard's magnitude has the potential to be "catastrophic", including multiple deaths, to the jurisdiction in which it occurs. Additionally, civil disorder can occur with very little, or no notice and can continue for days. Civil disorder could occur when any large crowd of persons gather. These disorders can have political, social or other causes making it difficult to determine when and where they will occur. At this point in time, for events having the potential for large crowds and /or mob activity, pre-planning is done and many potential civil disturbances are quelled through the presence of sufficient law enforcement personnel and pre-planning for crowd control.

State Estimates of Potential Losses

Potential losses from Civil Disorder include all 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 correctional facilities are somewhat more likely to be susceptible to such incidents. **Section 3.5** discusses State Correctional Facilities and other facilities in which Kansas Inmates are housed and **Table 3.33** below provides resident average daily inmate populations for each Kansas Correctional Facility. The cost of a response and recovery from a civil disorder is difficult to determine.

Table 3.33. Resident Average Daily Inmate Population in Kansas, by Correctional Facility, Fiscal Years 2010 and 2011

Facility / Location	2010 Inmate Population	2011 Inmate Population
Lansing / Leavenworth County	2,346	2,368
Hutchinson / Reno County	1,783	1,863
El Dorado / Butler County	1,242	1,281
Norton / Norton County	703	808
Ellsworth / Ellsworth County	812	820
Topeka / Shawnee County * (all female inmates)	562	615
Winfield / Cowley County	523	541
Wichita Work Release / Sedgwick County	251	249
Larned Correctional Mental Health / Leavenworth County	352	369
Larned State Hospital / Leavenworth County	110	105
Contract Jail Placement / County Varies	4	6

Source: Kansas Department of Corrections

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.

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 = $80,000 Buildings – Window replacement cost for approximately 50 buildings @ $1600 per building = $80,000

Traumatic Injuries=injuries of a serious nature requiring sophisticated medical interventions provided by hospital based providers. These injuries are caused by external forces such as flying debris, blast forces and deceleration. Urgent Care Injuries=Injuries serious enough to require medical care either immediately or within a few hours. This care might be provided by Emergency Medical Responders, Urgent Care Facilities or hospitals.

Development in Hazard Prone Areas

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 increases cost of the event. The cost for such an event is largely related to the location and the level of violence the crowd chooses.

Hazard 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 3.34** provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.34. EMAP Impact 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)

3.3.3. Dam and Levee Failure

Calculated Priority Risk Index	Planning Significance
2.35	Moderate

Description/Location

Kansas is a state with many dams, impoundments, 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. Based on this definition, there are approximately 80,000 dams in the United States. Over 95 percent of these dams are non federal, with most being owned by state governments, municipalities, watershed districts, industries, lake associations, land developers, and private citizens. Dam owners have primary responsibility for the safe design, operation, and maintenance of their dams. They also have responsibility for providing early warning of problems at the dam, for developing an effective emergency action plan, and for coordinating that plan with local officials.

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 6,128 state-regulated jurisdictional dams in Kansas. Of those, 227 were Class C (High Hazard Dams), 209 were Class B (Significant Hazard Dams), and 5,692 were Class A (Low Hazard Dams).

Table 3.35 provides the numbers of state-regulated low, significant, and high hazard dams for each county in Kansas broken down by Mitigation Planning Sub-region.

Table 3.35. Number of State-Regulated Dams by Hazard Class

County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Total Dams
Mitigation Planning Region A					
Cheyenne	27	0	0	0	27
Decatur	34	0	0	0	34
Gove	22	0	0	0	22
Logan	19	1	0	0	20
Rawlins	25	1	2	2	28
Sheridan	15	1	0	0	16
Sherman	10	0	0	0	10
Thomas	10	0	0	0	10
Wallace	11	0	0	0	11
Subtotal	**173**	**3**	**2**	**2**	**178**
Mitigation Planning Region B					
Ellis	26	0	1	0	27
Graham	49	0	0	0	49
Ness	41	1	2	1	44
Norton	61	0	0	0	61
Phillips	67	0	0	0	67
Rooks	56	1	1	1	58
Rush	26	9	1	1	36
Russell	36	0	0	0	36
Trego	23	0	0	0	23
Subtotal	**385**	**11**	**5**	**3**	**401**
Mitigation Planning Region C					
Grant	7	0	0	0	7
Greeley	4	0	0	0	4
Hamilton	31	0	0	0	31
Kearny	20	1	3	2	24
Lane	25	0	0	0	25
Morton	0	0	0	0	0
Scott	7	0	0	0	7
Stanton	12	0	0	0	12
Stevens	8	0	0	0	8
Wichita	12	0	0	0	12
Subtotal	**126**	**1**	**3**	**2**	**130**
Mitigation Planning Region D					
Clark	19	0	0	0	19
Finney	56	0	1	0	57
Ford	16	0	0	0	16
Gray	12	0	4	0	16
Haskell	2	0	0	0	2
Hodgeman	28	1	2	2	31
Meade	17	0	0	0	17
Seward	6	0	0	0	6
Subtotal	**156**	**1**	**7**	**2**	**164**
Mitigation Planning Region E					
Barber	91	1	1	0	93
Barton	16	0	3	2	19
Comanche	26	1	0	0	27

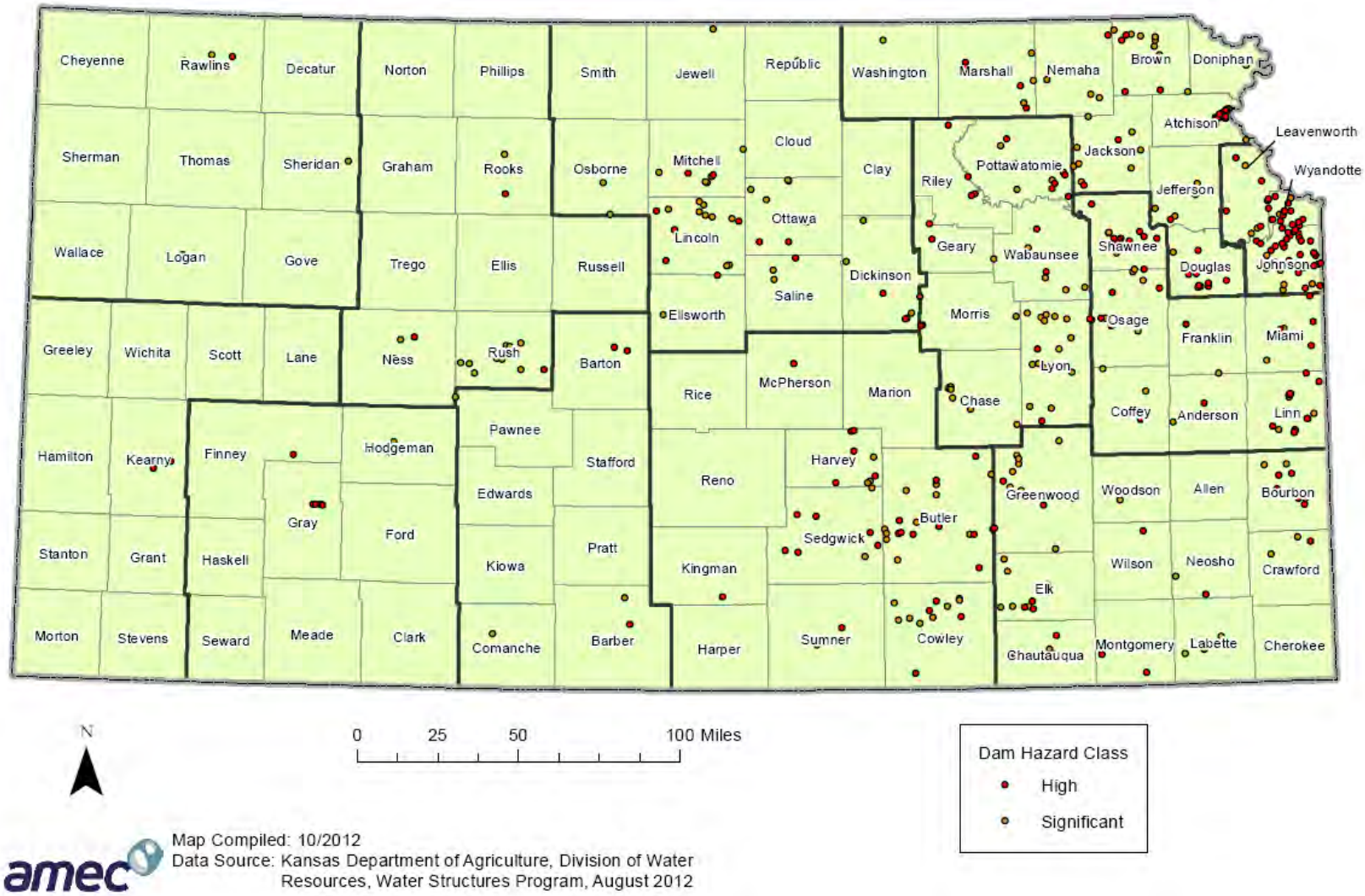
County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Total Dams
Edwards	3	0	0	0	3
Kiowa	8	0	0	0	8
Pawnee	21	1	0	0	22
Pratt	9	0	0	0	9
Stafford	2	0	0	0	2
Subtotal	**176**	**3**	**4**	**2**	**183**
Mitigation Planning Region F					
Clay	46	0	0	0	46
Cloud	36	0	0	0	36
Dickinson	88	4	2	2	94
Ellsworth	61	1	1	1	63
Jewell	56	1	0	0	57
Lincoln	82	9	4	3	95
Mitchell	35	5	2	0	42
Osborne	90	2	0	0	92
Ottawa	106	6	2	2	114
Republic	33	1	0	0	34
Saline	95	2	1	1	98
Smith	82	0	0	0	82
Subtotal	**810**	**31**	**12**	**9**	**853**
Mitigation Planning Region G					
Butler	220	10	10	2	240
Cowley	116	9	4	3	129
Harper	22	0	0	0	22
Harvey	23	3	5	3	31
Kingman	29	0	1	0	30
Marion	25	0	0	0	25
McPherson	28	0	1	1	29
Reno	18	0	0	0	18
Rice	17	0	0	0	17
Sedgwick	68	3	6	6	77
Sumner	9	1	1	0	11
Subtotal	**575**	**26**	**28**	**15**	**629**
Mitigation Planning Region H					
Allen	23	0	0	0	23
Bourbon	77	3	5	1	85
Chautauqua	80	1	3	0	84
Cherokee	8	0	0	0	8
Crawford	59	2	1	0	62
Elk	80	6	3	3	89
Greenwood	148	8	4	4	160
Labette	55	3	0	0	58
Montgomery	39	0	2	1	41
Neosho	64	1	1	1	66
Wilson	42	0	1	0	43
Woodson	43	1	0	0	44
Subtotal	**718**	**25**	**20**	**10**	**763**
Mitigation Planning Region I					
Chase	77	7	0	0	84
Geary	10	0	2	2	12
Lyon	96	14	3	2	113

County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Total Dams
Morris	46	1	4	4	51
Pottawatomie	84	4	6	4	94
Riley	14	0	4	4	18
Wabaunsee	48	5	3	1	56
Subtotal	**375**	**31**	**22**	**17**	**428**
Mitigation Planning Region J					
Anderson	52	1	1	1	54
Coffey	54	2	1	1	57
Franklin	66	2	2	2	70
Linn	66	6	9	7	81
Miami	64	2	4	3	70
Osage	43	6	5	1	54
Shawnee	139	3	11	6	153
Subtotal	**484**	**22**	**33**	**21**	**539**
Mitigation Planning Region K					
Atchison	149	7	20	1	176
Brown	211	9	4	1	224
Doniphan	100	1	0	0	101
Douglas	90	3	9	2	102
Jackson	241	9	2	1	252
Jefferson	309	5	1	1	315
Marshall	120	3	4	3	127
Nemaha	195	3	1	1	199
Washington	43	1	0	0	44
Subtotal	**1458**	**41**	**41**	**10**	**1540**
Mitigation Planning Region L					
Johnson	68	9	31	15	108
Leavenworth	159	3	6	3	168
Wyandotte	29	2	13	5	44
Subtotal	**256**	**14**	**50**	**23**	**320**
Statewide Totals	**5692**	**209**	**227**	**116**	**6128**

Source: Kansas Department of Agriculture, Division of Water Resources, Water Structures Program, 2012

Most of the state-regulated dams in Kansas are in the central and eastern parts of the State. The map in **Figure 3.15** provides the point locations of Significant and High Hazard State-regulated dams in Kansas.

Figure 3.15. Significant and High Hazard State Regulated Dams in Kansas



Federal Dams/Reservoirs

There are also 33 dams in Kansas that are maintained and operated by the federal government as seen in **Table 3.36**. Seven are maintained and operated by the Bureau of Reclamation, seven are maintained and operated by the U.S. Army, two are maintained and operated by the U.S. Fish & Wildlife Service, and the remaining seventeen are maintained and operated by the U.S. Army Corps of Engineers (USACE). Of those maintained by USACE, eight are maintained by the Tulsa District Office and nine are maintained by the Kansas City District Office.

The Corps has routinely inspected and continually evaluated its more than 600 dams for safety in accordance with the Federal Emergency Management Agency's Federal Guidelines for Dam Safety (1979). To better ensure public safety, the Corps has decided to use a risk-based approach to evaluate its dams. The results of those relative risk assessments are being used to prioritize dam rehabilitation funding. In collaboration with the Bureau of Reclamation and the Federal Energy Regulatory Commission, a Dam Safety Action Classification (DSAC) rating scale of 1 to V was developed.

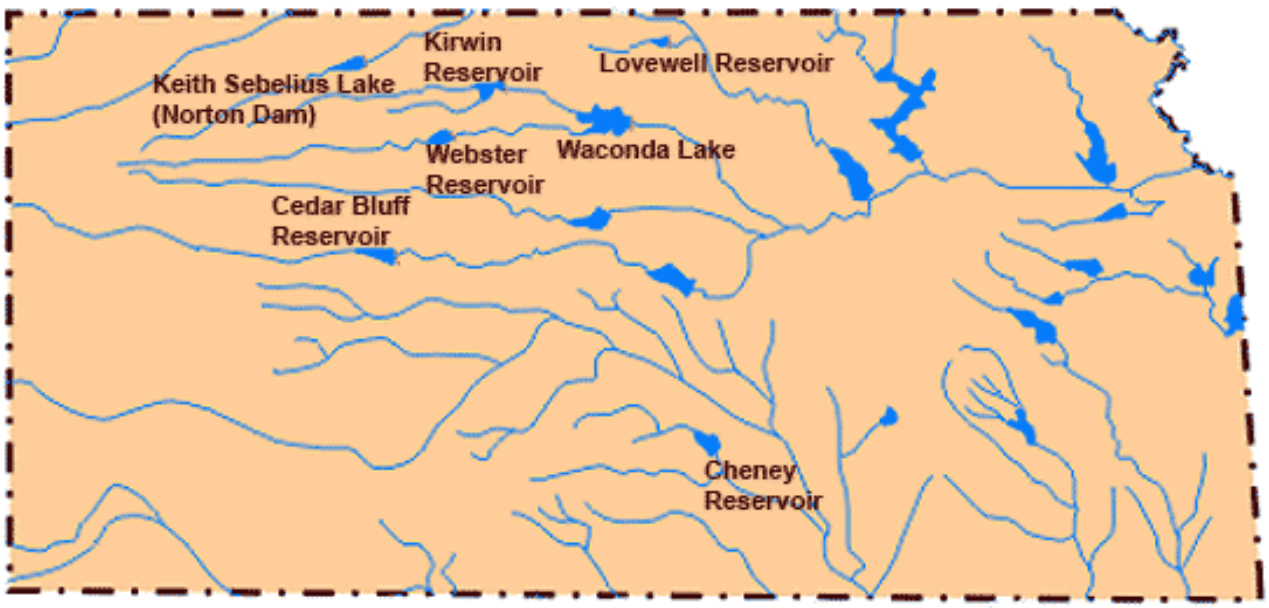
Table 3.36. Federal Reservoirs in Kansas

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)
B	Cedar Bluff	Trego	1950	BOR	Missouri	5,530	6,869	170,658
G	Cheney	Kingman, Reno, Sedgwick	1964	BOR	Arkansas	933	9,540	143,427
F	Glen Elder (Waconda)	Mitchell	1967	BOR	Missouri	5,076	12,602	217,426
B	Kirwin	Phillips	1955	BOR	Missouri	1,373	4,937	99,435
F	Lovewell	Jewell	1957	BOR	Missouri	364	2,986	41,690
B	Norton (Keith Sebelius)	Norton	1964	BOR	Missouri	712	2,180	34,330
B	Webster	Rooks	1956	BOR	Missouri	1,125	3,445	77,370
H	Ammunition Plant Dam	Labette	1/1/1942	US ARMY		NR	NR	NR
I	Camp Moon Lake Dam	Geary	1/1/1952	US ARMY		NR	NR	60
L	Merritt Lake	Leavenworth	1/1/1942	US ARMY		NR	NR	19
-	No Name Dam	NR	NR	US ARMY		NR	NR	NR
-	No Name Dam	NR	1/1/1970	US ARMY		NR	NR	35
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
E	Lake Darrynane	Stafford	1/1/1955	USF&W		NR	NR	50
J	Stateline Pond Dam Outlet	Linn	1/1/1972	USF&W		150	32.38	114.49
K	Clinton	Douglas	1977	USACE-KC	Missouri	367	7,120	120,643
J	Hillsdale	Miami	1981	USACE-KC	Missouri	144	4,576	71,950
F	Kanopolis	Ellsworth	1948	USACE-KC	Missouri	2,327	3,252	43,121
J	Melvern	Osage	1970	USACE-KC	Missouri	349	6,885	147,973
F	Milford	Clay	1964	USACE-KC	Missouri	3,796	15,314	351,577
K	Perry	Jefferson	1966	USACE-KC	Missouri	1,117	10,447	199,824
J	Pomona	Osage	1962	USACE-KC	Missouri	322	3,865	59,642
I	Tuttle Creek	Pottawatomie	1963	USACE-KC	Missouri	9,628	12,617	253,265
B	Wilson	Russell	1965	USACE-KC	Missouri	1,917	9,000	243,000
H	Big Hill (Pearson-Skubitz)	Labette	1981	USACE-Tulsa	Arkansas	37	1,192	26,650
I	Council Grove	Morris	1964	USACE-Tulsa	Arkansas	246	3,314	43,176
G	El Dorado	Butler	1981	USACE-Tulsa	Arkansas	234	7,911	157,973
H	Elk City	Montgomery	1966	USACE-Tulsa	Arkansas	634	4,188	38,385
H	Fall River	Greenwood	1949	USACE-Tulsa	Arkansas	585	2,329	19,433
J	John Redmond	Coffey	1964	USACE-Tulsa	Arkansas	3,015	8,084	44,385
G	Marion	Marion	1968	USACE-Tulsa	Arkansas	200	6,220	75,133
H	Toronto	Woodson	1960	USACE-Tulsa	Arkansas	730	2,580	15,734

Source: Kansas Water Office and Kansas Department of Agriculture, Division of Water Resources; *BOR=Bureau of Reclamation, USF&W = U.S. Fish & wildlife Service; USACE= U.S. Army Corps of Engineers; NR=Not Reported.

Figure 3.16 shows the locations of the Bureau of Reclamation Reservoirs in Kansas**. Figure 3.17** that follows shows the locations of both Bureau of Reclamation Reservoirs and U.S. Army Corps of Engineers Reservoirs in Kansas.

Figure 3.16. Bureau of Reclamation Reservoirs in Kansas



Source: Bureau of Reclamation, http://www.usbr.gov/gp/lakes_reservoirs/kansas_lakes.htm

Figure 3.17. Federal Reservoirs in Kansas

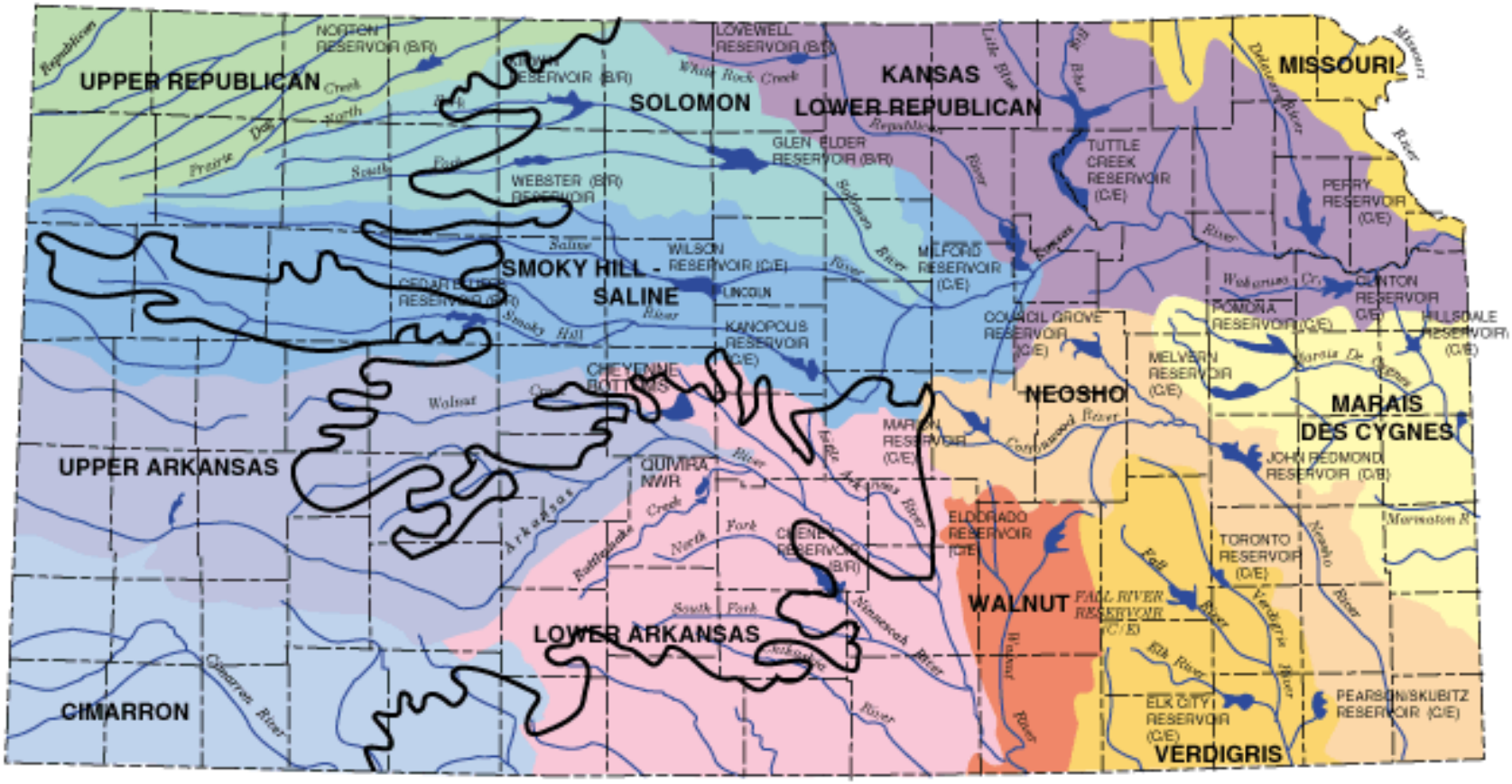


Figure 2. Kansas Rivers and Reservoirs (B/R = Bureau of Reclamation; C/E = Corps of Engineers) and major river basins. The two largest Kansas wetlands (Cheyenne Bottoms and Quivira National Wildlife Refuge, NWR) are also shown. The area west of the solid black line shows the extent of The High Plains aquifer in Kansas.

Source: Source: Surface Water in Kansas and its Interactions with Groundwater, 2000, www.kgs.ku.edu/HighPlains/atlas/atswqn.htm

Dams in Adjacent States

Colorado: The two large dams that could have flooding consequences in Kansas in the event of failure are Bonny Dam on the South Fork of the Republican River and John Martin Dam on the Arkansas. Both of these dams are federally owned/regulated dams. Bonny is owned by the Bureau of Reclamation and John Martin is owned by the Corps of Engineers.

Oklahoma: Most of the major rivers are flowing south into Oklahoma, rather than north into Kansas. The Cimarron River is the only major river that flows into Kansas from Oklahoma and there are no high hazard dams on that river that would impact Kansas in the event of failure.

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

- Hitchcock County-Trenton Dam,
- Red Willow County-Kelly Creek West Dam,
- Harlan County-Harlan County Dam: Rated as DSAC III in 2007,
- 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, and
- Richardson County-Long Branch 21 Dam.

Missouri: There are two dams in Bates County, Missouri that would potentially impact portions of Kansas in the unlikely event of failure:

- Drexel Lake Dam (ID # MO20046), and
- Drexel City Reservoir (ID# MO 20213).

There are also several dams in Jasper, Newton, Barton, Dade, and Lawrence Counties in Missouri that drain to Crawford and/or Cherokee County, Kansas. However, given the size of the dams and their distance upstream of the state line, it is unlikely that failure of any of these dams would have a significant impact 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)

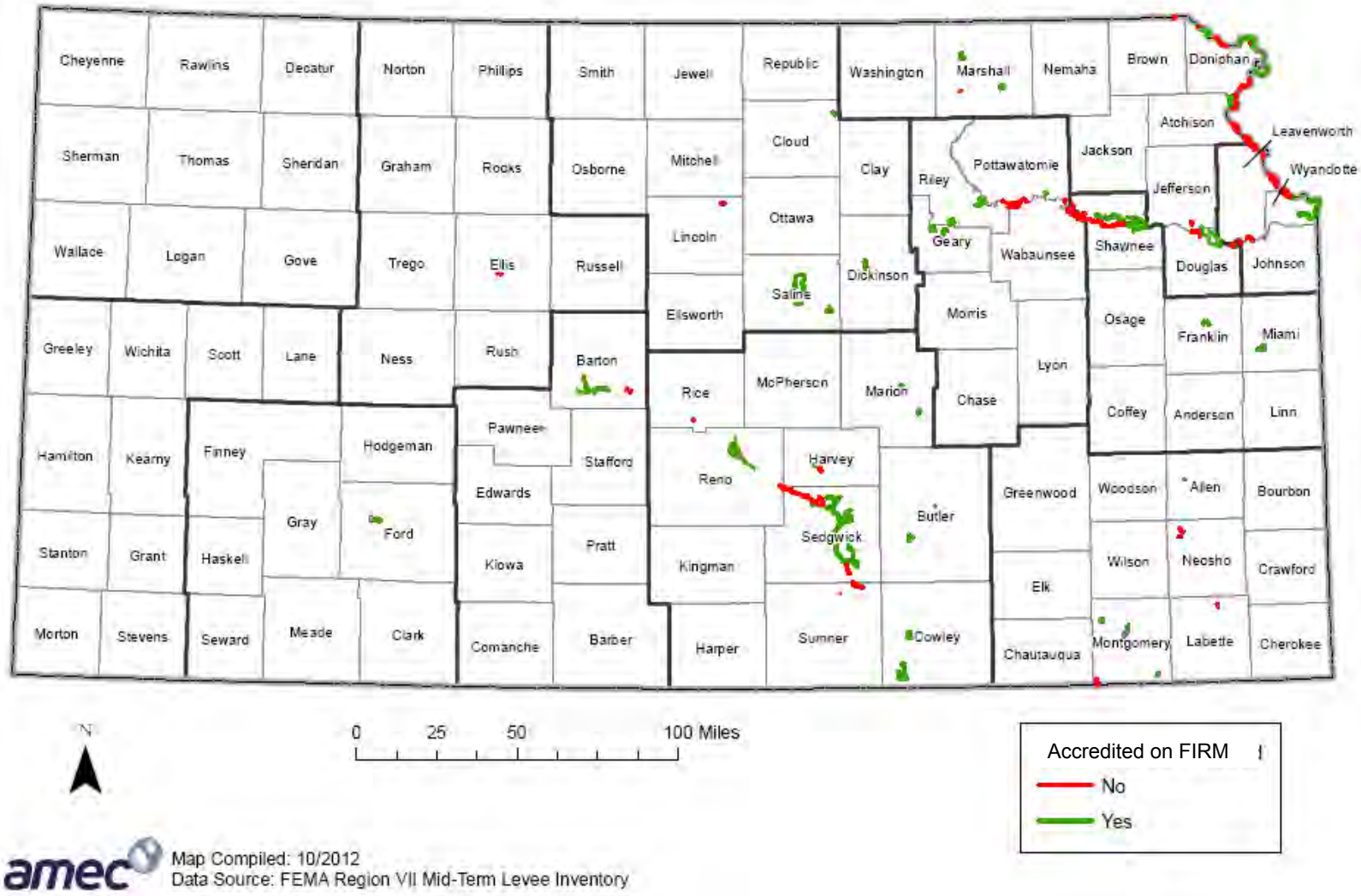
- Overtopping: When a Flood Is Too Big—Overtopping occurs when floodwaters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.
- Breaching: When a Levee Gives 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 Kansas 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 State 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 State. 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.

Figure 3.18 shows the 136 levees that were included in the MLI. Those in green are those levees that are currently shown on the effective Flood Insurance Rate Map (FIRM) as providing protection from at least the 1-percent annual chance flood.

Figure 3.18. Kansas Levees in the MLI Database

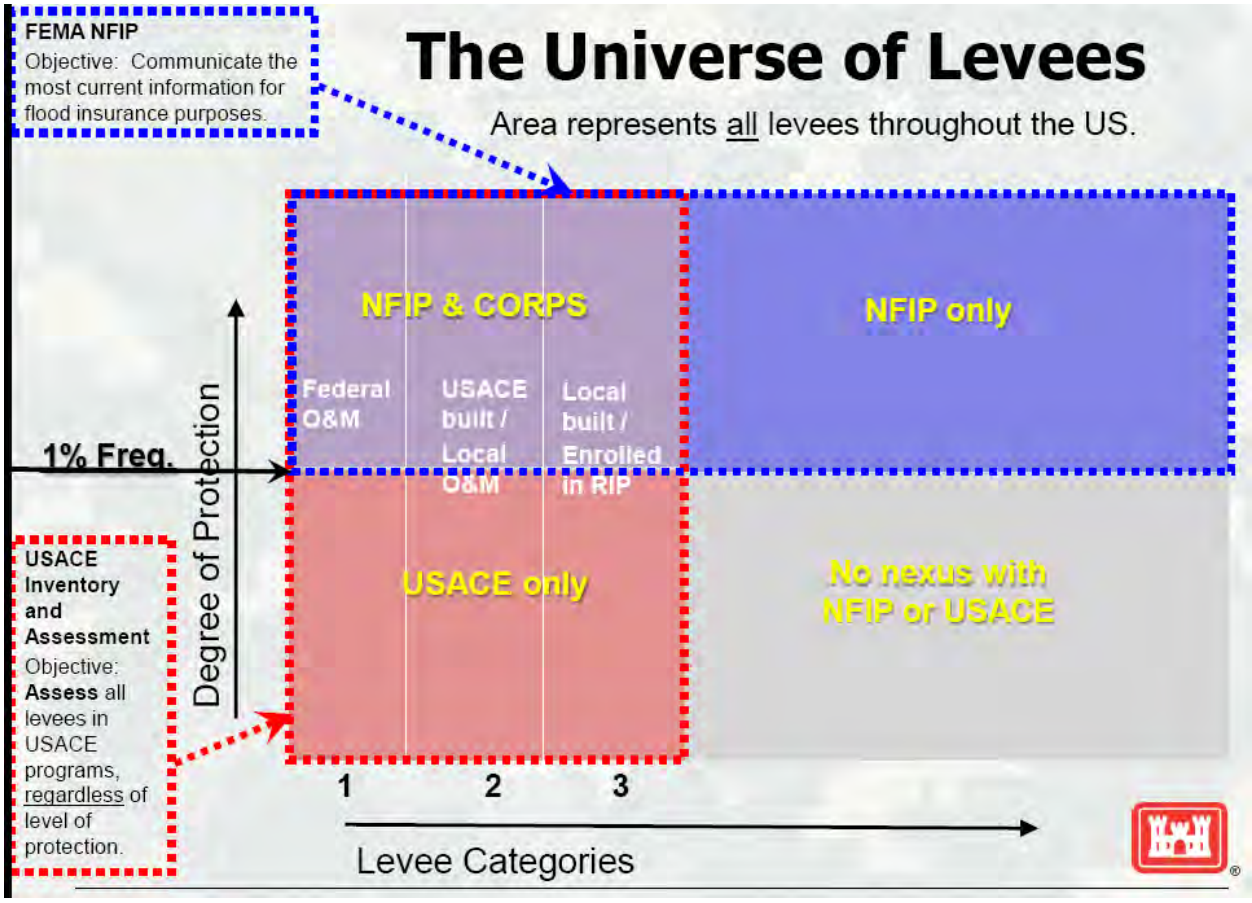


For purposes of the levee failure hazard profile and risk assessment in this hazard mitigation plan, levees in Kansas will be discussed in four categories:

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

The graphic in **Figure 3.19** displays the four levee categories described above. In terms of assessing risk, levees in categories 1, 2, and 3 all undergo or have undergone some sort of inspection, certification, or accreditation that indicates the level of protection and/or structural integrity of the levee system. However, the levees in the category 4 may not be regularly monitored or inspected.

Figure 3.19. Four Categories of Levees



Source: U.S. Army Corps of Engineers, Kansas City District

Levees in the USACE Levee Safety Program

USACE created the Levee Safety Program (LSP) in 2006 to assess the integrity and viability of levees and to make sure that levee systems do not present unacceptable risks to the public,

property, and environment. Under the Levee Safety Program, USACE conducts levee inspections (routine, periodic and special event). During these inspections, deficiencies may be identified such as unsatisfactory culverts, non-compliant vegetation, encroachments, and animal burrows. USACE uses inspection findings 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 98 levees in Kansas in the Levee Safety Program. The Kansas City District Office manages 64 of these and the Tulsa District Office manages 34. Of the 98 levees in Kansas that are in the USACE Levee Safety Program, 26 are not rated, 11 are rated Acceptable, 60 are rated Minimally Acceptable, and one, the El Dorado Levee in Butler County is rated Unacceptable. See **Table 3.39** for ratings of specific levees in the USACE Levee Safety Program.

USACE has recently finalized development of a Levee Screening Tool (LST) to understand the risks associated with each levee system and assist with developing risk management solutions. The screening results will support the assignment of a Levee Safety Action Classification (LSAC) to denote the level of risk associated with each system. The Kansas levees in the USACE LSP are in preliminary stages of screening and assignment of an LSAC rating. **Table 3.37** provides the descriptions of the five LSAC levels that will be assigned to each levee in the LSP.

Table 3.37. USACE Levee Safety Action Classifications.

Levee Safety Action Classification		
Class	**Characteristics**	**Actions**
Very High Urgency	**Likelihood of inundation with associated consequences characterizing each class, emphasis on life-safety.**	**Actions recommended for each class and level of urgency grouped by responsible O&M entity.**
High Urgency		
Moderate Urgency		
Low Urgency		
Normal		

Source: U.S. Army Corps of Engineers, Kansas City District

A primary purpose for assessing and classifying the risk associated with levee systems is to inform responsible parties on appropriate actions that should be taken to reduce risk. Risk assessments, including levee screenings, will identify risk drivers associated with a particular

levee. Risk assessments will also identify actions that may be taken to reduce those risks. Actions may be permanent in nature (e.g., replacing defective components or constructing physical improvements to a levee). In many cases Interim Risk Reduction Measures (IRRMs) may be warranted as a means of reducing risk in the interim while permanent measures are planned and implemented. IRRMs for a particular levee system may be developed and implemented by multiple authorities depending on the nature of the risk and the distribution of authorities for that levee system. Parties that could be involved with developing and implementing IRRMs could include: individuals (i.e., the general public); levee boards; local communities; county, state and federal emergency management agencies; USACE; and others. The USACE Engineering and Construction Bulletin (ECB) 2012-01provides additional information on this subject. Although the ECB is intended for application only on USACE-program levees the general concepts apply to levees of all kinds.

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..

Of the 45 Kansas counties that are in various stages of receiving Digital Flood Insurance Rate Maps, 25 of those counties have levees. According to the MLI, the total number of FEMA accredited levees in DFIRM counties is 77 levees. **Figure 3.20** shows these counties (outlined in red). Additionally, **Table 3.38** lists these counties grouped by Mitigation Planning Region.

Figure 3.20. Kansas DFIRM Counties with Levees-Map

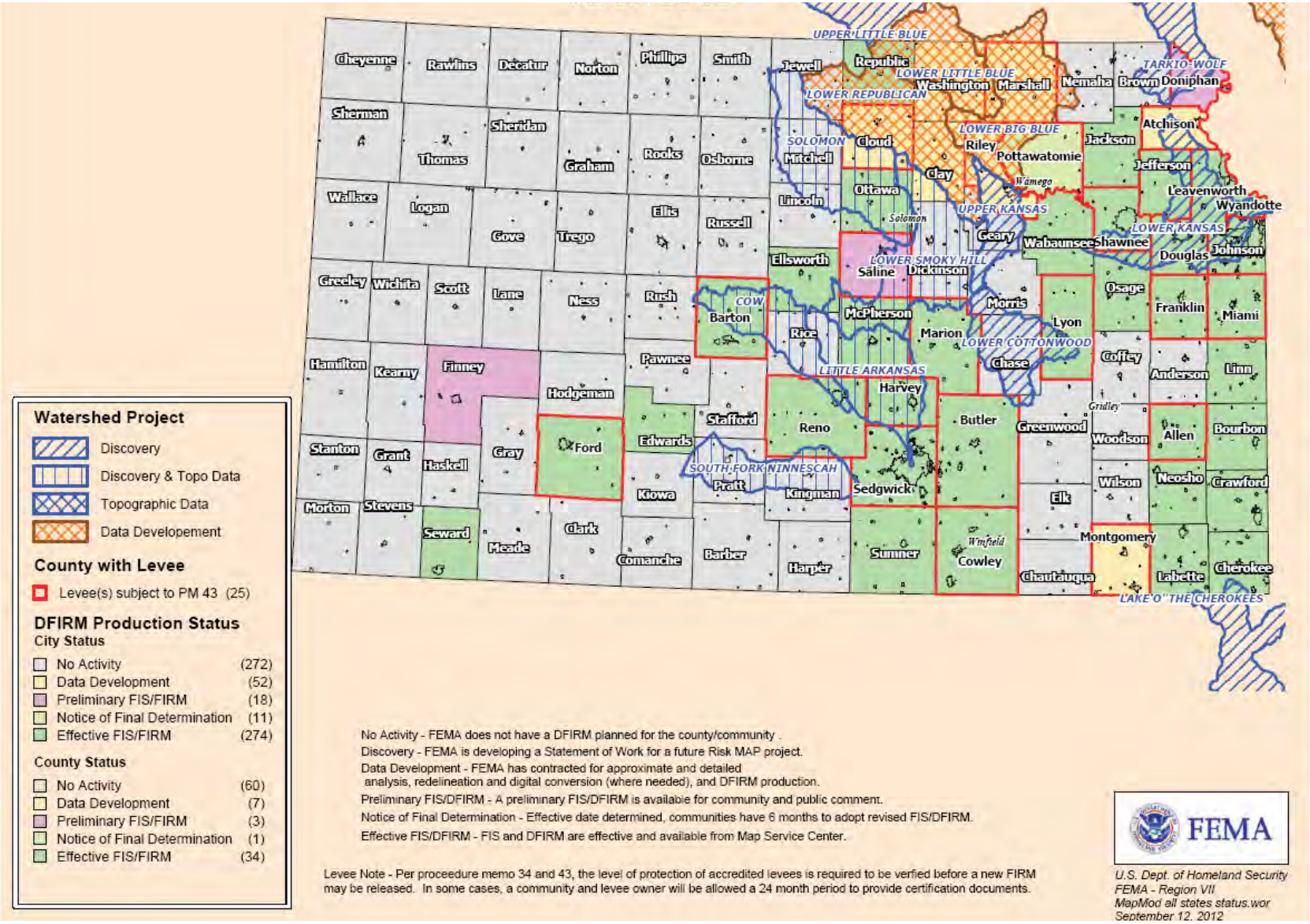


Table 3.38. Kansas DFIRM Counties With Levees-List

Mitigation Planning Region	DFIRM Counties with Levees
E	Barton
F	Cloud
F	Ford
F	Saline
G	Butler
G	Cowley
G	Harvey
G	Marion
G	Reno
G	Sedgwick
H	Allen
H	Montgomery

Mitigation Planning Region	DFIRM Counties with Levees
I	Lyon
I	Pottawatomie
I	Riley
J	Franklin
J	Miami
J	Shawnee
K	Atchison
K	Doniphan
K	Douglas
K	Jefferson
K	Marshall
L	Leavenworth
L	Wyandotte

FEMA Accredited Levees not Mapped on DFIRMs

Throughout the early days of the National Flood Insurance Program (NFIP), little guidance was available associated with the inclusion of existing levees. Decisions were made on whether to accredit hundreds of levees across Kansas. Because there were no levee standards and accreditation of a levee was left largely to the judgments of the study contractors, many levees were accredited as providing flood protection even though they would not meet the current NFIP levee standards as stated in 44 CFR 65.10.

During subsequent re-mapping, many of these levees were re-evaluated and accredited as providing flood protection, but do not meet the standards of 44 CFR 65.10. Additionally, some levees, originally indicated as accredited have never been re-evaluated. If levees are depicted on the paper FIRMS in counties that have not been re-mapped on DFIRMs, their protection level has not been re-evaluated. Until re-evaluation occurs, these levees are considered accredited. According to the MLI, there are 4 accredited levees that are not mapped on DFIRMS. The counties that have areas protected by FEMA-accredited levees that have not yet been re-evaluated through the re-mapping process include:

- Coffey
- Dickinson
- Geary
- Pawnee

This information was obtained by comparing the levees in the Mid-term Levee Inventory indicated as showing protection on the FIRM against the list of counties that have effective DFIRMs. It should be noted that both Dickinson and Geary Counties are included in current Watershed mapping efforts that are in the discovery phases.

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

Several Kansas levees are both accredited by FEMA and part of the USACE Levee Safety program. See **Table 3.39.**

All Other Levees

There are also levees throughout the State that are intended to mitigate low-level flooding and/or protect agricultural land that are not in the USACE Levee Safety program. Additionally, since these levees are not intended to protect populations or development from flooding from the 1% annual chance flood, they are not, nor seek to be accredited by FEMA for flood insurance purposes. These levees may provide a false sense of security to residents behind these levees. Additionally, these levees may not be routinely inspected by levee owners. There is no agency with regulatory authority over these levees.

According to comparative analysis of the MLI and NLD, there are currently 39 levees that are not accredited by FEMA or in the USACE Levee Safety Program. These levees are in the following counties: Atchison, Barton, Doniphan, Harvey, Johnson, Labette, Leavenworth, Montgomery, Neosho, Pottawatomie, Reno, Riley, Sedgwick, Shawnee, Sumner, and Wabaunsee. There are also likely many more levees, such as agricultural levees that have not been inventoried. Populations and development behind these levees could be considered to be at a higher risk since there are no requirements for these levees to be routinely inspected and/or certified.

The inventory of levees in **Table 3.39** has been compiled from the USACE NLD as well as the FEMA MLI. Please note that there may be some duplication as the names of the levees as well as the segmentation of the levees is not consistent in both inventories. Those levees marked with an asterisk (*) are likely duplicates.

Table 3.39. Levees in Kansas

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
H	Allen	Iola Levee	Yes	TULSA	Minimally Acceptable	Yes	Neosho River	Yes	Yes	1% Annual Chance
K	Atchison	Corkill	No	N/A	N/A	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Atchison	Grape-Bollin-Schwartz Levee Association-Atchison	Yes	KC	Not Reported	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Atchison	Henry Pohl Levee	Yes	KC	Not Reported	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Atchison	Hundley	No	N/A	N/A	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Atchison	Kemig	No	N/A	N/A	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Atchison	Millard-Overton	No	N/A	N/A	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Atchison	Mrls 440-R-Atchison	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	No	Yes	Unknown
K	Atchison	Hundley	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Atchison	Kemig	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Atchison	Millard-Overton	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Atchison	Schrader	Yes	KC	Not Reported	No	Not Reported	No		Unknown
E	Barton	Barton Co, Ks Agricultural Levees	No	N/A	N/A	Yes	ARKANSAS RIVER	No	Yes	Unknown
E	Barton	Great Bend Levee North Side & Walnut Creek	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
E	Barton	Great Bend Levee South Side	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
E	Barton	Phase Arkansas River Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
E	Barton	Phase Iii Airport Levee	Yes	Tulsa	Minimally Acceptable	Yes	WALNUT CREEK	Yes	Yes	1% Annual Chance
E	Barton	Phase Iii Walnut Creek	No	N/A	N/A	Yes	WALNUT CREEK	Yes	Yes	1% Annual Chance
K	Brown	Mrls 512-513-R	Yes	Kc	Minimally Acceptable	Yes	Roys Creek	No	No	1% Annual Chance
G	Butler	Walnut River Levee N.	No	N/A	N/A	Yes	WALNUT RIVER	Yes	Yes	1% Annual Chance
G	Butler	Walnut River Levee S.	No	N/A	N/A	Yes	WHITEWATER RIVER	Yes	Yes	1% Annual Chance
G	Butler	West Branch Walnut River Levee	No	N/A	N/A	Yes	WEST BRANCH WALNUT RIVER	Yes	Yes	1% Annual Chance
G	Butler	Whitewater River Elmcrk Levee	No	N/A	N/A	Yes	WHITEWATER RIVER/ELM CREEK	Yes	Yes	1% Annual Chance

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
G	Butler	Whitewater River Levee	No	N/A	N/A	Yes	WHITEWATER RIVER	Yes	Yes	1% Annual Chance
G	Butler	Augusta	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Butler	El Dorado Levee	Yes	TULSA	Unacceptable	No	Not Reported	No		Unknown
F	Cloud	Clyde	Yes	KC	Minimally Acceptable	Yes	ELK CREEK	Yes	Yes	1% Annual Chance
I, J	Coffey , Lyon	Hartford Levee (Neosho River)	Yes	TULSA	Not Reported	No	Not Reported	No		Unknown
G	Cowley	Arkansas River Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Cowley	Timber Creek Levee	No	N/A	N/A	Yes	TIMBER CREEK	Yes	Yes	1% Annual Chance
G	Cowley	Walnut River Levee - Arkc, Ks	No	N/A	N/A	Yes	WALNUT RIVER	Yes	Yes	1% Annual Chance
G	Cowley	Walnut River Levee - Winfield, Ks	No	N/A	N/A	Yes	WALNUT RIVER	Yes	Yes	1% Annual Chance
G	Cowley	Walnut River Tie Back Levee	No	N/A	N/A	Yes	WALNUT RIVER	Yes	Yes	1% Annual Chance
G	Cowley	Arkc	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Cowley	Winfield Levee	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
F	Dickinson	Abilene Unit	Yes	KC	Acceptable	Yes	MUD CREEK	Yes	No	1% Annual Chance
K	Doniphan	Cook	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual Chance
K	Doniphan	Earle Cole	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual Chance
K	Doniphan	Jones (Scholz)	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual Chance
K	Doniphan	Kirkland Kuebler-Miller	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual Chance
K	Doniphan	Mrls 440-R-Doniphan	Yes	KC	Minimally Acceptable	Yes	INDEPENDENCE CREEK	Yes	Yes	1% Annual Chance
K	Doniphan	Mrls 471-460-R	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	Yes	Yes	< 1% Annual Chance
K	Doniphan	Mrls 471-460-R Elwood-Gladden	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Doniphan	Mrls 482-R Doniphan-Burr Oak	Yes	KC	Not Reported	Yes	MISSOURI RIVER CANAL	No	Yes	< 1% Annual Chance
K	Doniphan	Mrls 500-R	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	Yes	Yes	1% Annual Chance
K	Doniphan	Mrls 500-R Iowa Point	Yes	KC	Minimally Acceptable	Yes	MISSOURI RIVER	No	Yes	< 1% Annual Chance
K	Doniphan	Roundy	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
										Chance
K	Doniphan	Ryan	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual Chance
K	Doniphan	Steanson-Mcdonough	No	N/A	N/A	Yes	MISSOURI	No	Yes	< 1% Annual Chance
K	Doniphan	Cook	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Doniphan	Earle Cole	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Doniphan	Jones (Scholz)	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Doniphan	Kirkland Kuebler-Miller	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Doniphan	Roundy	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Doniphan	Ryan	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Doniphan	Steanson-Mcdonough	Yes	KC	Not Reported	No	Not Reported	No		Unknown
K	Douglas	Douglas County Drainage District	Yes	KC	Acceptable	Yes	KANSAS RIVER	No	Yes	<1% Annual Chance
K	Douglas	Lawrence Unit-Douglas	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
K	Douglas	Mud Creek Levee	No	N/A	N/A	Yes	MUD CREEK	Yes	Yes	1% Annual Chance
B	Ellis	Hays City Levee	Yes	KC	Not Reported	Yes	BIG CREEK	No	No	<1% Annual Chance
D	Ford	Dodge City North	Yes	Tulsa	Minimally Acceptable	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
D	Ford	Dodge City South	Yes	Tulsa	Minimally Acceptable	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
J	Franklin	Ottawa Ks (Split To Left And Right Bank On Nld	Yes	KC	Portions Acceptable, Portions Minimally Acceptable	Yes	MARAIS DES CYGNES RIVER	Yes	Yes	Unknown
I	Geary	Ft. Riley - Forsyth	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	No	< 1% Annual Chance
I	Geary	Ft. Riley - Marshall Air Field	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	No	<1% ANNUAL CHANCE
G	Harvey	Little Arkansas River And Slough Creek Fpp	No	N/A	N/A	Yes	LITTLE ARKANSAS RIVER	No	Yes	Unknown
G	Harvey	Halstead Local Flood Protection Project	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
K	Jefferson	Lawrence Unit-Jefferson	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
K	Jefferson	Stonehouse Creek Drainage District No. 1	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	No	Yes	1% ANNUAL CHANCE
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
H	Labette	Labette Creek Levee	No	N/A	N/A	Yes	LABETTE CREEK	No	Yes	Unknown
L	Leavenworth	Fall Leaf Drainage District	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	No	Yes	< 1% Annual Chance

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
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	Leavenworth	Lower Iatan Bend	Yes	KC	Not Reported	No	Not Reported	No		Unknown
F	Lincoln	Barnard, Kansas	Yes	KC	Minimally Acceptable	Yes	SALT CREEK	No	No	1% Annual Chance
I	Lyon	Hartford Levee	No	N/A	N/A	Yes	NEOSHO RIVER	Yes	Yes	1% Annual Chance
G	Marion	Florence Levee	Yes	TULSA	Minimally Acceptable	Yes	DOYLE CREEK	Yes	Yes	1% Annual Chance
G	Marion	Marion Levee	Yes	TULSA	Minimally Acceptable	Yes	COTTONWOOD RIVER	Yes	Yes	1% Annual Chance
K	Marshall	Frankfort, Kansas	Yes	KC	Minimally Acceptable	Yes	BLACK VERMILLION RIVER	Yes	Yes	1% Annual Chance
K	Marshall	Marysville, Kansas Levee	Yes	KC	Not Reported	Yes	BIG BLUE RIVER	Yes	Yes	1% Annual Chance
K	Marshall	Tuttle Creek Dam Blue Rapids	Yes	KC	Not Reported	Yes	BLUE RIVER	No	Yes	Unknown
J	Miami	Osawatomie Levee	Yes	KC	Minimally Acceptable	Yes	MARAIS DES CYGNES RIVER	Yes	Yes	1% Annual Chance
H	Montgomery	Caney Levee	No	N/A	N/A	Yes	LITTLE CANEY RIVER	No	Yes	1% Annual Chance
H	Montgomery	Coffeyville Levee	No	N/A	N/A	Yes	VERDIGRIS RIVER	Yes	Yes	1% Annual Chance
H	Montgomery	Elk City Levee	No	N/A	N/A	Yes	ELK RIVER	Yes	Yes	1% Annual Chance
H	Montgomery	Elk City Reservoir Levee	No	N/A	N/A	Yes	ELK RIVER	Yes	Yes	Unknown
H	Montgomery	Coffeyville Levee	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
H	Montgomery	Elk City Lake	Yes	TULSA	Acceptable	No	Not Reported	No		Unknown
H	Montgomery , Washington	Caney Levee	Yes	TULSA	Acceptable	No	Not Reported	No		Unknown
H	Neosho	Chanute Levee	No	N/A	N/A	Yes	NEOSHO RIVER	No	Yes	Unknown
H	Neosho	Chanute/Santa Fe Lake Levee	No	N/A	N/A	Yes	LITTLE TURKEY CREEK	No	Yes	Unknown

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
H	Neosho	Neosho River/Chanute Levee	No	N/A	N/A	Yes	NEOSHO RIVER	No	Yes	Unknown
H	Neosho	Neosho River/Neosho County Levee	No	N/A	N/A	Yes	NEOSHO RIVER	No	Yes	Unknown
E	Pawnee	Larned Levee	Yes	Tulsa	Minimally Acceptable	Yes	ARKANSAS RIVER	Yes	No	1% Annual Chance
I	Pottawatomie	Belvue Levee	No	N/A	N/A	Yes	UNNAMED STREAM	Yes	Yes	Unknown
I	Pottawatomie	College Creek - St Mary's	No	N/A	N/A	Yes	COLLEGE CREEK	No	Yes	Unknown
I	Pottawatomie	Kansas River Levee - St George	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
I	Pottawatomie	Manhattan Unit-Pottawatomie	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
G	Reno	Ark Riv North Bank	No	N/A	N/A	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Reno	Ark Riv Ring Levee	No	N/A	N/A	Yes	ARKANSAS RIVER/COW CREEK	Yes	Yes	1% Annual Chance
G	Reno	Ark Riv South Bank	No	N/A	N/A	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Reno	Arkansas River North Bank Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	No	Yes	1% Annual Chance
G	Reno	Arkansas River South Bank Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	No	Yes	1% Annual Chance
G	Reno	Cow Creek Diversion	No	N/A	N/A	Yes	COW CREEK DRAINAGE CANAL; ARKANSAS RIVER; HARSHA DRAINAGE CANAL	Yes	Yes	1% Annual Chance
G	Reno	Willowbrook Ring Levee	No	N/A	N/A	Yes	COW CREEK	Yes	Yes	1% Annual Chance
G	Reno	Hutchinson Levee - Arkansas North & Cow Crk East	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Reno	Hutchinson Levee - Arkansas North & Cow Crk West	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Reno	Hutchinson Levee - Arkansas South Bank	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Reno	Hutchinson Levee - Levee C	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Reno	Hutchinson Levee - Ring Levee	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Rice	Bull Creek Levee	No	N/A	N/A	Yes	BULL CREEK	No	No	Unknown

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
I	Riley	Deep Creek Levee	No	N/A	N/A	Yes	DEEP CREEK	No	Yes	< 1% Annual Chance
I	Riley	Ft. Riley - Funston	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	< 1% Annual Chance
I	Riley	Kansas River Levee - St George	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
I	Riley	Manhattan Unit-Riley	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
F	Saline	Gypsum	Yes	KC	Minimally Acceptable	Yes	GYPSUM CREEK	Yes	Yes	1% Annual Chance
F	Saline	Salina, Ks Fpp	Yes	KC	Minimally Acceptable	Yes	DRY CREEK	No	Yes	< 1% Annual Chance
G	Sedgwick	Arkansas River East Bank Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Arkansas River North Bank Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	No	Yes	1% Annual Chance
G	Sedgwick	Arkansas River South Bank Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	No	Yes	1% Annual Chance
G	Sedgwick	Arkansas River West Bank Levee	No	N/A	N/A	Yes	ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Arkansas River/Wvcfldway Levee	No	N/A	N/A	Yes	LITTLE ARKANSAS RIVER & WICHITA VALLEY CENTER FLOODWAY	Yes	Yes	1% Annual Chance
G	Sedgwick	BIG SLOUGH LEVEE (Called Big Slough Levee D & Riverside Levee P & Levee R On NLD)	Yes	TULSA	Minimally Acceptable	Yes	BIG SLOUGH	Yes	Yes	1% Annual Chance
G	Sedgwick	BIG SLOUGH LEVEE C (ARKANSAS RIVER) (Split Into North And South On NLD)	Yes	TULSA	Minimally Acceptable	Yes	BIG SLOUGH NORTH / ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek East Bank Levee - 1	No	N/A	N/A	Yes	CHISHOLM CREEK	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek East Bank Levee - 2	No	N/A	N/A	Yes	CHISHOLM CREEK	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek East Bank Levee - 3	No	N/A	N/A	Yes	CHISHOLM CREEK	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek Middle Fork Levee	No	N/A	N/A	Yes	MIDDLE FORK CHISHOLM CREEK	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek West Bank Levee - 1	No	N/A	N/A	Yes	CHISHOLM CREEK	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek West Bank Levee - 2	No	N/A	N/A	Yes	CHISHOLM CREEK	Yes	Yes	1% Annual Chance

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
G	Sedgwick	Chisholm Creek Wst Brnch Est Bnk Levee	No	N/A	N/A	Yes	CHISHOLM CREEK - WEST BRANCH	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Creek Wst Brnch Wst Bnk Levee	No	N/A	N/A	Yes	LITTLE ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Cowskin Creek South Levee	No	N/A	N/A	Yes	COWSKIN CREEK SOUTH	No	Yes	Unknown
G	Sedgwick	Little Arkansas Div East Bank Levee	No	N/A	N/A	Yes	WICHITA -VALLEY CENTER FLOODWAY/ ARK RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Little Arkansas Div West Bank Levee	No	N/A	N/A	Yes	WICHITA -VALLEY CENTER FLOODWAY/ ARK RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Little Arkansas Rvr U-Levee	No	N/A	N/A	Yes	LITTLE ARKANSAS RIVER (LOWER REACH)	Yes	Yes	1% Annual Chance
G	Sedgwick	Little Arkansas Rvr West Bank Levee	No	N/A	N/A	Yes	WICHITA -VALLEY CENTER FLOODWAY/ ARK RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Ltl Ark Rvr South Bank Levee	No	N/A	N/A	Yes	BIG SLOUGH NORTH / ARKANSAS RIVER	Yes	Yes	1% Annual Chance
G	Sedgwick	Sedgwick Ditch Levee	No	N/A	N/A	Yes	SEDGWICK DITCH	No	Yes	Unknown
G	Sedgwick	Tributary M1 Middle Fork Chisholm Creek Levee	No	N/A	N/A	Yes	TRIBUTARY M1 MIDDLE FORK CHISHOLM CREEK	Yes	Yes	1% Annual Chance
G	Sedgwick	Wichita Valley Center Fldwy Levee	No	N/A	N/A	Yes	WICHITA VALLEY CENTER FLOODWAY	Yes	Yes	1% Annual Chance
G	Sedgwick	Chisholm Levee P & Levee N	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sedgwick	Chisolm Creek West Branch Chisholm Creek East Bank S1 & Levee T	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sedgwick	Chisolm Creek West Branch Chisholm Creek East Bank Spoil 2	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sedgwick	Chisolm Creek West Branch Chisholm Creek East Bank Spoil 3	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sedgwick	Chisolm Creek West Branch Chisholm Creek East Bank	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
		Spoil 4								
G	Sedgwick	Little Ark Levee J	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sedgwick	Little Ark Levees FKLM And West Branch West	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sedgwick	Park City Levee	Yes	TULSA	Minimally Acceptable	No	Not Reported	No		Unknown
J	Shawnee	Auburndale Unit (S. Topeka)	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
J	Shawnee	Kaw River Drainage District	Yes	KC	Not Reported	Yes	KANSAS RIVER	No	Yes	< 1% Annual Chance
J	Shawnee	North Topeka Unit	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
J	Shawnee	Oakland	No	N/A	N/A	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
J	Shawnee	Silver Lake Ditch Levee	No	N/A	N/A	Yes	SILVER LAKE DITCH	Yes	Yes	Unknown
J	Shawnee	Soldier Creek Unit (Split To 6 Left Bank And 1 Right Bank On Nld	Yes	KC	Portions Acceptable, Portions Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
J	Shawnee	South Topeka Unit	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
J	Shawnee	Tri-County Drainage District No. 1, Section 1-Shawnee	No	N/A	N/A	Yes	BOURBONAIS CREEK	No	Yes	< 1% Annual Chance
J	Shawnee	Tri-County Drainage District No. 1, Section 2	Yes	KC	Not Reported	Yes	BOURBONAIS CREEK	No	Yes	< 1% Annual Chance
J	Shawnee	Tri-County Drainage District No. 1, Section 3	Yes	KC	Not Reported	Yes	KANSAS RIVER	No	Yes	< 1% Annual Chance
J	Shawnee	Water Works Unit (South Topeka)	Yes	KC	Minimally Acceptable	Yes	KANSAS RIVER	Yes	Yes	1% Annual Chance
J	Shawnee	Oakland	Yes	KC	Minimally Acceptable	No	Not Reported	No		Unknown
G	Sumner	Cowskin Creek Levee	No	N/A	N/A	Yes	COWSKING CREEK	No	Yes	Unknown
G	Sumner	Ninnescah River	No	N/A	N/A	Yes	NINNESCAH RIVER	No	Yes	Unknown
I	Wabaunsee	Kansas River Wabaunsee 1	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
I	Wabaunsee	Kansas River Wabaunsee 2	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
I	Wabaunsee	Kansas River Wabaunsee 3	No	N/A	N/A	Yes	KANSAS RIVER	No	Yes	Unknown
I	Wabaunsee	Tri-County Drainage District No. 1, Section 1-Wabaunsee	Yes	KC	Not Reported	Yes	KANSAS RIVER	No	Yes	< 1% Annual Chance
I	Wabaunsee	Tri-County Drainage District No. 1, Section 2	Yes	KC	Not Reported	Yes	KANSAS RIVER	No	Yes	< 1% Annual Chance

Mitigation Planning Region	County	Levee Name	USACE LSP	USACE District	USACE Inspection Rating	MLI	Flooding Source	Accredited	DFIRM	Design Frequency
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

Notes: Gray highlight indicates that these levees are most likely duplicates of the same levee systems on both the MLI and NLD, but due to naming differences, could not be reconciled.

Previous Occurrences

This section discusses previous occurrences for dam and levee failure in Kansas.

Dam Failure

According to Stanford University_sNational Performance of Dams Program, there were 31 dam incidents in Kansas between 1925 and 2012. The most recent dam failure incident occurred March 13, 2002. No incidents were reported from this event to 2012. Of the 31 incidents, 7 (23 percent) of them were failures.

Table 3.40. Dam Incidents in Kansas, 1925-2002

MT Planning Region	County	NID #	Dam Name	Incident Date	Incident Type	Dam Failure
K	Brown	KS02458	Horton, City Of, Mission Lake Dam	1924	Not Known	Yes
*	Unknown	KSS00003	Unnamed Dam (KSS00003)	1951	Not Known	Yes
G	Butler	KS02146	Timber Creek Watershed Dam 1	1967	Piping	Yes
G	Butler	KS05104	Blackstone	1976	Inflow Flood - Hydrologic Event	Yes
K	Atchison	KS04490	Maur Hill Prep School, Inc.	May-78	Landslide	Yes
J	Osage	KS01572	Kitchen, E. L., Lake Oshawno Dam	5/18/1995	Concrete Deterioration; Embankment Slide	No
E	Pratt	KS07714	Pratt County Lake Dam	6/2/1995	Piping	No
H	Woodson	KS00900	Kansas F And Game Commission (Kansas Dept. Of Wildlife & Parks)	1/10/1996	Seepage	No
*	Unknown	KSS00001	Decker Dam	1996	Inflow Flood - Hydrologic Event	Yes
*	Unknown	KSS00002	Speer Dam	11/14/1996	Inflow Flood - Hydrologic Event	Yes
K	Jackson	KS00955	Porter, John M.	5/12/1997	Seepage/Piping	No
H	Montgomery	KS03891	Wheeler, C.L. & Vesta, Hadden-Wheeler Dam	10/8/1997	Concrete Deterioration	No
L	Wyandotte	KS02987	Ksnoname 2987	5/14/1997	Seepage; Piping	No
B	Trego	KS00019	Cedar Bluff	2/8/1998	Embankment Slide	No
K	Atchison	KS00180	Kansas F And Game Commission(Kansas Dept. Of Wildlife & Parks)	2/9/1998	Embankment Slide	No
H	Greenwood	KS02308	Upper Verdigris Watershed Dam 7-7	11/1/1998	Inflow Flood - Hydrologic Event	No
H	Greenwood	KS02311	Upper Verdigris Watershed Dam 9-2	11/1/1998	Inflow Flood - Hydrologic Event	No
H	Greenwood	KS02312	Upper Verdigris Wjd No 24, Frd No 9-3	11/1/1998	Inflow Flood - Hydrologic Event	No

MT Planning Region	County	NID #	Dam Name	Incident Date	Incident Type	Dam Failure
H	Greenwood	KS02310	Upper Verdigris Watershed Dam 9-1	11/1/1998	Inflow Flood - Hydrologic Event	No
L	Leavenworth	KS01251	Larson, Dr. O.M.	1/22/2001	Piping; Seepage	No
J	Shawnee	KS02885	Ksnoname 2885	1/23/2001	Concrete Deterioration	No
K	Douglas	KS00310	Augusta, City Of, Santa Fe Lake Dam	3/8/2001	Erosion/Animal Burrows	No
G	Butler	KS00309	Augusta, City Of, Augusta Waterworks Dam	3/8/2001	Erosion/Slides	No
F	Saline	KS04632	Ksnoname 4632	3/20/2001	Erosion/Wave Damage	No
F	Lincoln	KS04661	Day, William E.	7/6/2001	Concrete Deterioration	No
J	Miami	KS02504	Louisburg, City Of	7/25/2001	Head cut in the emergency spillway; submerged outlet; principal spillway pipe leakage; hydrologically inadequate	No
L	Leavenworth	KS01253	Demaranville, Don, Sarcoxie Lake Dam	7/25/2001	Seepage; Headcut in the emergency spillway	No
K	Douglas	KS02540	Douglas County, Lone Star Lake	8/15/2001	Cracking; Embankment Erosion	No
G	Kingman	KS03730	Yeager, Yeager Lakes Dam	1/7/2002	Seepage	No
L	Wyandotte	KS02987	Ksnoname 2987	3/6/2002	Seepage	No
G	Butler	KS00309	Augusta, City Of, Augusta Waterworks Dam	3/13/2002	Embankment Slide	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.

Additional Details about notable dam failure incidents are provided below:

- **1998**: Heavy rains and high winds damaged three Kansas reservoirs: Council Grove, John Redmond, and Fall River, all of which are high hazard dams.
- **May 1978**: Maur Hill Prep School Dam (Low Hazard Dam) in Atchison County on a tributary of Whisky Creek failed when a slide occurred on the downstream face to the top of the dam, centered near the outlet pipe.
- **1967**: Timber Creek Watershed Dam 1(Low Hazard Dam) in Butler County on a tributary of Timber Creek failed as a result of three piping failures that occurred just above the contact surface of the trench excavations in the foundation of the closure section.
- **1951**: KS No Name Dam KS00003 failed and resulted in 11 fatalities.
- **June 1925:** The Mission Lake Dam and Spillway, in Horton, Kansas, was completed in 1924. During the period of June 7-8 and 15-18, 1925, heavy rainfall caused the dam to overtop and a section just west of the spillway washed out (see **Figure 3.21**). Total rainfall

reports from the U.S. Weather Bureau for this period show a total of 14.30 inches over the 12-day period. No deaths, injuries, or property damage was indicated.

Figure 3.21. Mission Lake Dam, 1925

Source: 2010 Kansas State Hazard Mitigation Plan

Levee Failure

- **2011 Flood:** USACE reported that every non-federal levee from Rulo, NE to Wolcott,KS 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 Kansas were damaged by the flooding.

Project Type	Project Name	MR Mile Markers	State	City
Federal	MRLS 500-R	501.8 to 496.8	KS	Doniphan
Federal	MRLS 482-R	467.0 to 458.0	KS	Doniphan
Federal	MRLS 471-460-R	456.6 to 441.7	MO / KS	Elwood / St. Joseph
Non-Federal	Henry Pohl Levee	412.3 to 409.9	KS	Atchison
Non-Federal	Grape-Bollin-Schwartz Levee Association	409.9 to 406.2	KS	Leavenworth
Federal	MRLS 440-R	401.35 to 391.2	KS	Atchison
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
Federal	Clyde, Kansas		KS	Clyde

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

- **2010 Flooding**: The federal Tri-County Levee was damaged in 2010**. Figure 3.22** shows the location of the damage.

Figure 3.22. 2010 Flood Damaged Levees in Kansas

Source: USACE, KC District Website,
http://www.nwk.usace.army.mil/Portals/29/docs/emergencymanagement/leveerehab/LeveeRepairs-Status-KS.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 3.23** show the location of the damage.

Figure 3.23. 2009 Flood Damaged Levees

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

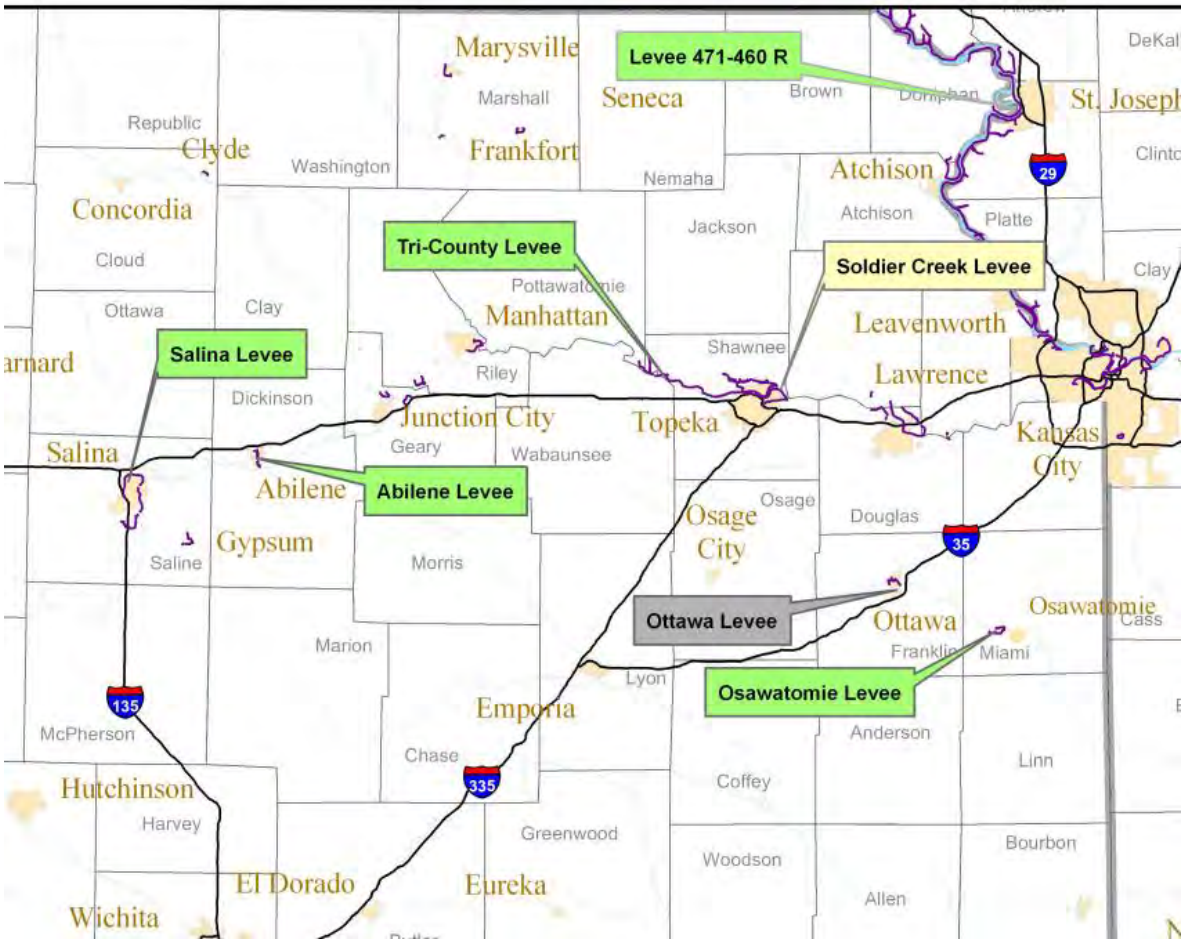
- **2008 Flooding:** Flooding in 2008 caused minor damage to several Kansas Levees as follows: MRLS 5-12-513 R, MRLS 482-R, MRLS 471-460. The map in **Figure 3.24** shows these levees along with several levees in Missouri that were damaged.

Figure 3.24. 2008 Flood Damaged Levees

Source: USACE KC District Website, http://www.nwk.usace.army.mil/Portals/29/docs/emergencymanagement/leveerehab/LeveeRepairs-Status-08%20flood-May21-2010.pdf

- **2007 Flood**: Heavy rains in caused widespread flooding in Kansas, particularly impacting Southeast Kansas. **Figure 3.25** shows damaged levees in Kansas that are under the jurisdiction of the KC District of USACE including MRLS 471-460 R, Tri-County Levee, Soldier Creek Levee, Salina Levee, Abilene Levee, and Ottawa Levee.

Figure 3.25. 2007 Flood Damaged Levees in Kansas.



Source: USACE KC District Website, http://www.nwk.usace.army.mil/Portals/29/docs/emergencymanagement/leveerehab/KSLeveeRepairs-Status%2007%20flood-May21-2010.pdf

During the night of June 30, 2007, the Verdigris River overflowed the levee around Coffeyville, Kansas. River levels rose rapidly and exceeded the height of the levee by 3.9 feet. As a result of this overtopping, flood waters entered the Coffeyville Refinery and caused a release of approximately 90,000 gallons of crude oil (see **Figure 3.26**).

Figure 3.26. Levee in Coffeyville, KS Overtopped During 2007 Floods

Source: Kansas Division of Water Resources

- **1998 Flooding:** November flooding damaged the Augusta Levee as a result of the Whitewater River breaching the city's levee system at several locations along the west side of Augusta. Subsequent to the flooding (2011), USACE began a project to raise and extend the levee to provide 500-year protection.
- **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

Probability of Future Hazard Events

Dam Failure

The variability of the size and construction of the dams in Kansas makes estimating the probability of dam failure difficult on any scale less 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. 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. Levees in 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 in the State of Kansas, This hazard‘s CPRI probability is ~~U~~**nlikely**” (event is possible within the next 10 years).

State Vulnerability Analysis

Dam Failure

The State requires emergency action plans for all high and significant hazard dams. Of the 227 high hazard dams, 111 have emergency action plans, and of the 209 significant hazard dams, only 19 have emergency action plans.

The 2009 Kansas Water Plan states that some dams are exhibiting structural deficiencies because of age, while post-construction development downstream of others has raised their hazard class.

The average age of the 3,882 dams with completion dates in the state‘s inventory database is 38.5 years old, and some of them are exhibiting structural deficiencies. Common problems with older dams include:

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

Nationally, there is growing concern that many small flood control dams, which were built by local watershed districts with U.S. Department of Agriculture technical and financial assistance are at or near the end of their 50-year planned design life. There are 776 watershed dams in Kansas built with this support that now qualify for rehabilitation assistance along with 55 other watershed dams (for a total of 831).

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 3.41 shows the results of this analysis for each county, grouped by Mitigation Planning Region.

Table 3.41. 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 A							
Cheyenne	27	0	0	0		27	Medium-Low
Decatur	34	0	0	0		34	Medium Low
Gove	22	0	0	0		22	Low
Logan	19	1	0	0		21	Low
Rawlins	25	1	2	2		37	Medium-Low
Sheridan	15	1	0	0		17	Low
Sherman	10	0	0	0		10	Low
Thomas	10	0	0	0		10	Low
Wallace	11	0	0	0		11	Low
Subtotal	**173**	**3**	**2**	**2**	**0**	**189**	
Mitigation Planning Region B							
Ellis	26	0	1	0		29	Medium-Low
Graham	49	0	0	0		49	Medium-Low
Ness	41	1	2	1		51	Medium
Norton	61	0	0	0	1	64	Medium
Phillips	67	0	0	0	1	70	Medium
Rooks	56	1	1	1	1	66	Medium
Rush	26	9	1	1		49	Medium-Low
Russell	36	0	0	0	1	39	Medium-Low
Trego	23	0	0	0	1	26	Low
Subtotal	**385**	**11**	**5**	**3**	**5**	**443**	
Mitigation Planning Region C							
Grant	7	0	0	0		7	Low
Greeley	4	0	0	0		4	Low
Hamilton	31	0	0	0		31	Medium-Low
Kearny	20	1	3	2		35	Medium-Low
Lane	25	0	0	0		25	Low
Morton	0	0	0	0		0	Low
Scott	7	0	0	0		7	Low
Stanton	12	0	0	0		12	Low
Stevens	8	0	0	0		8	Low
Wichita	12	0	0	0		12	Low
Subtotal	**126**	**1**	**3**	**2**	**0**	**141**	
Mitigation Planning Region D							
Clark	19	0	0	0		19	Low

County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Federal Reservoirs	Vulnerability Rating	Vulnerability Level
Finney	56	0	1	0		59	Medium
Ford	16	0	0	0		16	Low
Gray	12	0	4	0		24	Low
Haskell	2	0	0	0		2	Low
Hodgeman	28	1	2	2		40	Medium-Low
Meade	17	0	0	0		17	Low
Seward	6	0	0	0		6	Low
Subtotal	**156**	**1**	**7**	**2**	**0**	**183**	
Mitigation Planning Region E							
Barber	91	1	1	0		96	Medium-High
Barton	16	0	3	2		29	Medium-Low
Comanche	26	1	0	0		28	Medium-Low
Edwards	3	0	0	0		3	Low
Kiowa	8	0	0	0		8	Low
Pawnee	21	1	0	0		23	Low
Pratt	9	0	0	0		9	Low
Stafford	2	0	0	0	1	5	Low
Subtotal	**176**	**3**	**4**	**2**	**1**	**201**	
Mitigation Planning Region F							
Clay	46	0	0	0	1	49	Medium-Low
Cloud	36	0	0	0		36	Medium-Low
Dickinson	88	4	2	2		106	Medium-High
Ellsworth	61	1	1	1	1	71	Medium
Jewell	56	1	0	0	1	61	Medium
Lincoln	82	9	4	3		118	Medium-High
Mitchell	35	5	2	0	1	54	Medium
Osborne	90	2	0	0		94	Medium
Ottawa	106	6	2	2		128	Medium-High
Republic	33	1	0	0		35	Medium-Low
Saline	95	2	1	1		104	Medium-High
Smith	82	0	0	0		82	Medium
Subtotal	**810**	**31**	**12**	**9**	**4**	**938**	
Mitigation Planning Region G							
Butler	220	10	10	2	1	277	High
Cowley	116	9	4	3		152	Medium-High
Harper	22	0	0	0		22	Low
Harvey	23	3	5	3		50	Medium-Low
Kingman	29	0	1	0	1	35	Medium-Low
Marion	25	0	0	0	1	28	Medium-Low
McPherson	28	0	1	1		33	Medium-Low
Reno	18	0	0	0	1	21	Low

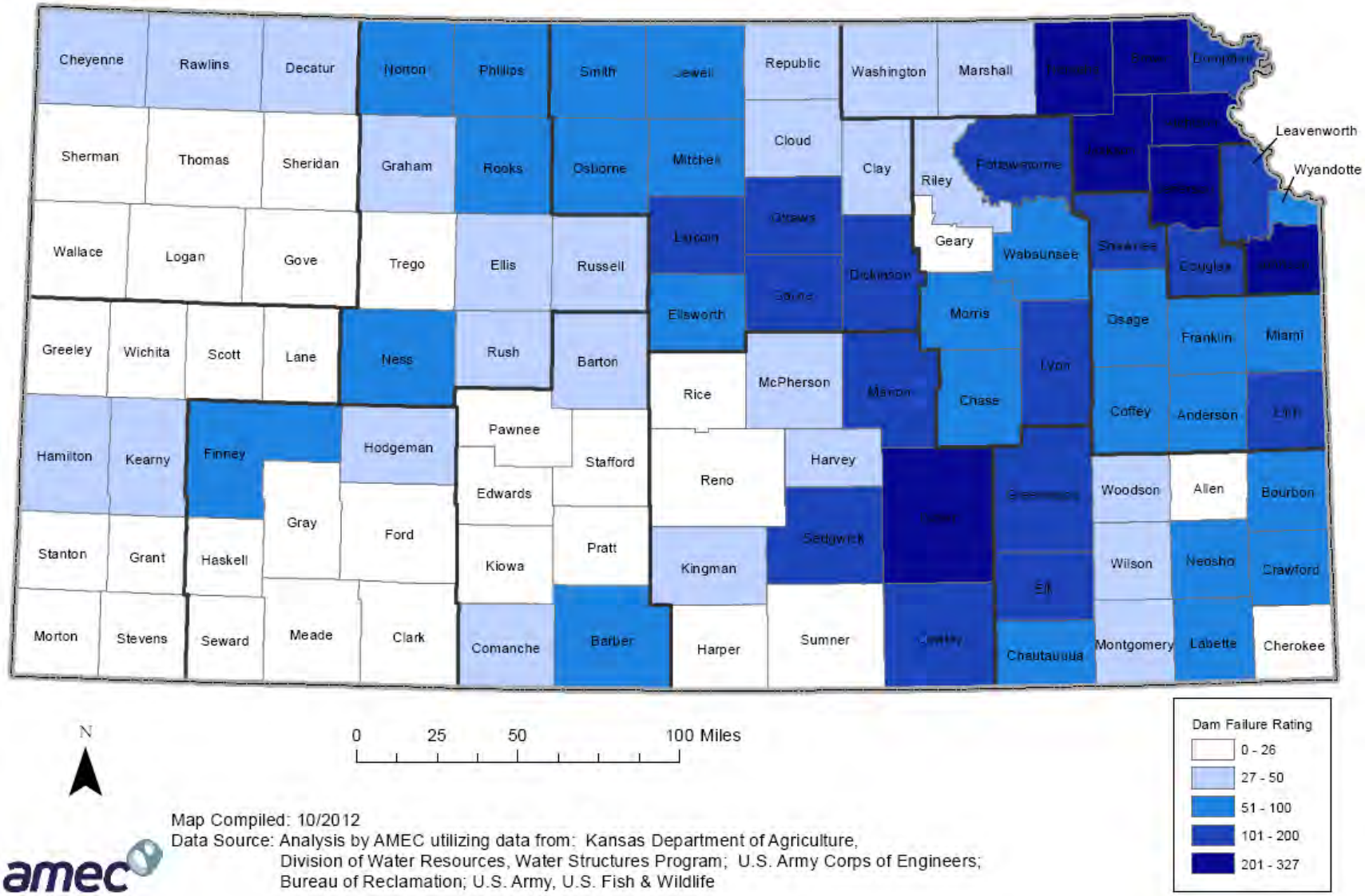
County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Federal Reservoirs	Vulnerability Rating	Vulnerability Level
Rice	17	0	0	0		17	Low
Sedgwick	68	3	6	6	1	107	Medium-High
Sumner	9	1	1	0		14	Low
Subtotal	**575**	**26**	**28**	**15**	**5**	**756**	
Mitigation Planning Region H							
Allen	23	0	0	0		23	L:pw
Bourbon	77	3	5	1		100	Medium
Chautauqua	80	1	3	0		91	Medium
Cherokee	8	0	0	0		8	Low
Crawford	59	2	1	0		66	Medium
Elk	80	6	3	3		107	Medium-High
Greenwood	148	8	4	4	1	187	Medium-High
Labette	55	3	0	0	2	67	Medium
Montgomery	39	0	2	1	1	50	Medium-Low
Neosho	64	1	1	1		71	Medium
Wilson	42	0	1	0		45	Medium-Low
Woodson	43	1	0	0	1	48	Medium-Low
Subtotal	**718**	**25**	**20**	**10**	**5**	**863**	
Mitigation Planning Region I							
Chase	77	7	0	0		91	Medium
Geary	10	0	2	2	1	23	Low
Lyon	96	14	3	2		137	Medium-High
Morris	46	1	4	4	1	71	Medium
Pottawatomie	84	4	6	4	1	121	Medium-High
Riley	14	0	4	4		34	Medium-Low
Wabaunsee	48	5	3	1		69	Medium
Subtotal	**375**	**31**	**22**	**17**	**3**	**546**	
Mitigation Planning Region J							
Anderson	52	1	1	1		59	Medium
Coffey	54	2	1	1	1	66	Medium
Franklin	66	2	2	2		80	Medium
Linn	66	6	9	7	1	122	Medium-High
Miami	64	2	4	3	1	89	Medium
Osage	43	6	5	1	2	78	Medium
Shawnee	139	3	11	6		190	Medium-High
Subtotal	**484**	**22**	**33**	**21**	**5**	**684**	
Mitigation Planning Region K							
Atchison	149	7	20	1		225	High
Brown	211	9	4	1		243	High
Doniphan	100	1	0	0		102	Medium-High

County	Low Hazard Dams	Significant Hazard Dams	High Hazard Dams	High Hazard Dams Without EAP	Federal Reservoirs	Vulnerability Rating	Vulnerability Level
Douglas	90	3	9	2	1	130	Medium-High
Jackson	241	9	2	1		267	High
Jefferson	309	5	1	1	1	327	High
Marshall	120	3	4	3		144	Medium-High
Nemaha	195	3	1	1		206	High
Washington	43	1	0	0		45	Medium-Low
Subtotal	**1,458**	**41**	**41**	**10**	**2**	**1,689**	
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
	256	**14**	**50**	**23**	**3**	**489**	
Statewide Totals	**5,692**	**209**	**227**	**116**	**33**	**7,122**	

Source: Analysis by AMEC utilizing data from: 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.

The map in **Figure 3.27** displays the results of this analysis on a statewide map.

Figure 3.27. Dam Failure Vulnerability Analysis Map



Map Compiled: 10/2012
Data Source: Analysis by AMEC utilizing data from: 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 & Wildlife

Table 3.42 shows the top ten counties by dam failure vulnerability rating based on the vulnerability analysis methodology described above.

Table 3.42. 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

During the development of this plan, the Kansas Department of Agriculture, Division of Water Resources was working on a project to complete dam inundation mapping for High and Significant hazard dams. This project will be ongoing until the fall of 2013. It is recommended that the State develop a state-wide dam inundation GIS layer that could be utilized to provide a more accurate analysis of vulnerability to dam inundation. A statewide dam inundation does not exist at this time.

Levee Failure

Delineation of areas protected is included in the MLI geodatabase 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 3.43 provides a breakdown by county of the population, structure value, contents value, and total value in levee protected areas for the 107 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 3.43. Populations and Values Protected by Levees (by Mitigation Planning Region)

Mitigation Planning Region	County	Structure Exposure (1,000s)	Contents Exposure (1000s)	Total Exposure (1000s)	Population
B	Ellis	$672,560	$491,610	$1,164,170	9,603
B Total		**$672,560**	**$491,610**	**$1,164,170**	**9,603**
D	Ford	$228,951	$184,417	$413,368	4,728
D Total		**$228,951**	**$184,417**	**$413,368**	**4,728**
E	Barton	$1,073,579	$774,543	$1,848,122	16,751
E	Pawnee	$21,651	$13,712	$35,363	317
E Total		**$1,095,230**	**$788,255**	**$1,883,485**	**17,068**
F	Cloud	$48,820	$34,294	$83,114	716
F	Dickinson	$257,135	$181,460	$438,595	3,543
F	Lincoln	$10,470	$7,311	$17,781	132
F	Saline	$2,710,233	$1,911,342	$4,621,575	41,580
F Total		**$3,026,658**	**$2,134,407**	**$5,161,065**	**45,971**
G	Butler	$112,534	$87,719	$200,253	1,609
G	Cowley	$852,599	$588,649	$1,441,248	12,904
G	Harvey	$125,137	$85,784	$210,921	1,730
G	Marion	$86,743	$63,698	$150,441	1,235
G	Reno	$2,998,904	$2,091,474	$5,090,378	45,171
G	Sedgwick	$10,394,195	$7,786,667	$18,180,862	140,247
G Total		**$14,570,112**	**$10,703,991**	**$25,274,103**	**202,896**
H	Allen	$787	$525	$1,312	20
H	Montgomery	$133,263	$100,311	$233,574	1,581
H Total		**$134,050**	**$100,836**	**$234,886**	**1,601**
I	Geary	$69,954	$41,742	$111,696	2,161
I	Lyon	$12,569	$6,557	$19,126	175
I	Pottawatomie	$83,439	$89,323	$172,762	249
I	Riley	$292,028	$229,846	$521,874	3,068
I Total		**$457,990**	**$367,468**	**$825,458**	**5,653**
J	Coffey	$4,388	$2,737	$7,125	61
J	Franklin	$166,108	$120,730	$286,838	2,110
J	Miami	$147,029	$86,116	$233,145	2,711
J	Shawnee	$1,318,189	$960,065	$2,278,254	19,047
J Total		**$1,635,714**	**$1,169,648**	**$2,805,362**	**23,929**
K	Atchison	$2,514	$1,378	$3,892	25
K	Brown	$3,522	$1,764	$5,286	74
K	Doniphan	$124,737	$97,152	$221,889	1,983
K	Douglas	$212,635	$156,061	$368,696	2,609
K	Jefferson	$11,002	$6,492	$17,494	161
K	Marshall	$145,529	$102,086	$247,615	1,785
K Total		**$499,939**	**$364,933**	**$864,872**	**6,637**
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**
Statewide Totals		**$23,625,735**	**$17,731,017**	**$41,356,752**	**322,098**

Source: FEMA Mid-term Levee Inventory, 2010

According to this analysis, both the greatest number of people and the highest value of development protected by levees are in Sedgwick County in Mitigation Planning Region G, followed by Reno County also in Planning Region G.

The map in **Figure 3.28** provides a statewide comparison based on total exposure of development in levee protected areas.

Figure 3.28. Value of Development in Levee Protected Areas

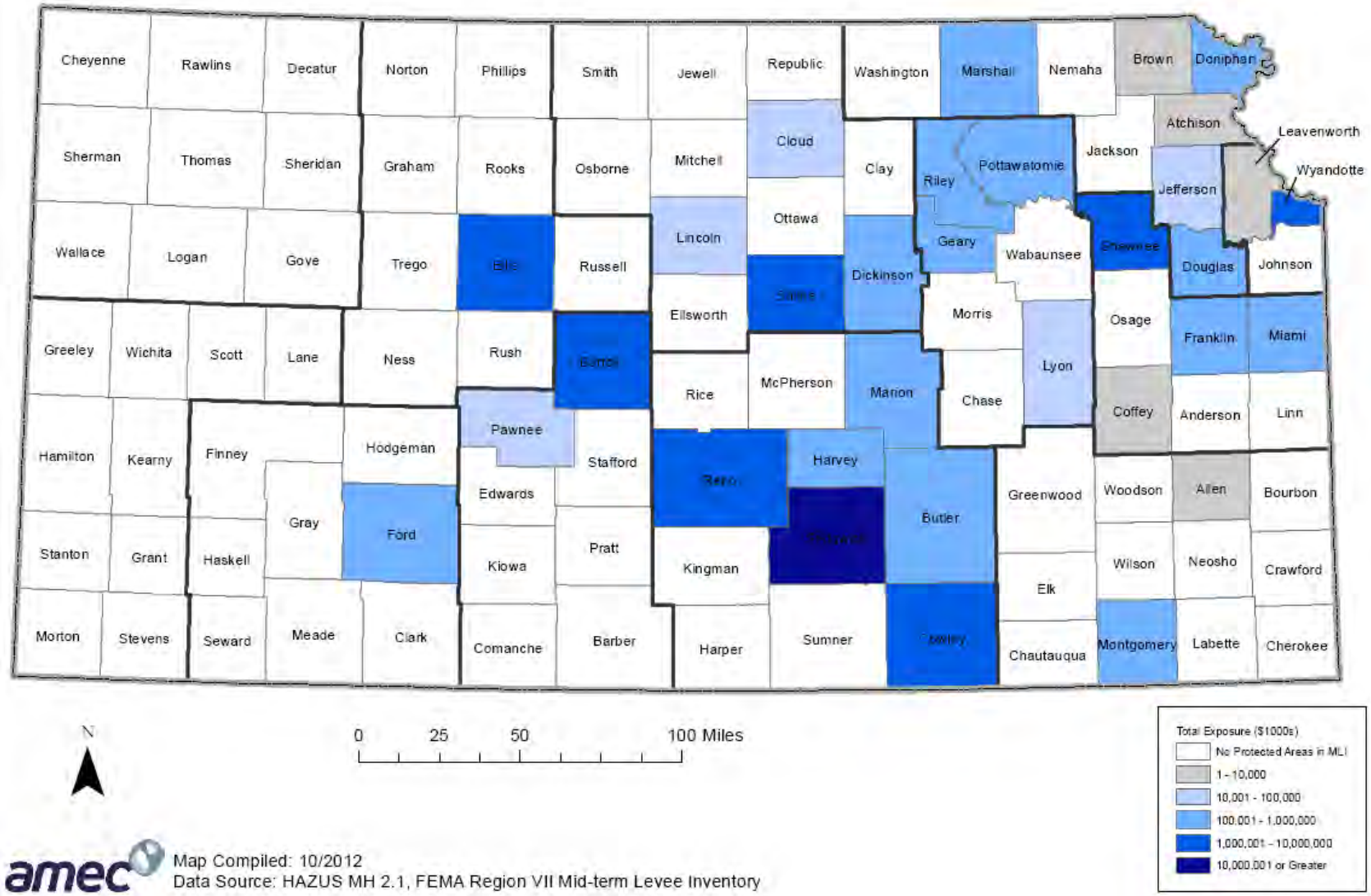


Table 3.44. Top 10 Counties--Development and Populations Protected by Levees

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

State Estimates of Potential Losses

Dam Failure

Inundation maps for state-regulated and federal dams are not readily available to determine loss estimates based on inundation areas. As inundation maps are developed for significant and high hazard dams, local hazard mitigation plans should work to develop potential loss estimates for dam failure events. At this time, it is not anticipated that a statewide dam inundation layer will be developed. Therefore, the State will rely on potential loss estimates generated in local plans for this hazard.

Levee Failure

To estimate potential losses associated with levee failure, 20 percent loss was considered for all development (structure and contents) in levee protected areas as defined on the Mid-term Levee Inventory. The 20 percent damage estimation is based on FEMA Flood Insurance Administration (FIA) depth-damage curves for a one-story structure with no basement flooded to two feet. Again, this analysis does not intend to make a determination as to specific levees that are prone to failure, but rather demonstrate an overall worst case scenario for those counties if they were all to fail in an event causing an average 20 percent in damages to the development protected by those levees**. Table 3.45** has the potential loss estimates for levee failure.

Table 3.45. State Estimates of Potential Loss-Levee Failure (by Mitigation Planning Region)

Mitigation Planning Region	County	Value of Development in Levee Protected Areas (1,000s)	Loss Estimates at 20% Damage (1000s)
B	Ellis	$1,164,170	$232,834
B Total		**$1,164,170**	$232,834
D	Ford	$413,368	$82,674
D Total		$413,368	$82,674
E	Barton	$1,848,122	$369,624
E	Pawnee	$35,363	$7,073
E Total		**$1,883,485**	$376,697
F	Saline	$4,621,575	$924,315
F	Dickinson	$438,595	$87,719
F	Cloud	$83,114	$16,623
F	Lincoln	$17,781	$3,556
F Total		**$5,161,065**	$1,032,213
G	Sedgwick	$18,180,862	$3,636,172
G	Reno	$5,090,378	$1,018,076
G	Cowley	$1,441,248	$288,250
G	Harvey	$210,921	$42,184
G	Butler	$200,253	$40,051
G	Marion	$150,441	$30,088
G Total		**$25,274,103**	$5,054,821
H	Montgomery	$233,574	$46,715
H	Allen	$1,312	$262
H Total		**$234,886**	$46,977
I	Riley	$521,874	$104,375
I	Pottawatomie	$172,762	$22,339
I	Geary	$111,696	$34,552
I	Lyon	$19,126	$3,825
I Total		**$825,458**	$165,092
J	Shawnee	$2,278,254	$455,651
J	Franklin	$286,838	$46,629
J	Miami	$233,145	$57,368
J	Coffey	$7,125	$1,425
J Total		**$2,805,362**	$561,072
K	Douglas	$368,696	$73,739
K	Marshall	$247,615	$44,378
K	Doniphan	$221,889	$49,523
K	Jefferson	$17,494	$3,499
K	Brown	$5,286	$1,057
K	Atchison	$3,892	$778
K Total		**$864,872**	$172,974
L	Wyandotte	$2,720,200	$544,040
L	Leavenworth	$9,783	$1,957
L Total		**$2,729,983**	$545,997
Statewide Total		**$41,356,752**	$8,271,350

Development in Hazard Prone Areas

Dam Failure

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. Those counties, in order of housing unit gains are: Johnson, Shawnee, Leavenworth, and Butler. It is not known if development is occurring within dam inundation zones. Most counties within Kansas do not have ordinances prohibiting or limiting development in dam inundation areas. If additional development does occur in inundation areas, the vulnerability to this hazard also increases.

Levee Failure

Of the top 10 counties in terms of development protected by levees, four were also in the top 10 for greatest housing unit gains from 2000 to 2010. Those counties in order of housing unit gains are: Sedgwick, Shawnee, Riley, and Saline. Additionally, of the top 10 counties in terms of populations protected by levees, 2 were also in the top 10 for population gains from 2000 to 2010. Those counties in order of population gains are: Sedgwick and Shawnee. If additional development and population growth is occurring in levee protected areas, this increases the vulnerability if levee failures or overtopping occur.

Consequence 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 3.46** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.46. EMAP Consequence 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.

3.3.4. Drought

Calculated Priority Risk Index	Planning Significance
2.8	Moderate

Description/Location

Drought is generally defined as a condition of moisture levels significantly below normal for an extended period of time over a large area that adversely affects plants, animal life, and humans. 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 Kansas. 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 instream 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 Kansas's agricultural-based economy and is also relatively easy to monitor based on crop viabilities for different regions.

The National Drought Mitigation Center (NDMC) located at the University of Nebraska in Lincoln provides drought monitoring and technical assistance to all areas of the world. NDMC's website is found at http://www.drought.unl.edu/. Specific drought impacts by county are recorded at http://droughtreporter.unl.edu/.

Periods of drought are normal occurrences in all parts of Kansas. Drought in Kansas is caused by severely inadequate amounts of precipitation that adversely affect farming and ranching, surface and ground water supplies, and uses of surface waters for navigation and recreation. 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.

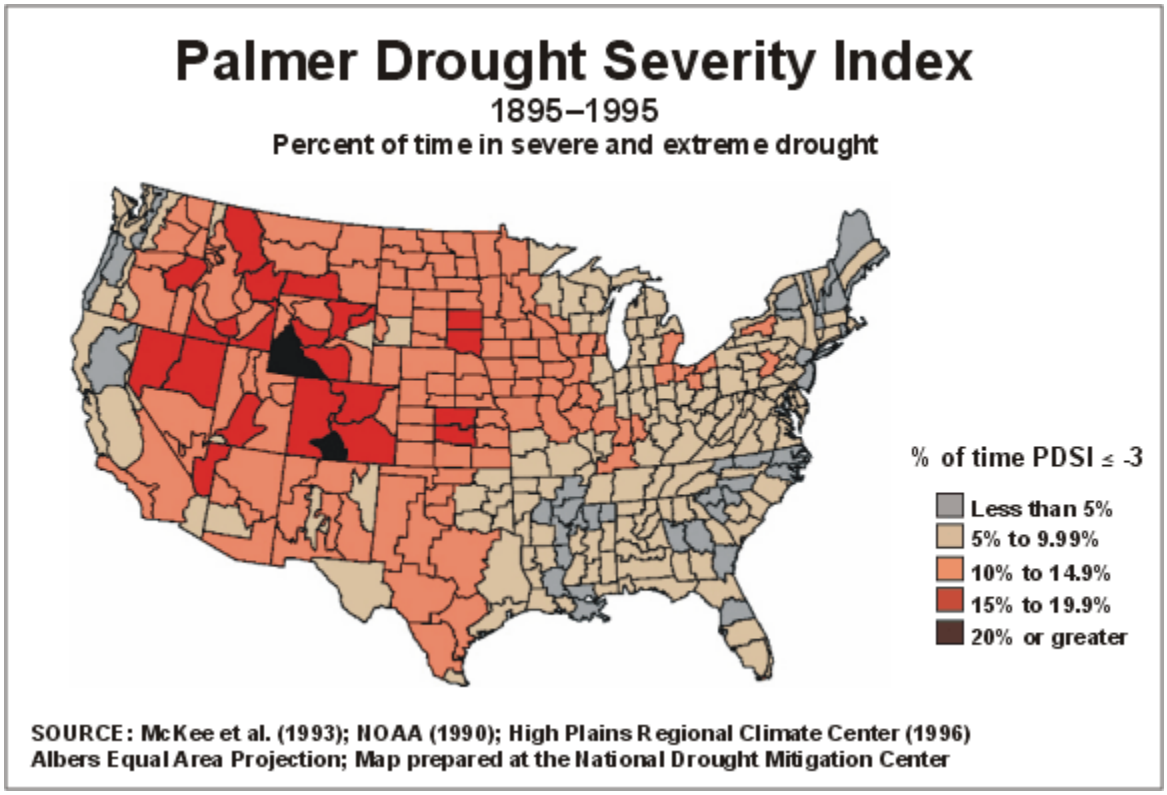
Although drought is not predictable, long-range outlooks may indicate an increased chance of drought, which can serve as a warning (P.L. 109-430 established a National Integrated Drought Information System within the National Oceanic and Atmospheric Administration to improve drought monitoring and forecasting 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.

Each year, an estimated 18 percent of the United States is impacted by drought and the nation incurs an estimated $6 to $8 billion in drought-related losses. The 2011 drought damage was estimated at $12 billion, 1988–89 drought damage was estimated at $40 billion, 1980 drought damage was estimated at $20 billion nationally and the 2012 damage amounts are predicted to

be higher than last year‘s costs of $12 billion. It is still believed, that the drought in the 1930s would have exceeded these damage level.

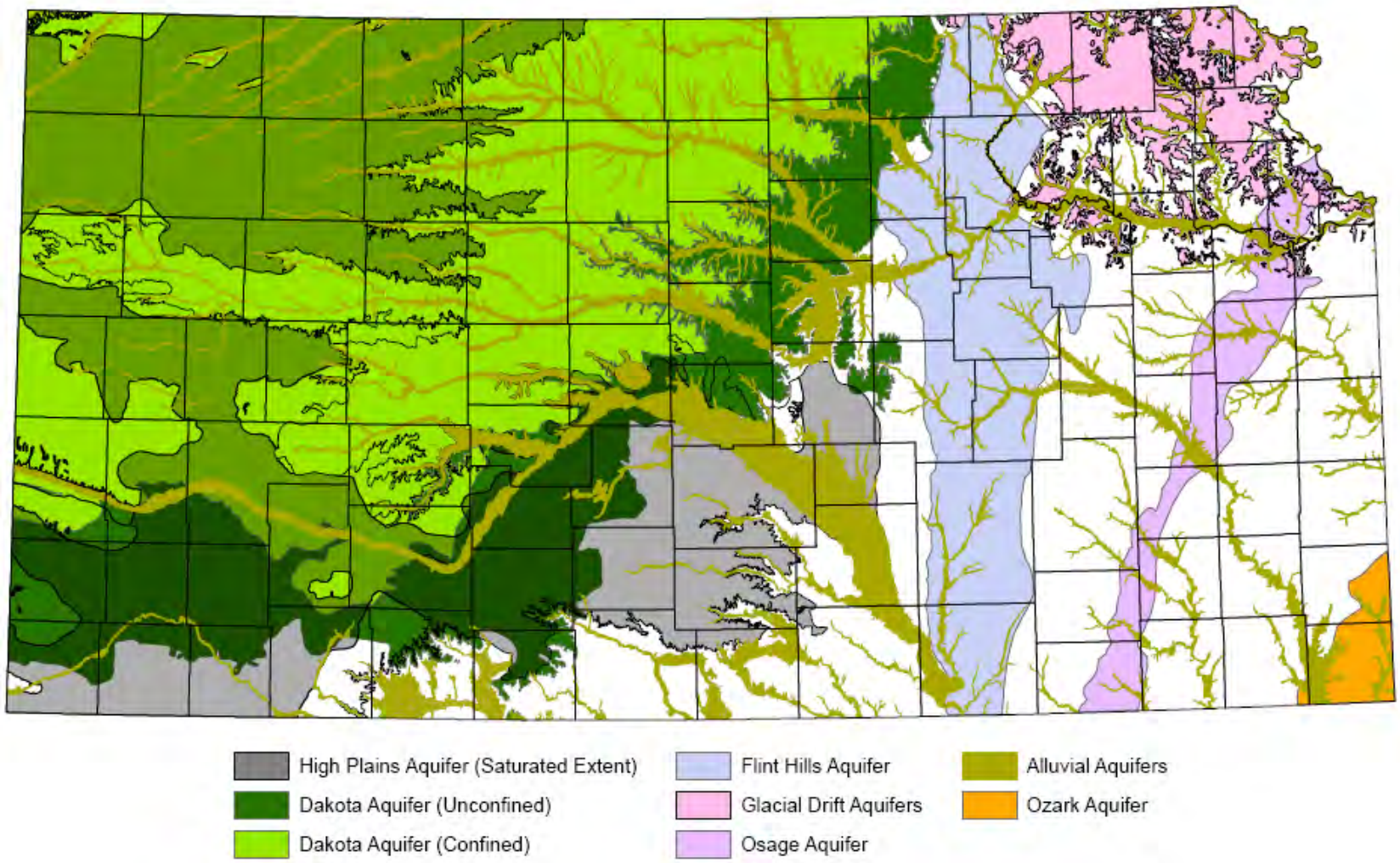
Figure 3.29 indicates that all of Kansas has experienced drought. For the 100-year period 1895-1995, most of Kansas was in severe or extreme drought 10-14.9 percent of the time, and the central and north-central portions of the state were in severe or extreme drought 15-19.9 percent of the time.

Figure 3.29. United States: Percent of Time in Drought, 1895–1995



In eastern Kansas, the primary source of water is surface water: rivers, federal reservoirs, multipurpose small lakes, and municipal lakes. In western Kansas, the primary source is groundwater drawn from wells that reach into the water bearing aquifers. While 68 percent of the State‘s public water systems rely upon groundwater sources, these systems serve only 29 percent of the population. Ground water from the Dakota aquifer is used for domestic, municipal, industrial and agricultural purposes, primarily where the aquifer is near the surface in southwestern and central Kansas. In southwestern Kansas, the Dakota is used in conjunction with the overlying High Plains aquifer (the Ogallala and associated shallow aquifers) as a source of water for irrigation. In central Kansas, the Dakota provides a good source of water for irrigation, stock watering, municipal supply and industry. In west-central Kansas, the aquifer is a primary source of water for livestock and domestic use (see **Figure 3.30**).

Figure 3.30. Major and Minor Aquifers in Kansas

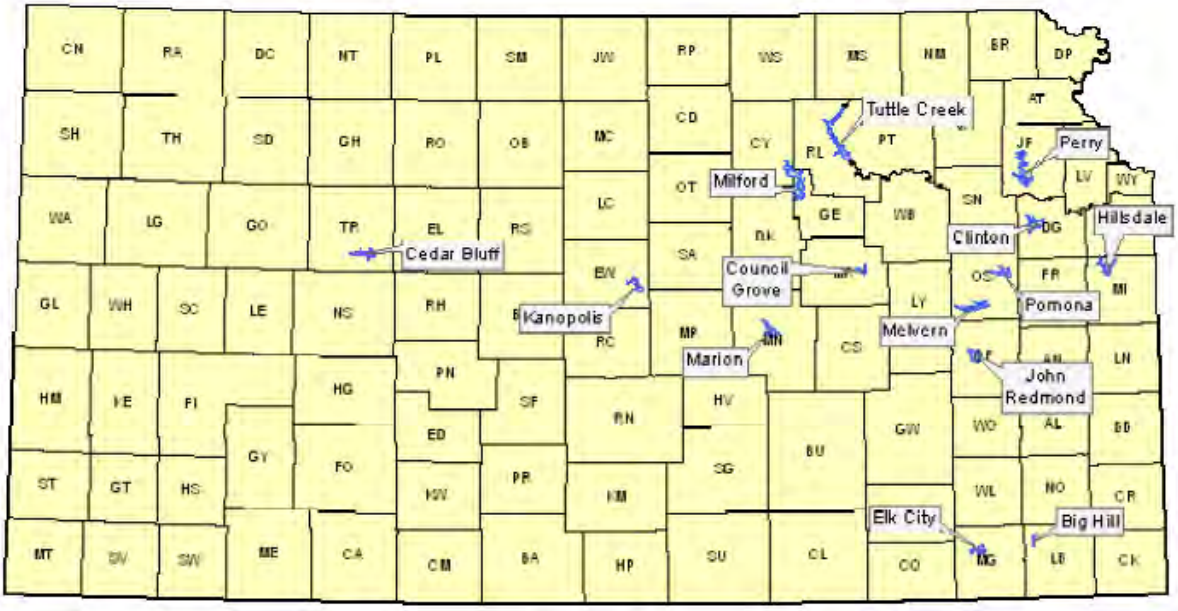


Source: Kansas Geological Survey, http://www.kgs.ku.edu

There are 24 federal reservoirs in the State 16 of which provide water either directly or indirectly through another system to roughly two-thirds of Kansas‘ citizens. The twenty-four reservoirs have a total conservation or multi-purpose storage capacity of 2.7 million acre-feet. This total does not include exclusive flood control storage. As part of the State‘s water marketing or water assurance programs, the State has contracted with the federal government for water-supply storage in thirteen of these reservoirs operated by the U.S. Army Corps of Engineers (see **Figure 3.31**). Water from this storage is sold to municipal and industrial users and is also released during times of low-flow for use by water assurance district members (see discussion of sedimentation in these reservoirs in **Section 3.3.16** Soil Erosion and Dust).

The Federal Reservoirs in **Figure 3.31** below can aid in providing water to the State during drought conditions.

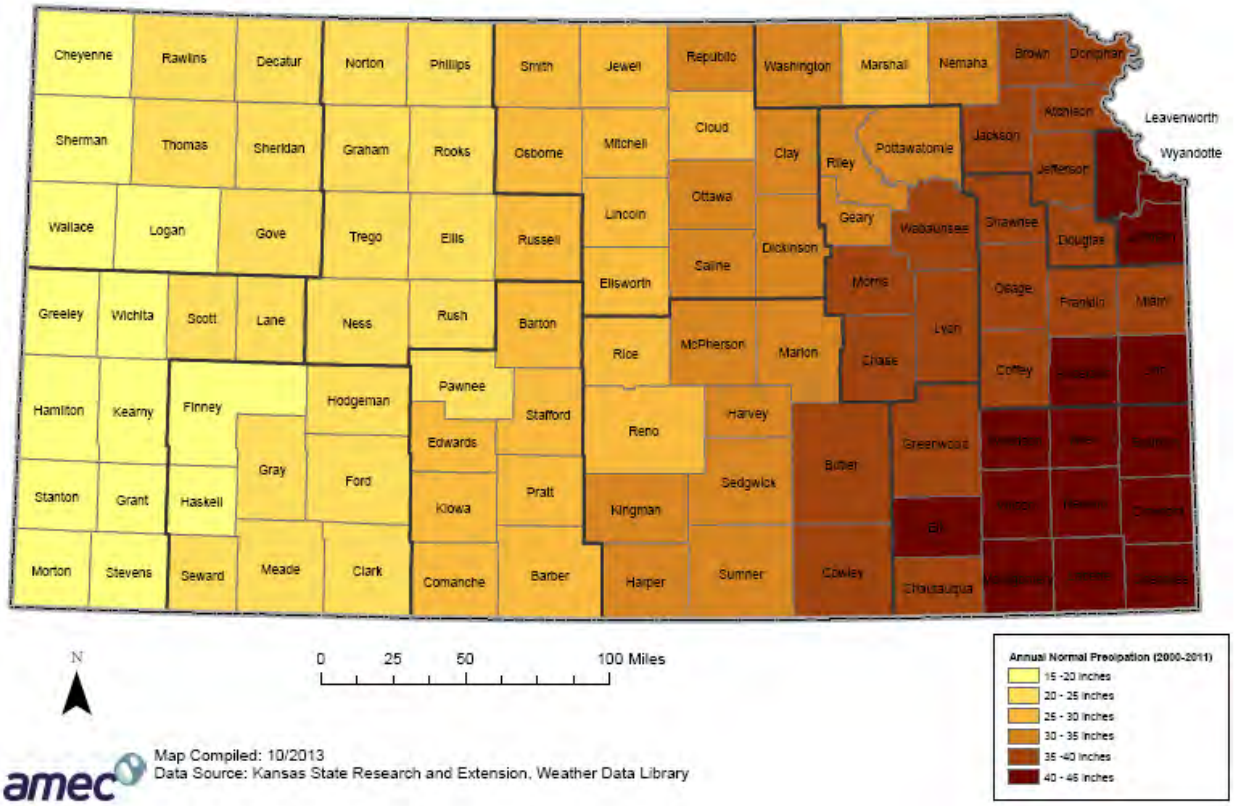
Figure 3.31. Federal Reservoirs with Water Supply Storage



Source: Kansas Water Office, www.kwo.org/ReservoirInformation/Map_Federal_Lakes_State_Storage.pdf
Note: All reservoirs are operated by the U.S. Army Corps of Engineers with the exception of Cedar Bluff. The state owns storage in the Cedar Bluff reservoir, but it is not part of the water marketing or water assurance program.

Figure 3.32 shows the annual precipitation normals for the State of Kansas from 1971 to 2000. This figure demonstrate the variations in precipitation across Kansas and how significantly the differences are from the western counties averaging only 15 to 20 inches of precipitation annually to the southeastern counties averaging 40 to 46 inches of precipitation annually.

Figure 3.32. Kansas Annual Precipitation Normals (2000-2011)

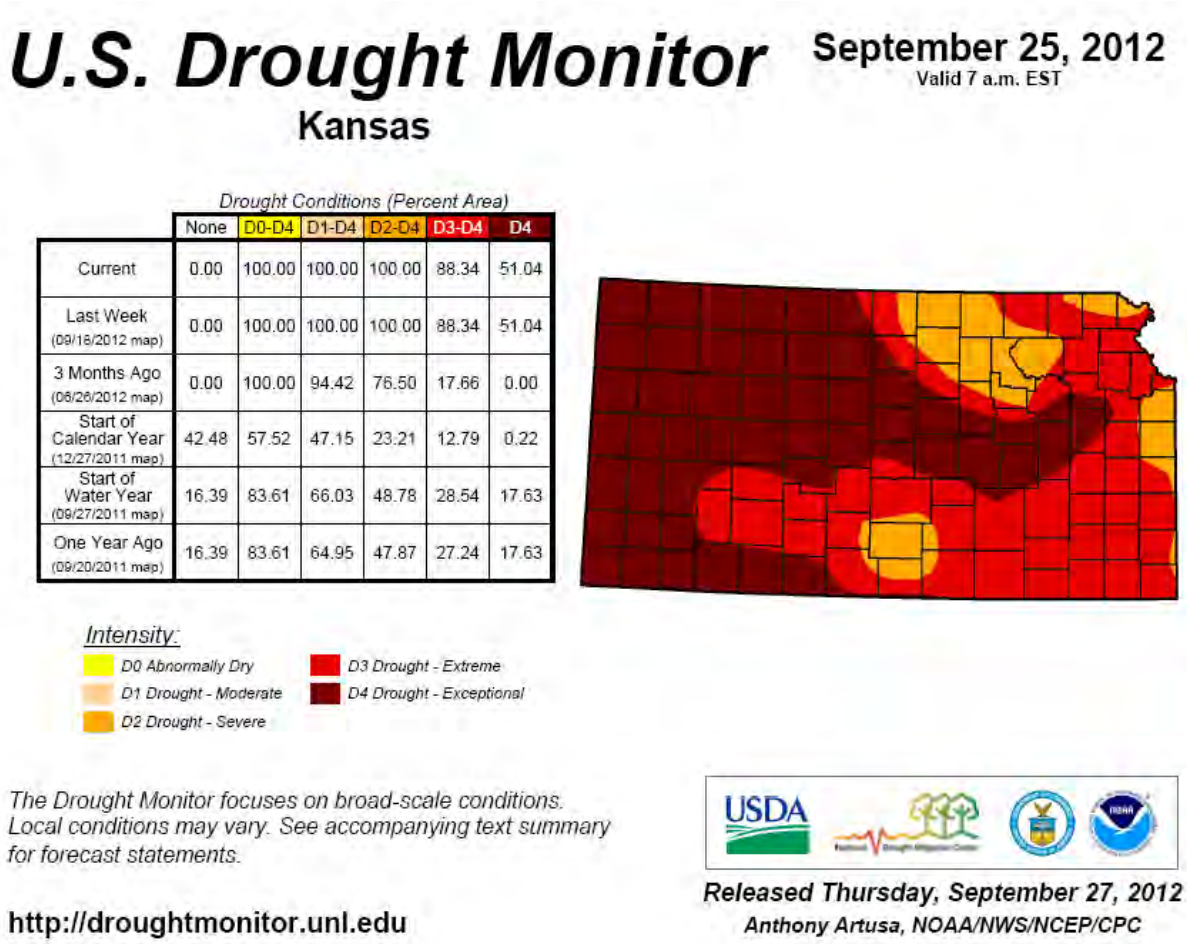


Source: Kansas State Research and Extension, Weather Data Library, http://www.ksre.ksu.edu/wdl/AnnualPrecipMaps.asp

Previous Occurrences

The U.S. Drought Monitor is a composite of several observed weather variables and drought indices that is updated weekly. It is the primary drought monitoring tool. The September 25, 2012, map (see **Figure 3.33**), shown here, indicated the entire State is severe drought or worse. Extreme drought now covers 88 percent of the State with over 50 percent of the State in exceptional drought conditions; whereas a year ago, only 27 percent of the State was classified with extreme drought conditions.

Figure 3.33. Kansas Drought Conditions, September 25, 2012



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	88.34	51.04
Last Week (09/18/2012 map)	0.00	100.00	100.00	100.00	88.34	51.04
3 Months Ago (06/26/2012 map)	0.00	100.00	94.42	76.50	17.66	0.00
Start of Calendar Year (12/27/2011 map)	42.48	57.52	47.15	23.21	12.79	0.22
Start of Water Year (09/27/2011 map)	16.39	83.61	66.03	48.78	28.54	17.63
One Year Ago (09/20/2011 map)	16.39	83.61	64.95	47.87	27.24	17.63

Kansas has had recurring periods of drought throughout history, some of them lasting for very long extended periods. As shown in **Figure 3.29**, Kansas was in severe or extreme drought between 10 and 20 percent of the last century. During this time, perhaps the most notorious drought was during the Dust Bowl years of the 1930s. During the past century, several major and numerous minor droughts affected Kansas. The Kansas Water Office has established guidelines for a phased drought response. All regions of Kansas are subject to drought of varying levels of severity and duration. **Table 3.47** summarizes Kansas county drought declarations made by the Governor between 2002 and 2012.

Table 3.47. Kansas Drought Stage 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

Date	Executive Order	Emergency	Warning	Watch	Total Counties
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
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.
First declarations under phased, three-stage response per Governor's Drought Response Team Operations Plan.
Total counties declared under all Executive Orders on that date.
EO 07-13 rescinds all county drought stages declared on 03/06/2007.

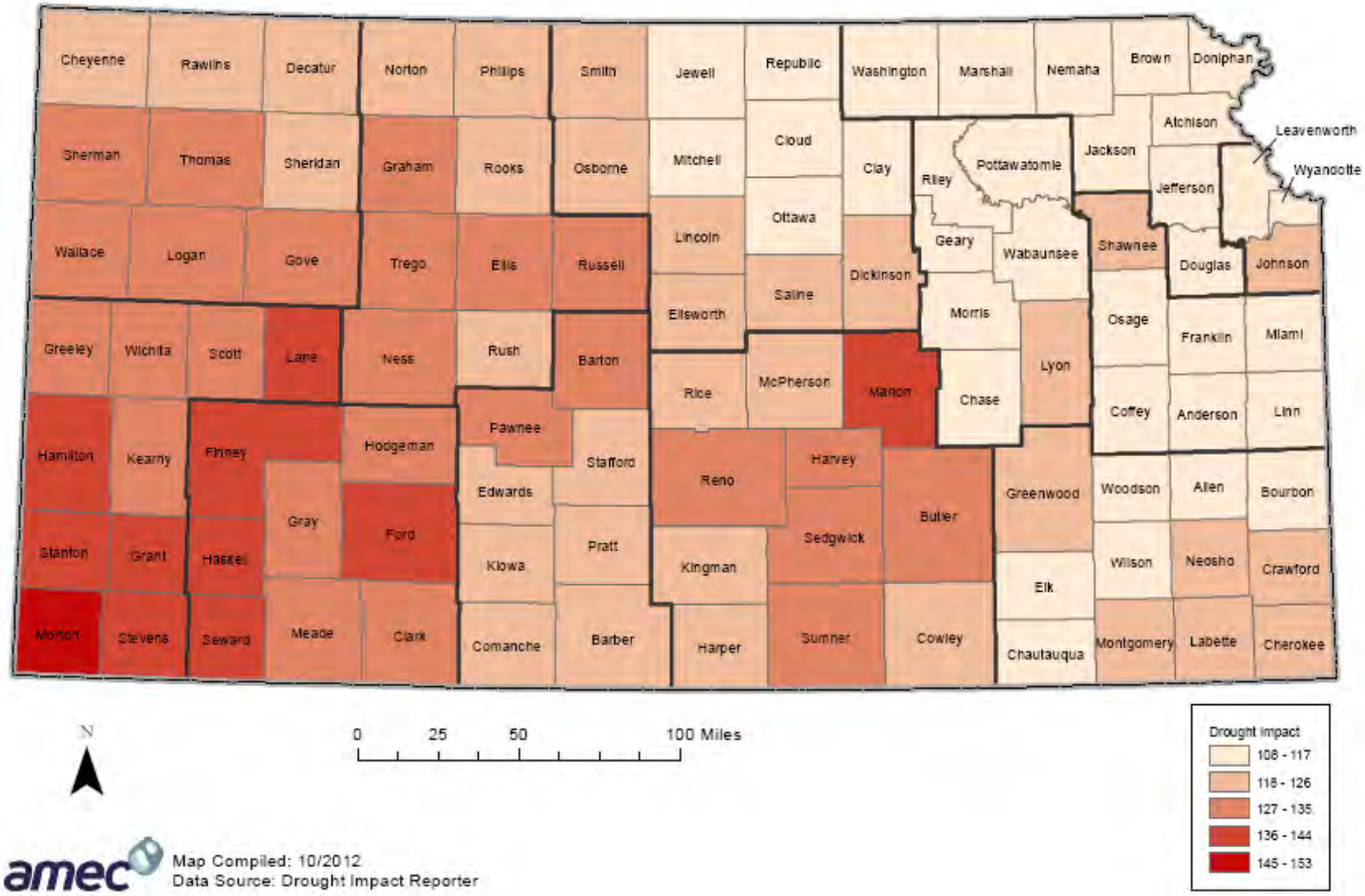
The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. The Drought Impact Reporter maps the effects of drought, based on reports from media, observers and other sources. Impacts are an observable loss or change at a specific place and time due to drought. The Drought Impact Reporter is not a comprehensive set of data, but is useful in tracking drought, if submissions are adequate, to aid in better understanding and response to drought impacts. The main emphasis is for drought planning.

The Drought Impact Reporter contains information on 363 drought impacts from droughts that affected Kansas between January 2002 and September 2012. Forty-two percent of them are from media reports. Most of the impacts, 226, were classified as "agriculture." Other impacts include "energy" (7), "plants and wildlife" (34), "society and public health" (33), "water supply and quality" (77), "business and industry" (18), "fire" (45), "relief, response, and restrictions" (85),

and —tourism and recreation" (7). These categories of agriculture, energy, plants and wildlife, society and public health, water supply and quality, business and industry, fire, relief, response, and restrictions, and tourism and recreation are described on the National Drought Mitigation Center, Drought Impact Reporter website http://droughtreporter.unl.edu/.

Figure 3.34 is a statewide map showing the 363 drought-related impacts by county that have been reported from January 2002 through September 2012. As shown, the counties of Morton and Marion have the highest reported drought impacts. Looking at the entire state, the southwest counties have historically had the most drought-related impacts in Kansas.

Figure 3.34. Kansas Drought Impacts Reported 2002- September 2012



Source: National Drought Mitigation Center, Drought Impact Reporter, http://droughtreporter.unl.edu/

- **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_sDrought Response Team which updated activities and responses. The Governor's Office created a Drought Resources Website, http://governor.ks.gov/kansas-drought-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° 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. Significant portions of southern Kansas had below normal monthly-average streamflows begin to occur in April, increasing in area and or severity each month until peaking in July.

  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.

- **2007 – 2010:** During the period of July 1, 2007 through June 1, 2010, periods of abnormal to extreme drought conditions were reported in the western two-thirds of the State. Normal to abnormally dry conditions were present throughout the Western and South Central regions by mid October. By the end of 2007, this changed to moderately dry conditions in the extreme Southwestern counties.

  By late April 2008, conditions in this area had changed to the severe level and reached extreme levels by May 27. On June 11, the Governor declared drought warnings and watches in 13 Kansas counties, via Executive Order 08-07. Under drought warnings were the following counties: Grant, Hamilton, Morton, Stanton and Stevens. Under a drought watch were the following counties: Finney, Greeley, Haskell, Kearney, Meade, Scott, Seward and Wichita. The Executive Order was lifted 60 days later on August 10, but was renewed on August 22 although Hamilton was taken out of the warning and placed into the

watch area. Finney and Scott were taken off the watch list. On August 2, the USDA issued an order implementing approval for emergency haying and grazing on Conservation Reserve Program (CRP) lands within the counties of Grant, Greeley, Hamilton, Haskell, Sherman, Stanton, Stevens and Wallace. Other major impacts of this drought period included decreased grain yields and lower wildlife survival rates. By August 26, the drought level returned to a moderate rating and from the end of October through December 30, levels were upgraded to abnormally dry.

By the end of February 2009, the Southwestern and South Central counties were downgraded to a moderate rating, but by the end of March the level was upgraded to abnormally dry. This area grew to encompass the entire western two-thirds of the State. This rating persisted until April, when the abnormally dry conditions moved into North Central and Central Kansas. These conditions remained in roughly the same areas until late September. Between this time and the end of 2009, conditions were upgraded to a normal state.

From January through mid-April of 2010, the State remained in a normal condition. Between April 13 and May 26, the South Central portion of the State downgraded to abnormally dry, but has since recovered to normal. As of June 1, 2010 the entire state is under normal drought conditions.

A total of 35 drought related impacts were reported in Kansas during this time period, including: 12 agricultural, 4 fire, 3 water/energy, 2 environmental and 14 other.

- **October 2006:** Kansas also experienced drought conditions in 2006. In October 2006, the U.S. Department of Agriculture designated 57 Kansas counties primary natural disaster areas because of losses caused by the combined effects of various disasters that occurred during the past year, including a late spring freeze, drought, high winds, and extreme temperatures. Eighteen contiguous counties were also eligible for assistance. Earlier that year, in June, Cherokee and Morton Counties were designated as primary disaster areas because of losses caused by drought, high winds, wildfires, and above normal temperatures. Contiguous counties Crawford, Labette, Stanton, and Stevens were also eligible for assistance. Two declarations in 2007 for 2006 made 15 more counties eligible for assistance as primary natural disaster areas and 19 more as contiguous counties. Provisional streamflow data from the U.S. Geological Survey indicated that several long-term low streamflow records were broken in July.

- **June 5, 2004:** The Palmer Drought Severity Index (PDSI) classified the northwest with a -5.03 rating as extreme drought rating while much of the south and east registers as near normal or wetter than normal. Western Kansas had received less than 25 percent of their normal precipitation in the month of May. Also twelve of the 24 reservoirs in Kansas were below the pool elves reported at the same time last year. Kirwin, Sebelius and Webster Lakes in northwest Kansas are all more than 12 feet below the top of the conservation pool.

- **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.

- **2001:** The Small Business Administration made economic injury disaster loans available in seventeen counties because of drought impacts.

  The U.S. Supreme Court ruled that Colorado owed Kansas $29 million in damages and interest for depleting the Arkansas River. For years, Colorado farmers dug wells that diverted millions of gallons of Arkansas River water to their fields, reducing the availability of water for Kansans.

- **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 percent 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 streamflow 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.

Insured Crop Loss Data

According to the USDA Risk Management Agency, insured crop losses through the State of Kansas as a result of drought conditions for the ten year period of 2002-2011 totaled $2,004,751,551. In **Table 3.48,** the USDA Risk Management Agency insured crop losses through the State of Kansas as a result of drought conditions are shown by year, 2002-2011. It shows the highest year of crop losses as 2011 in this 10-year period, then the years of 2002, 2006, and 2003. This information is also reported and annualized by county in **Table 3.52** in the State Estimates of Potential Losses Section. 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.

Table 3.48. Total Insured Crop Insurance Paid by Year, 2002-2011

Year	Crop Insurance Paid
2011	$738,806,086
2010	$28,851,246
2009	$24,402,619
2008	$144,605,896
2007	$21,687,555
2006	$256,320,552
2005	$49,309,653
2004	$179,430,910
2003	$223,116,504
2002	$338,220,532
Total	**$2,004,751,552**

Source: USDA Risk Management Agency

Probability of Future Hazard Events

Based on historical Kansas Drought Stage Declarations, (26 declarations in 11 years) that have affected certain counties, and the Drought Impact Reporter reporting 363 drought impacts in Kansas between January 2002 and September 2012, the State of Kansas can expect a drought occurrence at a minimum of every 3 years. This hazard's CPRI probability is ~~L~~**likely**" (probable within the next 3 years).

In recent years, drought has affected certain counties and regions of the State on a more reoccurring basis. With the possibility of climate change, this hazard may affect more regions of the State even more often.

State Vulnerability Analysis

In Kansas, 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 3.49** shows the drought stage descriptions and impacts as a combination of U.S. Drought Monitor and the Municipal Guidelines.

Table 3.49. Kansas 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 Stage 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;

Stage	U.S. Drought Monitor Description	Declared by	Possible Impacts	Response Summary
				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.

While the entire state is moderately susceptible to drought, some jurisdictions may be more at risk from drought based on such factors as the adequacy of their water supply system, dependence on agriculture, the potential adverse affects to nearby navigation and water-based recreation, and vulnerability to drought-related hazards such as expansive soils, wildfire and wind erosion. 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. As risk assessments from local mitigation plans become available, the estimated risk to individual counties from drought can be more accurately documented.

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. 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 3.50** 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. **Figure 3.35** is a state-wide map of these drought vulnerable public water suppliers by county.

Table 3.50. Kansas 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 A				
Atwood	Rawlins	Basic Source	X	
Colby	Thomas	Water Watch		X
Goodland	Sherman	Water Watch		X
Gove	Gove	Basic Source, Distribution System	X	
Grinnell	Gove	Water Right	X	
Hoxie	Sheridan	Basic Source	X	
McDonald	Rawlins	Water Right	X	
Oakley	Logan	Unknown, Water Watch	X	X
Oberlin	Decatur	Basic Source, Distribution System, Treatment Capacity & Water Warning	X	X
Park	Gove	Basic Source	X	
Quinter	Gove	Water Watch		X
Rexford	Thomas	Unknown	X	
Wallace	Wallace	Water Right, Single Well Source	X	
Wallace RWD 01	Wallace	Single Well Source	X	
Mitigation Planning Region B				
Alexander	Rush	Unknown	X	
Bunker Hill	Russell	Single Well Source	X	
Damar	Rooks	Distribution System, Contractual	X	
Dorrance	Russell	Water Watch		X
Ellis	Ellis	Distribution System	X	
Ellis RWD 05	Ellis	Water Watch		X
Gorham	Russell	Water Watch		
Hays	Ellis	Basic Source & Water Watch	X	X
Hill City	Graham	Unknown & Water Watch	X	X
Logan	Phillips	Basic Source & Water Warning	X	X
Luray	Russell	Water Watch		X
Morland	Graham	Unknown	X	
Ness City	Ness	Unknown & Water Watch	X	X
Norton	Norton	Unknown	X	
Norton RWD 01	Norton	Single Well Source	X	
Otis	Rush	Water Warning		X
Palco	Rooks	Distribution System	X	
Paradise	Russell	Water Watch		X
Phillipsburg	Phillips	Water Warning		X
Post Rock RWD (Ellsworth RWD 01)	Ellis	Water Watch		X
Ransom	Ness	Basic Source	X	
Rooks RWD 02	Rooks	Single Well Source	X	
Russell	Russell	Basic Source, Treatment Capacity & Water Emergency	X	X
Russell RWD 02	Russell	Single Well Source	X	
Russell RWD 03	Russell	Distribution System, Water Right & Water Warning	X	X

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
Stockton	Rooks	Basic Source	X	
Victoria	Ellis	Water Warning	X	X
Waldo	Russell	Water Watch		X
Wilson Lake Estates	Russell	Water Watch		X
Mitigation Planning Region C				
Hugoton	Stevens	Distribution System	X	X
Lakin	Kearny	Basic Source		X
Lane RWD 01	Lane	Water Right	X	X
Moscow	Stevens	Basic Source	X	X
Rolla	Morton	Basic Source	X	
Scott City	Wichita	Water Warning		X
Syracuse	Hamilton	Unknown	X	
Mitigation Planning Region D				
Copeland	Gray	Water Right	X	
Dodge City	Ford	Distribution System & Water Watch	X	X
Ensign	Gray	Distribution System	X	
Liberal	Seward	Basic Source	X	X
Montezuma	Gray	Basic Source, Distribution System	X	
Mitigation Planning Region E				
Barber RWD 02	Barber	Water Watch		X
Barton RWD 02	Barton	Water Watch		X
Coldwater	Comanche	Basic Source	X	
Kinsley	Edwards	Unknown	X	
Pratt	Pratt	Unknown	X	
Susank	Barton	Basic Source, Distribution System & Water Warning	X	X
Mitigation Planning Region F				
Abilene	Dickinson	Basic Source & Water Warning	X	X
Alton	Osborne	Basic Source, Minimum Desirable Streamflow	X	
Beloit	Mitchell	Unknown	X	
Bennington	Ottawa	Water Warning		X
Brookville	Saline	Water Watch		X
Chapman	Dickinson	Unknown	X	
Clay RWD 01	Clay	Single Well Source, Minimum Desirable Streamflow & Water Right	X	
Delphos	Ottawa	Basic Source	X	
Dickinson RWD 01	Dickinson	Basic Source & Water Warning	X	X
Dickinson RWD 02	Dickinson	Water Warning		X
Downs	Osborne	Basic Source	X	
Ellsworth	Ellsworth	Minimum Desirable Streamflow, Water Right & Water Emergency	X	X
Esbon	Jewell	Unknown	X	

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
Glen Elder	Mitchell	Unknown	X	
Herington	Dickinson	Water Watch		X
Kanopolis	Ellsworth	Basic Source	X	
Lincoln	Lincoln	Basic Source	X	X
Manchester	Dickinson	Unknown	X	
Morganville	Clay	Basic Source & Water Watch	X	X
Osborne	Osborne	Basic Source	X	
Osborne RWD 02	Osborne	Water Watch		X
Randall	Jewell	Unknown	X	
Salina	Saline	Basic Source & Water Watch	X	X
Saline RWD 03	Saline	Water Watch		X
Saline RWD 07	Saline	Water Watch		X
Smith Center	Smith	Basic Source	X	
Tescott	Ottawa	Basic Source	X	
Tipton	Mitchell	Basic Source	X	
Mitigation Planning Region G				
Arlington	Reno	Basic Source	X	
Attica	Harper	Basic Source	X	
Augusta	Butler	Water Emergency		X
Bluff City	Harper	Single Well Source	X	
Burrton	Harvey	Basic Source, Distribution System	X	
Butler RWD 04	Butler	Contractual	X	
Caldwell	Sumner	Water Warning		X
Cambridge	Cowley	Contractual	X	
Derby (El Paso WC)	Sedgwick	Distribution System	X	
Dexter	Cowley	Contractual	X	
Florence	Marion	Water Watch		X
Geneseo	Rice	Unknown	X	
Goddard	Sedgwick	Distribution System	X	
Goessel	Marion	Water Warning		X
Hesston	Harvey	Basic Source, Water Right	X	X
Hillsboro	Marion	Water Watch		X
Inman	Reno	Basic Source	X	
Leon	Butler	Basic Source	X	
Lindsborg	McPherson	Basic Source	X	X
Lyons	Rice	Unknown & Water Watch	X	X
Marion	Marion	Water Watch		X
Marion Improvement District 02	Marion	Water Watch		X
McPherson RWD 06	McPherson	Water Watch		X
Mulvane	Butler	Water Emergency		X
Peabody	Marion	Unknown & Water Watch	X	X
Sedgwick RWD 02	Sedgwick	Contractual	X	
Zenda	Kingman	Single Well Source	X	

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
		Mitigation Planning Region H		
Allen RWD 04	Allen	Water Warning		X
Allen RWD 06	Allen	Water Warning		X
Allen RWD 08	Allen	Water Warning		X
Allen RWD 16	Allen	Water Warning		X
Altamont	Labette	Water Watch		X
Bartlett	Labette	Water Watch		X
Bourbon Consolidated RWD 02	Bourbon	Distribution System, Water Watch	X	X
Cherryvale	Montgomery	Water Watch		X
Coffeyville	Montgomery	Water Watch		X
Edna	Labette	Water Watch		X
Elk City	Montgomery	Water Watch		X
Erie	Neosho	Water Warning		X
Fort Scott	Bourbon	Water Watch		X
Fulton	Bourbon	Unknown	X	
Hamilton	Greenwood	Unknown	X	
Howard	Elk	Basic Source	X	
Iola	Allen	Water Warning		X
Independence	Montgomery	Minimum Desirable Streamflow, Water Emergency	X	X
La Harpe	Allen	Water Warning		X
Labette RWD 02	Labette	Water Watch		X
Labette RWD 03	Labette	Water Watch		
Labette RWD 05	Labette	Water Watch		X
Labette RWD 06	Labette	Water Watch		X
Labette RWD 07	Labette	Water Watch		X
Labette RWD 08	Labette	Water Watch		X
Longton	Elk	Basic Source	X	
Madison	Greenwood	Basic Source	X	
Montgomery RWD 01	Montgomery	Water Emergency		X
Montgomery RWD 01C	Montgomery	Water Emergency		X
Montgomery RWD 02	Montgomery	Water Watch		
Montgomery RWD 04	Montgomery	Water Emergency		X
Montgomery RWD 06	Montgomery	Water Watch		X
Montgomery RWD 08	Montgomery	Water Emergency		X
Montgomery RWD 09	Montgomery	Water Watch		X
Montgomery RWD 12	Montgomery	Water Watch		X
Montgomery RWD 13	Montgomery	Water Watch		X
Moran	Allen	Watch Warning		X

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
Mound Valley	Labette	Water Watch		X
Neodesha	Wilson	Unknown	X	
Neosho RWD 04	Neosho	Water Warning		X
Neosho RWD 06	Neosho	Water Warning		X
Neosho RWD 07	Neosho	Water Warning		X
Neosho RWD 09	Neosho	Water Warning		X
Neosho RWD 12	Neosho	Water Warning		X
Neosho-Allen RWD 02	Neosho	Water Warning		X
Parsons	Labette	Water Warning		X
Prescott	Bourbon	Water Watch		
PWWSD No. 04	Montgomery	Water Watch		
PWWSD No. 05	Allen	Water Warning		X
Uniontown	Bourbon	Unknown & Water Watch	X	X
Walnut	Crawford	Water Warning		X
Wilson RWD 01	Wilson	Contractual	X	
Wilson RWD 02	Wilson	Contractual	X	
Wilson RWD 05	Wilson	Contractual	X	
Wilson RWD 07	Wilson	Contractual	X	
Mitigation Planning Region I				
Alma	Wabaunsee	Water Watch		X
Cedar Point	Chase	Single Well Source	X	
Cottwood Falls	Chase	Water Warning		X
Council Grove	Morris	Water Warning		X
Emporia	Lyon	Water Warning		X
Geary RWD 02	Geary	Single Well Source	X	
Hartford	Lyon	Water Warning		X
Harveyville	Wabaunsee	Water Watch		X
Junction City	Geary	Water Watch		X
Lyon RWD 01	Lyon	Water Warning		X
Lyon RWD 02	Lyon	Water Warning		X
Lyon RWD 04	Lyon	Water Warning		X
Lyon RWD 05	Lyon	Water Warning		X
Manhattan	Riley	Water Watch		X
McFarland	Wabaunsee	Basic Source		
Morris RWD 01	Morris	Water Warning		X
Olpe	Lyon	Water Warning		X
Pottawatomie RWD 01	Pottawatomie	Basic Source	X	
St. George	Pottawatomie	Basic Source	X	
White City	Morris	Basic Source	X	
Mitigation Planning Region J				
Anderson RWD 04	Anderson	Water Watch		X
Anderson RWD 05	Anderson	Water Warning		X
Burlingame	Osage	Water Watch		X

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
Fontana	Miami	Basic Source, Single Well Source	X	
Franklin RWD 01	Franklin	Contractual, Water Watch	X	X
Franklin RWD 02	Franklin	Water Watch		X
Franklin RWD 04	Franklin	Water Watch		X
Franklin RWD 06	Franklin	Water Watch		X
Garnett	Anderson	Water Watch		X
Gridley	Coffey	Water Warning		X
La Cygne	Linn	Water Watch		X
Lebo	Coffey	Water Watch		
LeRoy	Coffey	Water Warning		X
Linn RWD 02	Linn	Basic Source	X	
Louisburg	Miami	Treatment Capacity & Water Watch	X	X
Lyndon	Osage	Water Watch		X
Marais des Cygnes Public Utility Authority	Miami	Water Watch		X
Melvern	Osage	Water Watch		X
Miami RWD 01	Miami	Water Watch		X
Miami RWD 02	Miami	Water Watch		X
Miami RWD 04	Miami	Water Watch		X
New Strawn	Coffey	Water Warning		X
Osage City	Osage	Water Watch		X
Osage RWD 02	Osage	Basic Source, Distribution System & Water Watch	X	X
Osage RWD 03	Osage	Water Watch		X
Osage RWD 04	Osage	Water Watch		X
Osage RWD 05	Osage	Water Watch		X
Osage RWD 07	Osage	Water Watch		X
Osage RWD 08	Osage	Water Watch		X
Osawatomie	Miami	Water Watch		X
Oswego	Labette	Water Warning		X
Ottawa	Franklin	Water Watch		
Overbrook	Osage	Unknown	X	
Paola	Miami	Water Watch		
Pleasanton	Linn	Basic Source	X	
Pomona	Franklin	Water Watch		X
Princeton	Franklin	Water Watch		X
PWWSD No. 12	Coffey	Water Watch		X
Quenemo	Osage	Water Watch		X
Rantoul	Franklin	Water Watch		X
Rossville	Shawnee	Water Watch		X
Shawnee Consolidated RWD 01	Shawnee	Water Watch		X
Shawnee Consolidated RWD 03	Shawnee	Water Watch		X
Shawnee RWD 04C	Shawnee	Unknown	X	

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
Shawnee RWD 08	Shawnee	Water Watch		X
Topeka	Shawnee	Water Watch		X
Waverly	Coffey	Water Watch		X
Wellsville	Franklin	Distribution System & Water Watch	X	X
Williamsburg	Franklin	Water Watch		X
Mitigation Planning Region K				
Baldwin City	Douglas	Treatment Capacity, Contractual & Water Watch	X	X
Bern	Nemaha	Water Watch		X
Corning	Nemaha	Distribution System	X	
Douglas RWD 01	Douglas	Water Watch		X
Douglas RWD 02	Douglas	Water Watch		X
Douglas RWD 03	Douglas	Water Watch		X
Douglas RWD 04	Douglas	Water Watch		X
Douglas RWD 05	Douglas	Water Watch		X
Douglas RWD 06	Douglas	Water Watch		X
Effingham	Atchison	Water Watch		X
Frankfort	Marshall	Basic Source	X	
Hanover	Washington	Distribution System	X	
Hoyt	Jackson	Water Watch		X
Jackson RWD 01	Jackson	Unknown & Water Watch	X	X
Jefferson RWD 01	Jefferson	Water Watch		X
Jefferson RWD 08	Jefferson	Water Watch		
Jefferson RWD 09	Jefferson	Unknown	X	X
Jefferson RWD 13	Jefferson	Water Watch		X
Kickapoo Tribe	Brown	Basic Source, Water Warning	X	X
Lawrence	Douglas	Water Watch		X
Marysville	Marshall	Distribution System	X	
McLouth	Jefferson	Water Watch		X
Meriden (Jefferson RWD 01 customer)	Jefferson	Water Watch		X
Nemaha RWD 01	Nemaha	Basic Source & Water Watch	X	X
Nemaha RWD 02	Nemaha	Contractual, Water Watch	X	X
Nemaha RWD 03	Nemaha	Distribution System	X	
Nortonville	Jefferson	Water Watch		X
Prairie View	Jefferson	Unknown	X	
Seneca	Nemaha	Basic Source, Water Watch	X	X
Soldier	Jackson	Contractual	X	
Valley Falls	Jefferson	Basic Source & Water Watch	X	X
Washington RWD 02	Washington	Unknown	X	
Willis	Brown	Unknown	X	
Mitigation Planning Region L				
Bonner Springs	Wyandotte	Water Watch		X
Desoto	Johnson	Water Watch		X

Public Water Supplier	County	2007 Limitation Category List* and/or 2012 Conservation Stage**	2007 List	2012 Conservation Stage
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.

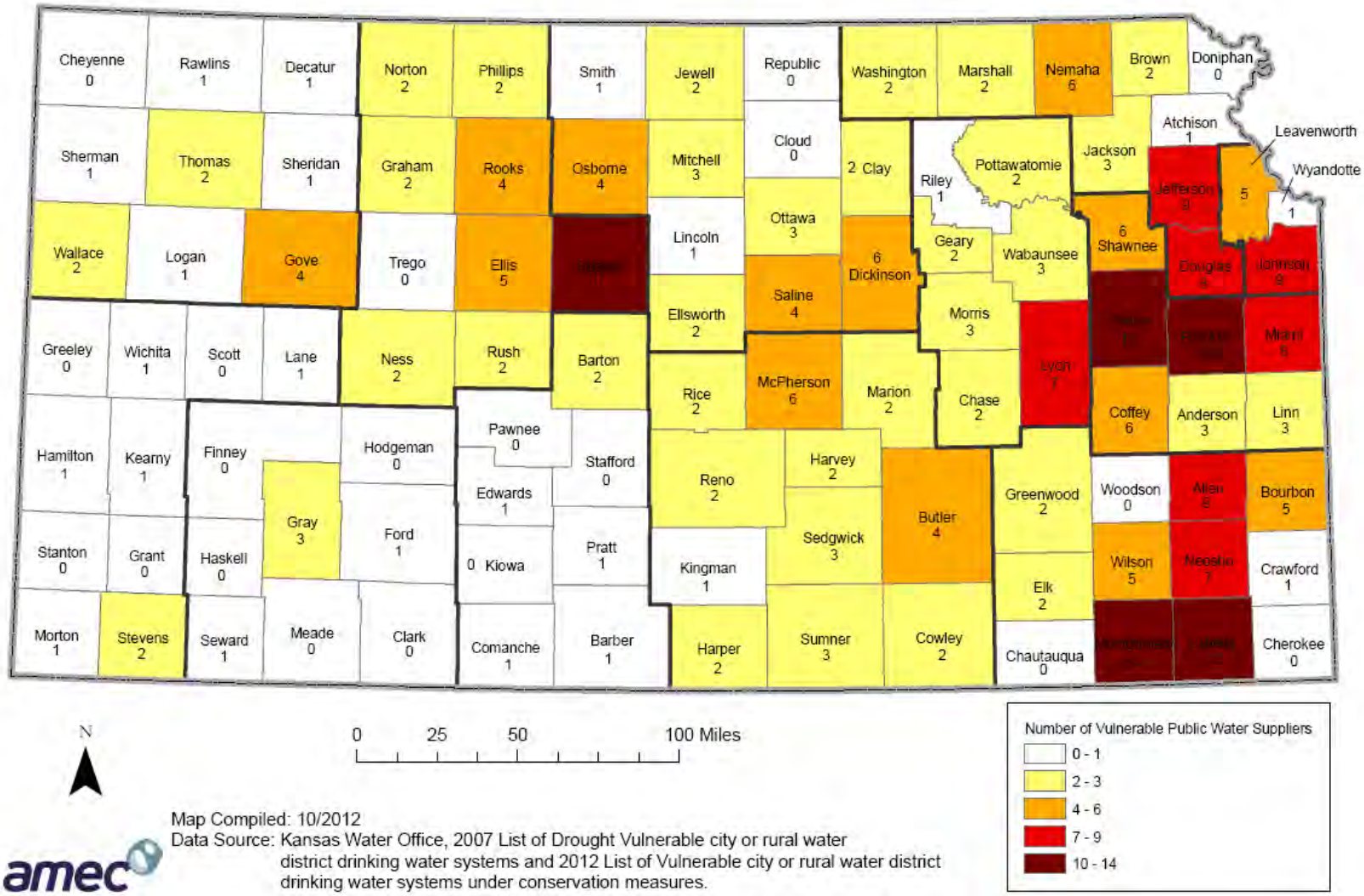
Treatment Capacity Limitation—The supplier has difficulty or is unable to meet drought-induced customer demand for water due to inadequate raw water treatment capacity.

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

Figure 3.35 below, shows that the counties with the highest number of vulnerable public water suppliers are Montgomery, Labette, Osage, Franklin and Russell. Most of these counties are in eastern Kansas.

Figure 3.35. Kansas Drought Vulnerable Public Water Suppliers by County



Map Compiled: 10/2012
Data Source: Kansas Water Office, 2007 List of Drought Vulnerable city or rural water district drinking water systems and 2012 List of Vulnerable city or rural water district drinking water systems under conservation measures.

State Estimates of Potential Losses

This statistical analysis uses two significant factors in determining the drought vulnerability for Kansas. One is the USDA Risk Management Agency's annualized crop insurance payments 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 3.50** above. It was determined that all counties in Kansas 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 Kansas counties and public water supply is an essential service to all Kansans.

Table 3.51 provides the rating values assigned to the range of results for each of the two factors considered as well as the rating values (Medium, Medium-High, and High) assigned to the total drought vulnerability rating.

Table 3.51. 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 Rating	1	2	3-6	7-9	10-14
Total Drought Vulnerability Rating	n/a	n/a	1-2	3-6	8-10

Table 3.52 and **Figure 3.36** shows the variance of drought conditions by county in Kansas. There are 12 counties that make the high drought vulnerability rating. These are Allen, Labette, Montgomery, Gove, Linn, Neosho, Bourbon, Ellis, Franklin, Harper, Lyon, Osage, Russell and Sumner.

Table 3.52. 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 A								
Cheyenne	$52,458,000	$3,154,391	6.013%	3	0	0	3	Medium-High
Decatur	$49,747,000	$3,807,171	7.653%	4	1	1	5	Medium-High
Gove	$59,084,000	$5,085,446	8.607%	5	4	3	8	High
Logan	$47,558,000	$4,160,132	8.747%	5	1	1	6	Medium-High
Rawlins	$59,406,000	$4,614,080	7.767%	4	1	1	5	Medium-High
Sheridan	$95,542,000	$5,046,441	5.282%	3	1	1	4	Medium-High
Sherman	$108,370,000	$5,343,869	4.931%	3	1	1	4	Medium-High
Thomas	$129,521,000	$8,228,144	6.353%	3	2	2	5	Medium-High
Wallace	$47,203,000	$2,268,327	4.805%	3	2	2	5	Medium-High
Subtotal	**$648,889,000**	**$41,707,999.50**			**13**			
Mitigation Planning Region B								
Ellis	$27,729,000	$1,826,343	6.586%	4	5	3	7	High
Graham	$42,105,000	$3,244,532	7.706%	4	2	2	6	Medium-High
Ness	$37,636,000	$2,896,918	7.697%	4	2	2	6	Medium-High
Norton	$42,614,000	$3,254,277	7.637%	4	2	2	6	Medium-High
Phillips	$41,104,000	$1,592,941	3.875%	2	2	2	4	Medium-High
Rooks	$46,688,000	$1,372,991	2.941%	2	4	3	5	Medium-High
Rush	$33,863,000	$1,444,676	4.266%	2	2	2	4	Medium-High
Russell	$23,659,000	$783,465	3.311%	2	10	5	7	High
Trego	$30,057,000	$2,679,699	8.915%	5	0	0	5	Medium-High
Subtotal	**$325,455,000**	**$19,095,842.80**			**29**			
Mitigation Planning Region C								
Grant	$63,853,000	$2,304,170	3.609%	2	0	0	2	Medium
Greeley	$64,552,000	$5,460,795	8.460%	5	0	0	5	Medium-High
Hamilton	$51,817,000	$3,500,130	6.755%	4	1	1	5	Medium-High
Kearny	$66,321,000	$2,465,586	3.718%	2	1	1	3	Medium-High
Lane	$31,082,000	$4,348,631	13.991%	5	1	1	6	Medium-High
Morton	$42,645,000	$3,548,236	8.320%	5	1	1	6	Medium-High
Scott	$71,718,000	$5,920,866	8.256%	5	0	0	5	Medium-High
Stanton	$76,592,000	$3,194,609	4.171%	2	0	0	2	Medium

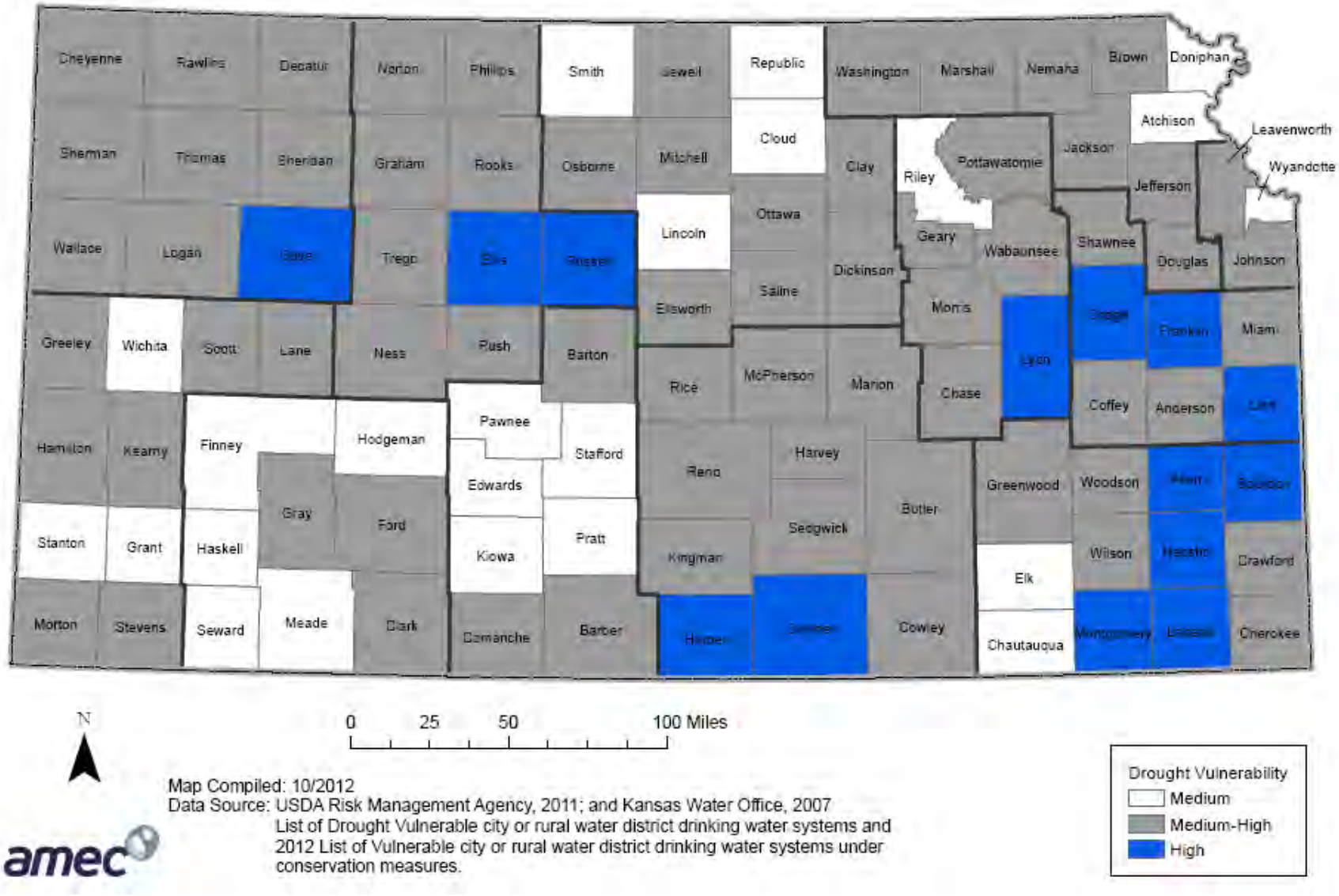
County	Crop Exposure (2007 Census of Agriculture)	Annualized Crop Insurance Paid/Drought Damage	Annual Crop Claims Ratio	Crop Loss Ratio Rating	Number of Drought Vulnerable Public Water Suppliers	Drought Vulnerable Public Water Suppliers Rating	Total Rating (Crops & Water Suppliers)	Vulnerability Rating
Stevens	$124,066,000	$2,784,503	2.244%	1	2	2	3	Medium-High
Wichita*	$0	$2,883,323	0.000%	0	1	1	1	Medium
Subtotal	**$592,646,000**	**$36,410,846.90**			**7**			
Mitigation Planning Region D								
Clark	$15,466,000	$813,440	5.260%	3	0	0	3	Medium-High
Finney	$140,746,000	$4,137,961	2.940%	2	0	0	2	Medium
Ford	$87,004,000	$3,231,043	3.714%	2	1	1	3	Medium-High
Gray	$109,340,000	$3,325,721	3.042%	2	3	3	5	Medium-High
Haskell	$116,154,000	$2,402,183	2.068%	1	0	0	1	Medium
Hodgeman	$41,068,000	$1,706,585	4.156%	2	0	0	2	Medium
Meade	$91,206,000	$948,167	1.040%	1	0	0	1	Medium
Seward	$81,688,000	$997,024	1.221%	1	1	1	2	Medium
Subtotal	**$682,672,000**	**$17,562,123.40**			**5**			
Mitigation Planning Region E								
Barber	$15,969,000	$1,098,601	6.880%	4	1	1	5	Medium-High
Barton	$65,249,000	$2,298,360	3.522%	2	2	2	4	Medium-High
Comanche	$13,395,000	$549,694	4.104%	2	1	1	3	Medium-High
Edwards	$73,732,000	$1,298,154	1.761%	1	1	1	2	Medium
Kiowa	$34,681,000	$649,819	1.874%	1	0	0	1	Medium
Pawnee	$67,357,000	$1,855,259	2.754%	1	0	0	1	Medium
Pratt	$62,967,000	$1,470,961	2.336%	1	1	1	2	Medium
Stafford	$74,613,000	$1,563,452	2.095%	1	0	0	1	Medium
Subtotal	**$407,963,000**	**$10,784,300.10**			**6**			
Mitigation Planning Region F								
Clay	$47,769,000	$891,667	1.867%	1	2	2	3	Medium-High
Cloud	$55,096,000	$1,005,695	1.825%	1	0	0	1	Medium
Dickinson	$50,121,000	$1,640,740	3.274%	2	6	3	5	Medium-High
Ellsworth	$19,376,000	$898,935	4.639%	3	2	2	5	Medium-High
Jewell	$61,168,000	$1,256,678	2.054%	1	2	2	3	Medium-High
Lincoln	$32,667,000	$857,417	2.625%	1	1	1	2	Medium
Mitchell	$61,762,000	$1,197,844	1.939%	1	3	3	4	Medium-High
Osborne	$37,801,000	$1,232,243	3.260%	2	4	3	5	Medium-High
Ottawa	$35,560,000	$690,541	1.942%	1	3	3	4	Medium-High
Republic	$79,639,000	$1,043,195	1.310%	1	0	0	1	Medium

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
Saline	$26,903,000	$1,011,250	3.759%	2	4	3	5	Medium-High
Smith	$54,022,000	$1,498,498	2.774%	1	1	1	2	Medium
Subtotal	**$561,884,000**	**$13,224,702.60**			**28**			
Mitigation Planning Region G								
Butler	$41,249,000	$2,392,102	5.799%	3	4	3	6	Medium-High
Cowley	$23,126,000	$1,551,414	6.709%	4	2	2	6	Medium-High
Harper	$17,809,000	$1,629,738	9.151%	5	2	2	7	High
Harvey	$49,189,000	$1,737,559	3.532%	2	2	2	4	Medium-High
Kingman	$25,749,000	$854,607	3.319%	2	1	1	3	Medium-High
McPherson	$57,227,000	$1,943,855	3.397%	2	6	3	6	Medium-High
Marion	$43,687,000	$2,045,072	4.681%	3	2	2	4	Medium-High
Reno	$69,497,000	$2,409,537	3.467%	2	2	2	4	Medium-High
Rice	$53,225,000	$2,388,206	4.487%	2	2	2	4	Medium-High
Sedgwick	$56,918,000	$2,335,962	4.104%	2	3	3	5	Medium-High
Sumner	$50,711,000	$4,078,574	8.043%	4	3	3	7	High
Subtotal	**$488,387,000**	**$23,366,626.10**			**29**			
Mitigation Planning Region H								
Allen	$15,462,000	$1,533,937	9.921%	5	9	4	9	High
Bourbon	$9,918,000	$646,995	6.523%	4	5	3	7	High
Chautauqua	$4,971,000	$132,876	2.673%	1	0	0	1	Medium
Cherokee	$53,420,000	$2,617,162	4.899%	3	0	0	3	Medium-High
Crawford	$34,463,000	$2,116,197	6.140%	3	1	1	4	Medium-High
Elk*	$0	$260,036	0.000%	0	2	2	2	Medium
Greenwood	$8,087,000	$641,647	7.934%	4	2	2	6	Medium-High
Labette	$22,765,000	$1,610,514	7.075%	4	12	5	9	High
Montgomery	$16,616,000	$1,131,518	6.810%	4	14	5	9	High
Neosho	$17,811,000	$1,418,849	7.966%	4	7	4	8	High
Wilson	$26,882,000	$1,447,752	5.386%	3	5	3	6	Medium-High
Woodson	$14,486,000	$940,203	6.490%	4	0	0	4	Medium-High
Subtotal	**$224,881,000**	**$14,497,684.40**			**57**			
Mitigation Planning Region I								
Chase	$6,222,000	$442,840	7.117%	4	2	2	6	Medium-High
Geary	$11,039,000	$232,090	2.102%	1	2	2	3	Medium-High
Lyon	$24,554,000	$1,220,888	4.972%	3	7	4	7	High

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
Morris	$21,783,000	$1,318,314	6.052%	3	3	3	6	Medium-High
Pottawatomie	$30,455,000	$524,600	1.723%	1	2	2	3	Medium-High
Riley	$23,622,000	$316,974	1.342%	1	1	1	2	Medium
Wabaunsee	$17,358,000	$744,609	4.290%	2	3	3	5	Medium-High
Subtotal	**$135,033,000**	**$4,800,314.60**			**20**			
Mitigation Planning Region J								
Anderson	$33,029,000	$1,732,725	5.246%	3	3	3	6	Medium-High
Coffey	$25,497,000	$1,012,932	3.973%	2	6	3	5	Medium-High
Franklin	$32,349,000	$1,051,820	3.251%	2	10	5	7	High
Linn	$13,053,000	$1,138,667	8.723%	5	3	3	8	High
Miami	$27,726,000	$598,150	2.157%	1	8	4	5	Medium-High
Osage	$27,618,000	$1,013,497	3.670%	2	12	5	7	High
Shawnee	$32,959,000	$421,410	1.279%	1	6	3	4	Medium-High
Subtotal	**$192,231,000**	**$6,969,199.70**			**48**			
Mitigation Planning Region K								
Atchison	$42,536,000	$561,867	1.321%	1	1	1	2	Medium
Brown	$86,532,000	$1,458,030	1.685%	1	2	2	3	Medium-High
Doniphan	$67,800,000	$406,337	0.599%	1	0	0	1	Medium
Douglas	$27,973,000	$572,648	2.047%	1	8	4	5	Medium-High
Jackson	$21,169,000	$484,784	2.290%	1	3	3	4	Medium-High
Jefferson	$33,429,000	$499,540	1.494%	1	9	4	5	Medium-High
Marshall	$81,815,000	$2,667,621	3.261%	2	2	2	4	Medium-High
Nemaha	$67,091,000	$2,816,877	4.199%	2	6	4	6	Medium-High
Washington	$65,762,000	$1,853,191	2.818%	2	2	2	4	Medium-High
Subtotal	**$494,107,000**	**$11,320,894.40**			**33**			
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
Subtotal	**$50,455,000**	**$734,620.70**			**15**			
Statewide Total	**$4,887,212,000**	**$200,475,155.20**			**290**			

Source: USDA Risk Management Agency; *Note: Elk, Wichita, Wyandotte Counties were not published in the Crop Exposure 2007 Census to avoid disclosure of individual operations. Thus the vulnerability rating for these counties is not a true reflection of their drought vulnerabilities.

Figure 3.36. Vulnerability Summary for Drought



Map Compiled: 10/2012
Data Source: USDA Risk Management Agency, 2011; and Kansas Water Office, 2007
List of Drought Vulnerable city or rural water district drinking water systems and 2012 List of Vulnerable city or rural water district drinking water systems under conservation measures.

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.

Development in Hazard Prone Areas

Areas that appear to be the most vulnerable to drought are the focus of the Governor‘s Drought Response Team for planning, management and mitigation activities. While drought does not usually cause damage to buildings and critical facilities, work and living locations do affect people.

Also, as counties experience significant increases in population it will create greater demands on public water suppliers. Of the counties that were determined to be in the high vulnerability category to drought as a result of this analysis, none are in the top 10 Kansas Counties for population growth.

Consequence Analysis

The information in **Table 3.53** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.53. EMAP 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 Governance	Minimal	Confidence could be at issue during periods of 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/Location

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.

Concerns about induced seismicity, or earthquake activity related to fracking, have been raised in some areas. Hydraulic fracturing or —fracking" is a method of enhancing oil and gas recovery from wells by injecting water, sand, and chemicals into rock formations under very high pressure to fracture the rock and release trapped hydrocarbons. According to the Kansas Geological Survey, there is no evidence that hydraulic fracturing itself triggers earthquakes (Kansas Geological Survey, Public Information Circular (PIC) 32).

Earthquakes with magnitude of about 2.0 or less are usually called microearthquakes; 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.

In Kansas, a series of faults called the Humboldt Fault Zone runs through Riley and Pottawatomie Counties in north-central Kansas and extends to the south along the Nemaha Ridge (also known as the Nemaha Uplift) (see **Figure 3.37**)

Figure 3.37. Humboldt Fault Zone

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

Previous Occurrences

Kansas experiences small micro-earthquakes on a routine basis, but few are of a magnitude that could cause damage to buildings or the infrastructure. According to a FEMA report, Kansas

ranks 45 among the states in the amount of damage caused by earthquakes in an average year. The Kansas City, Missouri, area was ranked 35th among 35 major metropolitan areas.

The earliest reported earthquake in Kansas, and also the strongest, occurred on April 24, 1867, in the Humboldt Fault zone near the town of Wamego. It had a magnitude of 5.5 and caused structural damage in Manhattan and minor damage in other nearby communities. There were several injuries and some damage as well as a two-foot wave on the Kansas River at Manhattan. The tremor was felt over a 300,000 square mile area in the Midwest.

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.
- **January 1, 2008:** A 2.7 magnitude earthquake registered with an epi-center 15 miles West of Arkansas City
- **March 23, 2007**: A 3.1 magnitude earthquake struck 15 miles west southwest of Atchison. It was felt at Atchison and Norton.
- **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.
- **June 1989:** A magnitude 4.0 earthquake shook Palco in Rooks County and did minor damage (this may have been human induced, e.g., mining-related).
- **November 9, 1968**: A 5.3 magnitude earthquake centered in southern Illinois was felt in eastern Kansas.
- **April 13, 1961**: With an epicenter in Kansas, this earthquake affected Norton County.
- **January 6, 1956:** This earthquake caused minor damage at Coats, Coldwater, Medicine Lodge, and Wilmore. The damage was limited to loosened bricks, cracked plaster and chimneys, and objects knocked from walls and shelves. Many observers reported being shaken from their beds by the shock.
- **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.
- **February 20, 1933**: A moderate earthquake was felt in Norton and Decatur Counties.
- Fall 1929: Four earthquakes with magnitudes between 3.2 and 4.2 occurred near Manhattan between September 23 and December 7, 1929.
- **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

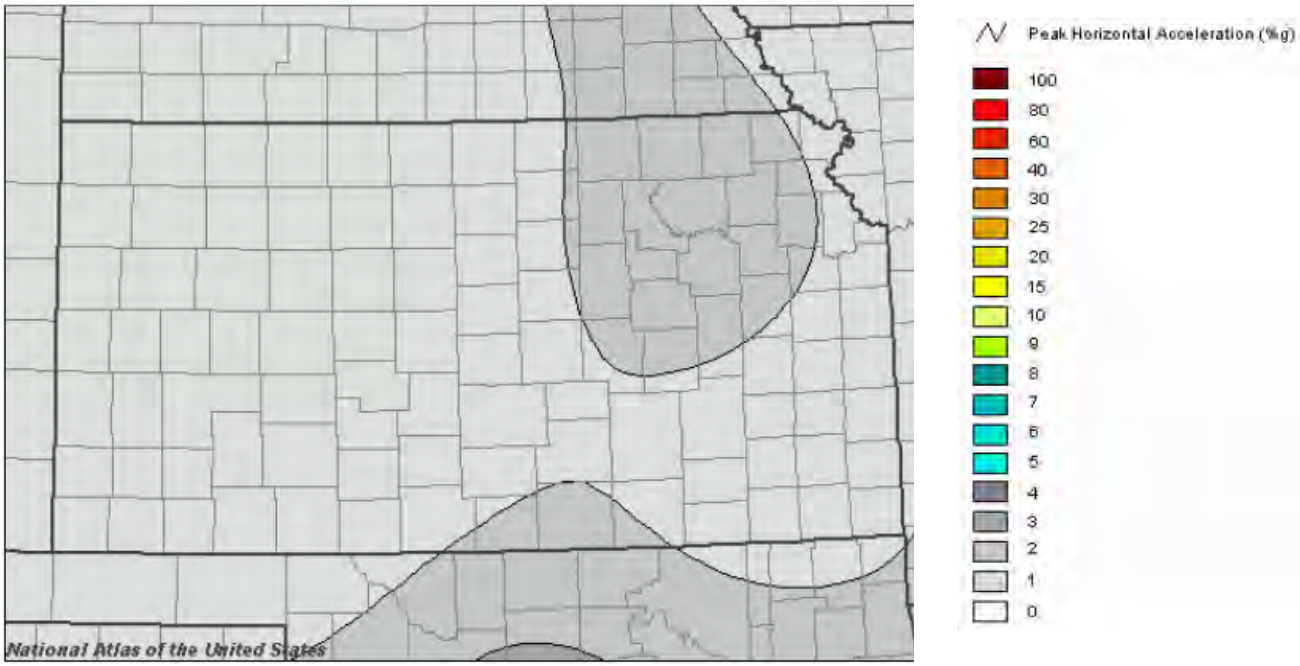
walls were observed at Manhattan. Houses and buildings vibrated at Topeka, where a loud roaring sound was also heard. A series of small aftershocks were felt in Manhattan.

- **October 27, 1904:** An earthquake shook the area around Dodge City and Meade, in western Kansas.
- **October 31, 1895**: This earthquake near Charleston, Missouri, affected a million square miles over 23 states. The strongest effects in Kansas were reported in Topeka.
- **November 8, 1875:** A moderate earthquake near Valley Falls north of Topeka was felt over 8,000 square miles but did little damage.

Probability of Future Hazard Events

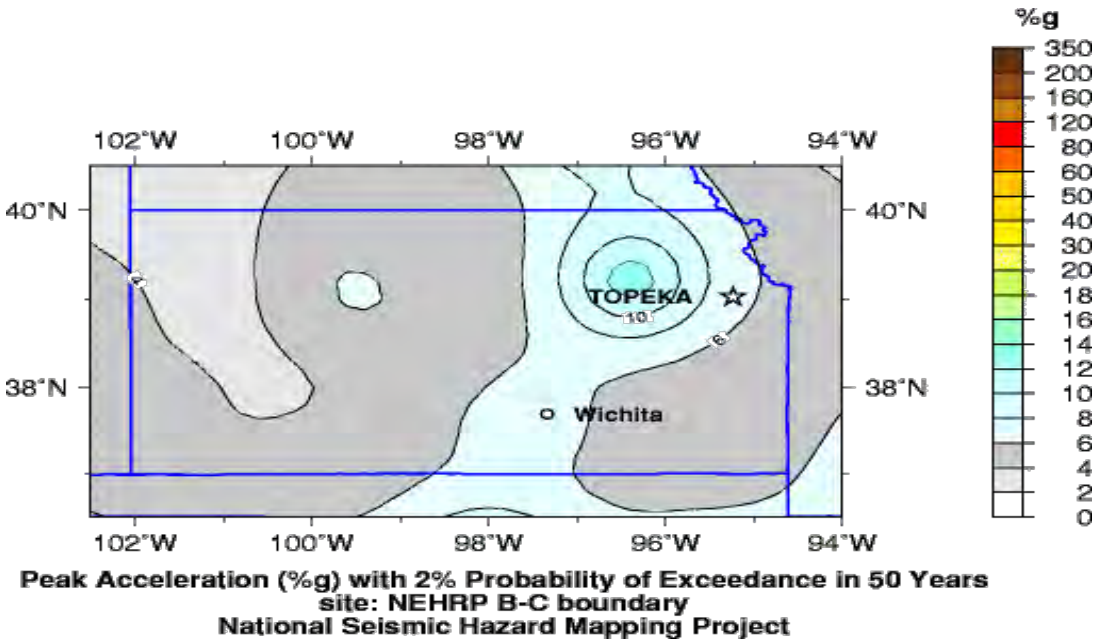
Figure 3.38 and **Figure 3.39** are probabilistic seismic hazard maps of Kansas from the U.S. Geological Survey that depict the probability that ground motion will reach a certain level during an earthquake. The data shows peak horizontal ground acceleration (the fastest measured change in speed for a particle at ground level that is moving horizontally because of an earthquake). **Figure 3.38** depicts the shaking level that has a 10 percent chance of being exceeded over a period of 50 years. **Figure 3.39**, 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 3.38. Kansas Seismic Hazard Map—10% Probability of Exceedance in 50 Years



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

Figure 3.39. Kansas Seismic Hazard Map 2 % Probability of Exceedance in 50 Years



Source: U.S. Geological Survey Earthquake Hazards Program, http://earthquake.usgs.gov/regional/states/kansas/hazards.php

This hazard's probability on a state-wide basis is ~~"~~**Unlikely**" to occur in the next three years. Recognizing that there is a high hazard dam and that there have been two recorded earthquakes in the Manhattan, Kansas area in less than 100 years, local mitigation plans created around the Humboldt Fault Zone are encouraged to recognize the earthquake risk in their hazard analysis updates in the future.

State Vulnerability Analysis

Overall, Kansas is in an area of relatively low seismic activity. The most earthquake-prone part of the State is north-central Kansas, particularly Riley and Pottawatomie Counties. A significant earthquake (the maximum credible earthquake in the area is a magnitude 6.6) in this area could result in the failure of Tuttle Creek dam (see **Section 3.3.3** Dam and Levee Failure). Kansas is not expected to experience damaging shaking from a large New Madrid Seismic Zone event. The New Madrid Seismic Zone roughly follows the Mississippi River valley from southeastern Missouri to northwestern Mississippi. A large earthquake in this region could displace several thousand people and potentially lead to an influx into Kansas of victims fleeing the destruction

The counties that are at least partially in Kansas' highest zone of peak horizontal acceleration (for the 10 percent probability of exceedence in 50 years) are Atchison, Brown, Chase, Clay, Cloud, Dickinson, Douglas, Geary, Jackson, Jefferson, Lyon, Marion, Marshall, Morris, Nemaha, Osage, Ottawa, Pottawatomie, Republic, Riley, Saline, Shawnee, Wabaunsee, and Washington in the northeast and Barber, Cowley, Harper, and Sumner in the south.

HAZUS-MH 2.1 was used to analyze statewide vulnerability and estimate losses to earthquakes. HAZUS is a regional earthquake loss estimation model that was developed by

FEMA and the National Institute of Building Sciences. This analysis used the default inventory data associated with the February 2012 release of HAZUS-MH 2.1 which includes 2006 building valuations. A Probabilistic, 2,500 Year 6.7 Magnitude earthquake scenario was chosen to reveal areas of the State that are most vulnerable to this worst-case scenario event. These results are not meant to indicate annualized losses or damages as a result of a more –typical" low-magnitude event, but rather reveal vulnerabilities and losses for the worst-case scenario as well as help demonstrate which counties are most threatened by earthquakes and those most vulnerable to damage and loss.

The map in **Figure 3.40** demonstrates the ground shaking potential of a worst-case scenario 2,500-year 6.7 Magnitude earthquake. It is important to note that ground shaking potential is not only related to proximity to the fault, but also the geology involved. For example areas with high sand content are subject to higher shaking than areas with high rock content. This may explain why the HAZUS model shows peak ground acceleration over 7.6% not only around the areas near the Humboldt fault, but also in an area west of the fault.

Figure 3.40. Worst-Case 2500-Year, 6.7 Magnitude Earthquake Ground Shaking Potential

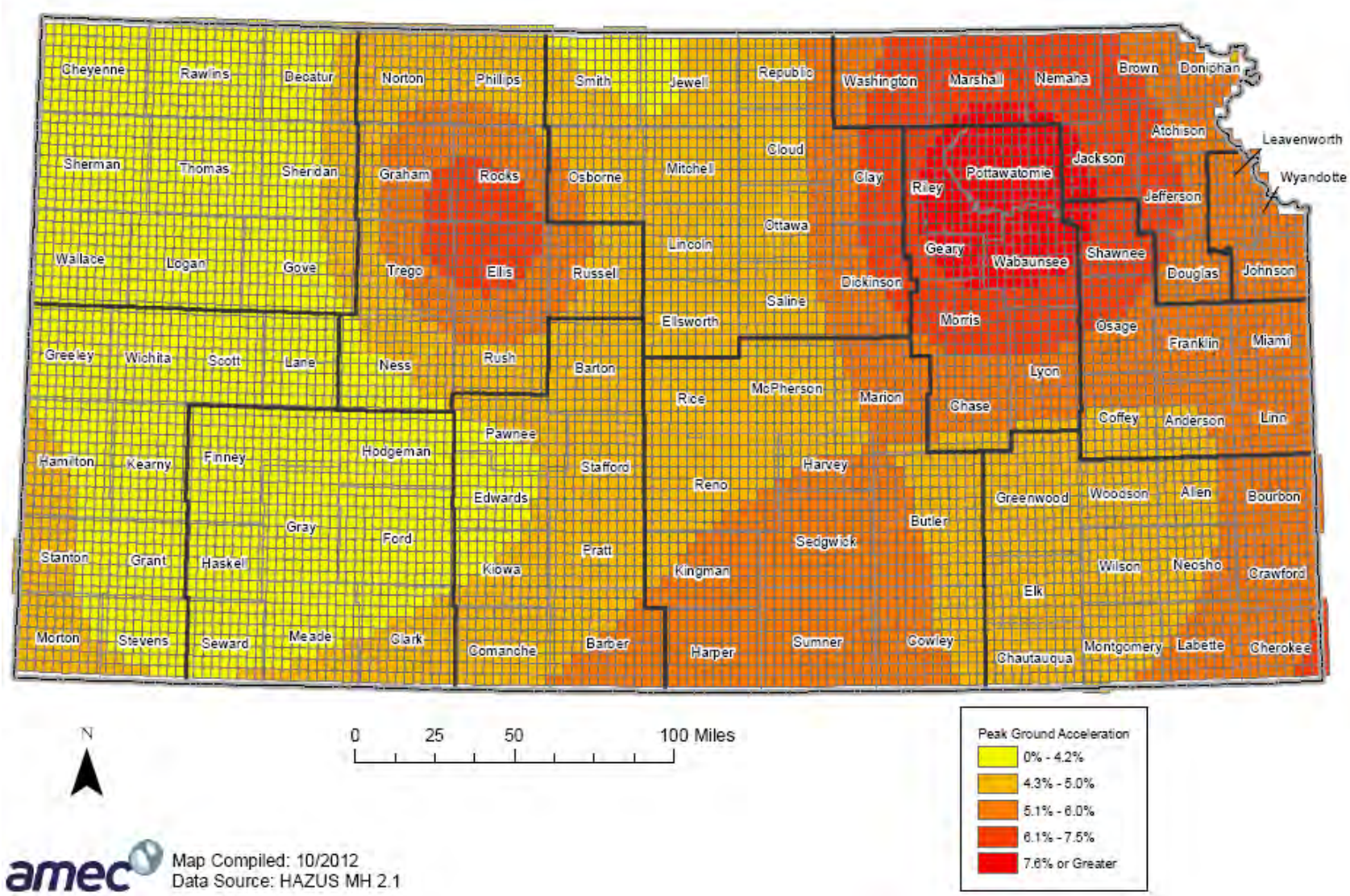


Table 3.54 lists the counties by Mitigation Planning Region and indicates the shake zones that impact each county.

Table 3.54. Worst-Case 2500-Year, 6.7 Magnitude Earthquake Ground Shaking Potential for Each Kansas County by Mitigation Planning Region

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
Mitigation Planning Region A					
Cheyenne	x				
Decatur	x	x			
Gove	x	x			
Logan	x				
Rawlins	x				
Sheridan	x	x			
Sherman	x				
Thomas	x				
Washington			x	x	
Subtotal	8	3	1	1	0
Mitigation Planning Region B					
Ellis		x	x	x	
Graham		x	x	x	
Ness	x	x	x		
Norton		x	x		
Philips		x	x		
Rush		x	x		
Rooks		x	x	x	
Russell		x	x		
Trego		x	x	x	
Subtotal	1	9	9	4	0
Mitigation Planning Region C					
Grant	x				
Greeley	x				
Hamilton	x	x			
Kearney	x				
Lane	x				
Morton	x	x			
Scott	x				
Stanton	x	x			
Stevens	x	x			
Wichita	x				
Subtotal	10	4	0	0	0

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
Mitigation Planning Region D					
Clark	x	x			
Finney	x				
Ford	x				
Gray	x				
Haskell	x				
Hodgeman	x				
Meade	x	x			
Seward	x	x			
Subtotal	8	3	0	0	0
Mitigation Planning Region E					
Barber		x	x		
Barton		x			
Comanche		x			
Edwards	x	x			
Kiowa	x	x			
Pawnee	x	x			
Pratt		x			
Stafford		x			
Subtotal	3	8	1	0	0
Mitigation Planning Region F					
Clay			x	x	
Cloud		x	x		
Dickinson			x	x	
Ellsworth		x			
Jewell	x	x			
Lincoln		x			
Mitchell		x			
Osborne		x	x		
Ottawa		x	x		
Republic		x	x		
Saline		x	x		
Smith	x	x			
Subtotal	2	10	7	2	0
Mitigation Planning Region G					
Butler		x	x		
Cowley		x	x		
Harper			x		
Harvey		x	x		
Kingman		x	x		
Marion		x	x		
McPherson		x			

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
Reno		x	x		
Rice		x			
Sedgwick			x		
Sumner			x		
Subtotal	0	8	9	0	0
Mitigation Planning Region H					
Allen		x	x		
Bourbon			x		
Chautauqua		x			
Cherokee			x	x	
Crawford			x		
Elk		x			
Greenwood		x			
Labette		x	x		
Montgomery		x	x		
Neosho		x	x		
Wilson		x			
Woodson		x			
Subtotal	0	9	7	1	0
Mitigation Planning Region I					
Chase		x	x		
Geary				x	x
Lyon			x	x	
Morris				x	x
Pottawatomie					x
Riley				x	x
Wallace	x				
Subtotal	1	1	2	4	4
Mitigation Planning Region J					
Anderson		x	x		
Coffey		x	x		
Franklin			x		
Linn			x		
Miami			x		
Osage			x	x	
Shawnee				x	x
Subtotal	0	2	6	2	1
Mitigation Planning Region K					
Atchison			x	x	
Brown			x	x	
Doniphan			x		

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
Douglas			x	x	
Jackson				x	x
Jefferson			x	x	
Marshall				x	x
Nemaha				x	x
Wabaunsee				x	x
Subtotal	0	0	5	8	4
Mitigation Planning Region L					
Johnson			x		
Leavenworth			x		
Wyandotte			x		
Subtotal	0	0	3	0	0

The Mitigation Planning Regions with Counties in the highest shake zone are I, J, and K. There are nine counties in the zone with a PGA of 7.6 and higher including: Geary, Jackson, Marshall, Morris, Nemaha, Pottawatomie, Riley, Shawnee, and Wabaunsee Counties.

State Estimates of Potential Losses

Although the areas of the State that are most vulnerable to an earthquake are along the Humboldt fault, losses would be greater in terms of damages in areas of the State that have more development and larger populations. 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.

Table 3.55 below provides estimated building losses and displaced households for all counties in Kansas (reported by Mitigation Planning Region) as a result of a 2,500 year probabilistic 6.7 Magnitude earthquake followed by **Table 3.56** which shows the top 10 counties in terms of building damage. **Figure 3.41** That follows shows how the losses vary in terms of the jurisdictions most vulnerable to building damage. Similarly, **Figure 3.42** shows estimates of displaced households across the State and **Table 3.57** shows the top 10 counties in terms of displaced households. Again, it should be noted that these losses are for an absolute worst-case scenario event. Analyzing these results in terms of losses relative to one part of the State versus another may be more valuable than the actual dollar losses and number of displaced households.

Table 3.55. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Total Building Loss and Displaced Households by County

County	Total Earthquake Losses (1000s)	Displaced Households
Mitigation Planning Region A		
Cheyenne	$902	<1
Decatur	$1,207	<1
Gove	$1,301	<1
Logan	$1,199	<1
Rawlins	$996	<1
Sheridan	$1,115	<1
Sherman	$2,489	<1
Thomas	$3,025	1
Wallace	$646	<1
Subtotal	**$12,880**	**<5**
Mitigation Planning Region B		
Ellis	$20,968	15
Graham	$1,843	<1
Ness	$1,595	<1
Norton	$2,630	<1
Phillips	$2,819	<1
Rooks	$7,110	<1
Rush	$1,638	<1
Russell	$4,102	<1
Trego	$1,875	<1
Subtotal	**$44,580**	**<20**
Mitigation Planning Region C		
Grant	$3,258	<1
Greeley	$772	<1
Hamilton	$1,258	<1
Kearny	$1,307	<1
Lane	$879	<1
Morton	$1,789	<1
Scott	$1,806	<1
Stanton	$1,142	<1
Stevens	$1,876	<1
Wichita	$941	<1
Subtotal	**$15,028**	**<4**
Mitigation Planning Region D		
Clark	$1,224	<1
Finney	$11,924	8
Ford	$10,346	6
Gray	$1,951	<1
Haskell	$1,562	<1

County	Total Earthquake Losses (1000s)	Displaced Households
Hodgeman	$655	<1
Meade	$1,763	<1
Seward	$7,664	<1
Subtotal	**$37,089**	**<20**
Mitigation Planning Region E		
Barber	$4,043	1
Barton	$12,535	4
Comanche	$1,217	<1
Edwards	$1,436	<1
Kiowa	$1,558	<1
Pawnee	$2,690	<1
Pratt	$5,792	2
Stafford	$2,083	<1
Subtotal	**$31,354**	**<10**
Mitigation Planning Region F		
Clay	$7,523	2
Cloud	$5,696	2
Dickinson	$14,704	6
Ellsworth	$3,062	<1
Jewell	$1,520	<1
Lincoln	$1,475	<1
Mitchell	$3,295	<1
Osborne	$2,555	<1
Ottawa	$3,138	<1
Republic	$3,301	<1
Saline	$31,019	16
Smith	$1,729	<1
Subtotal	**$79,017**	**<32**
Mitigation Planning Region G		
Butler	$34,313	14
Cowley	$25,013	10
Harper	$5,729	2
Harvey	$21,460	11
Kingman	$5,878	2
Marion	$8,306	3
McPherson	$17,925	7
Reno	$37,342	19
Rice	$4,856	1
Sedgwick	$352,186	232
Sumner	$17,748	5
Subtotal	**$530,756**	**<308**

County	Total Earthquake Losses (1000s)	Displaced Households
Mitigation Planning Region H		
Allen	$11,766	4
Bourbon	$16,226	7
Chautauqua	$3,401	<1
Cherokee	$23,169	7
Crawford	$45,280	24
Elk	$1,863	<1
Greenwood	$4,809	2
Labette	$19,565	8
Montgomery	$31,251	12
Neosho	$14,910	5
Wilson	$7,851	3
Woodson	$2,183	<1
Subtotal	**$182,274**	**<74**
Mitigation Planning Region I		
Chase	$1,795	<1
Geary	$23,826	20
Lyon	$31,762	20
Morris	$6,044	1
Pottawatomie	$22,838	5
Riley	$71,807	68
Wabaunsee	$6,929	
Subtotal	**$165,001**	**<116**
Mitigation Planning Region J		
Anderson	$6,168	2
Coffey	$7,394	2
Franklin	$18,598	8
Linn	$8,248	2
Miami	$24,384	9
Osage	$11,735	4
Shawnee	$175,161	111
Subtotal	**$251,688**	**<137**
Mitigation Planning Region K		
Atchison	$15,357	5
Brown	$8,876	3
Doniphan	$5,750	2
Douglas	$84,716	86
Jackson	$11,332	3
Jefferson	$13,234	3
Marshall	$11,118	3
Nemaha	$9,897	3
Washington	$4,754	1
Subtotal	**$165,034**	**<110**

County	Total Earthquake Losses (1000s)	Displaced Households
Mitigation Planning Region L		
Johnson	$522,644	282
Leavenworth	$52,209	29
Wyandotte	$153,125	96
Subtotal	**$727,978**	**<408**
Statewide Total	**$2,242,679**	**~1,236**

Source: HAZUS MH 2.1

Figure 3.41. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Total Building Loss by County-Map ($1000s)

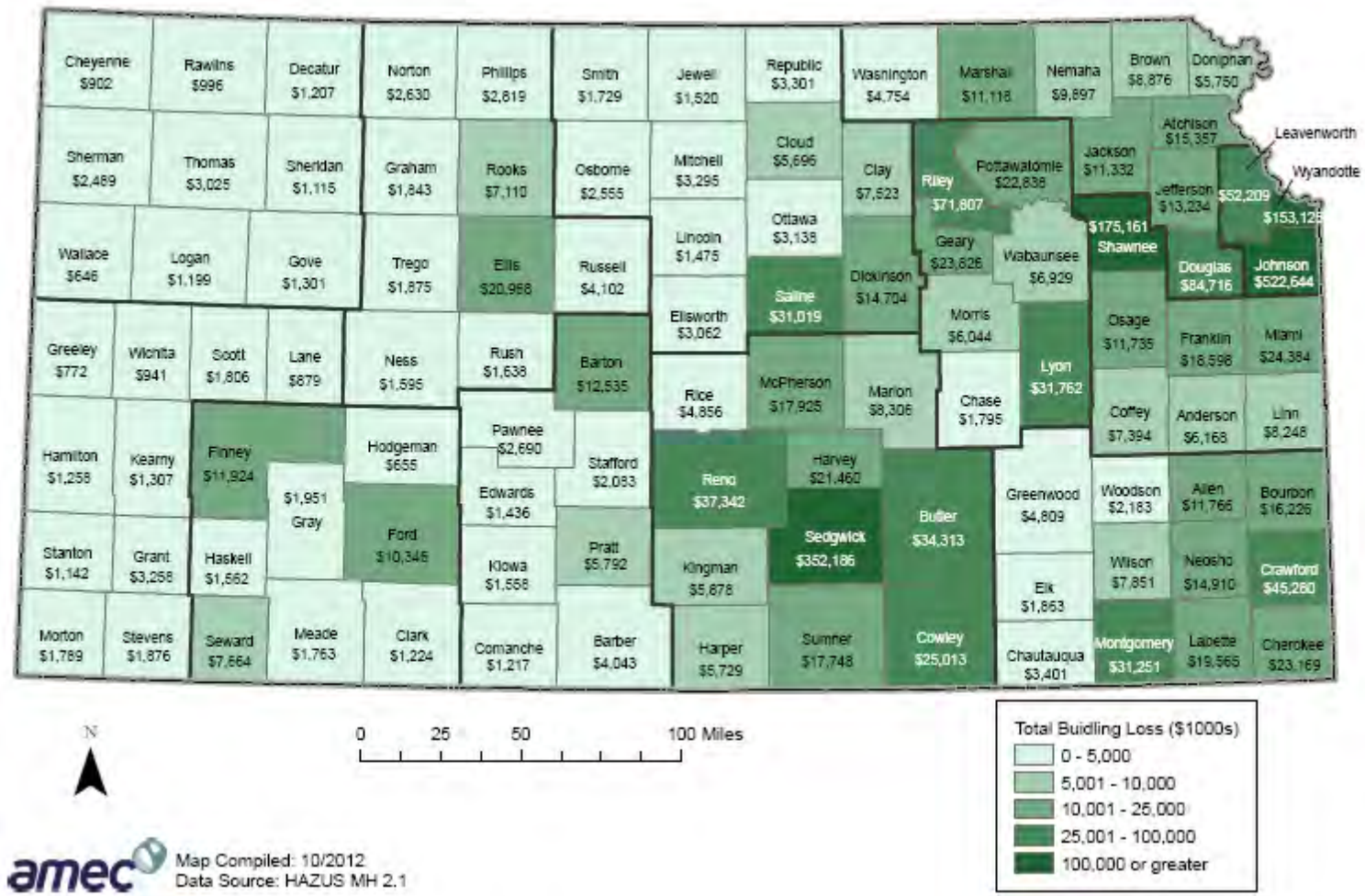


Table 3.56. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Top 10 Counties by Building Loss (1000s)

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

Figure 3.42. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Displaced Households

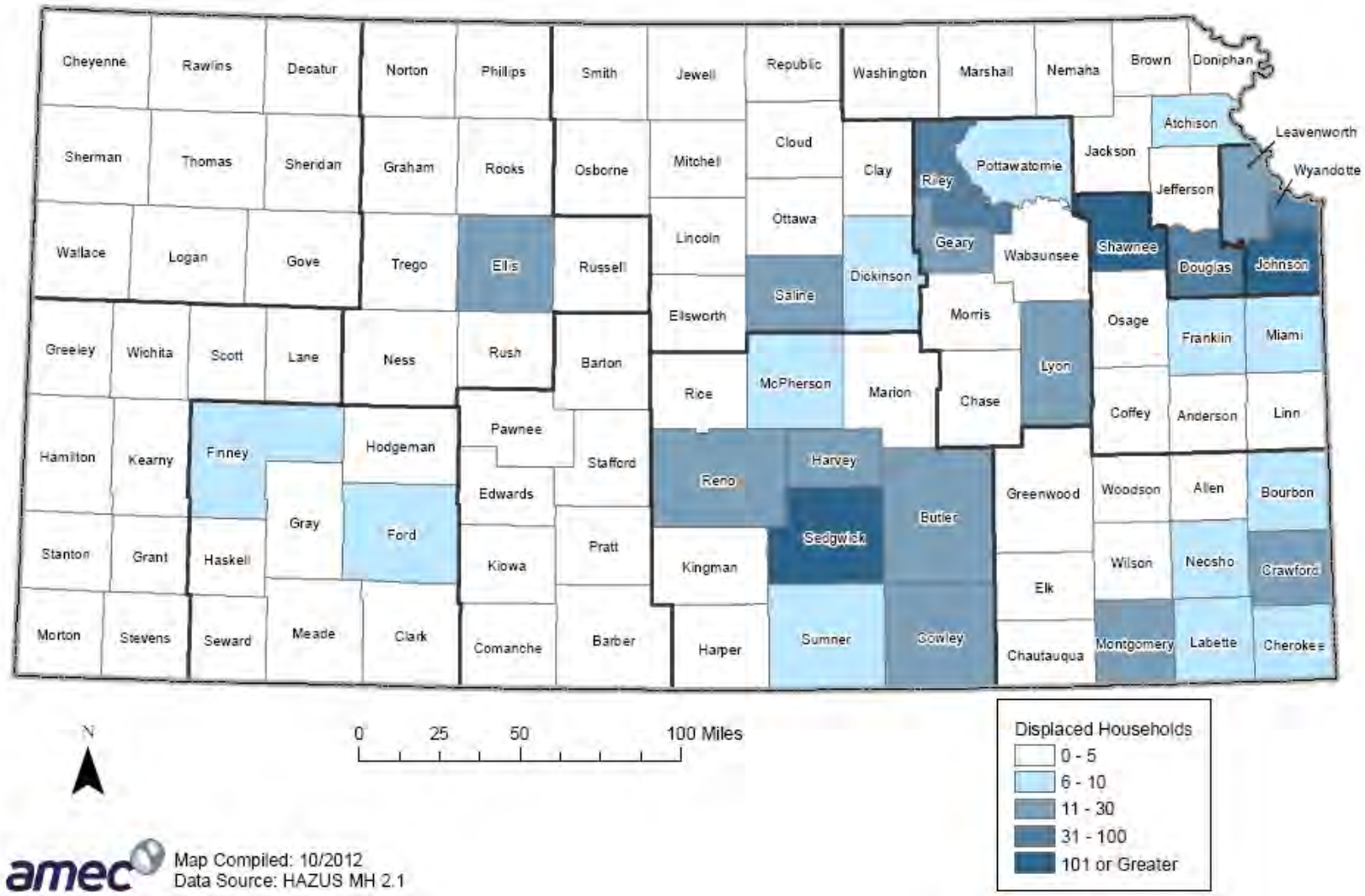


Table 3.57. Worst-Case 2,500 Year, 6.7 Magnitude Earthquake Top 10 Counties by Displaced Households

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
I	Geary	20

Development in Hazard Prone Areas

Growing counties in northeastern Kansas indicate that potentially more property and people will be at risk to earthquake shaking. Three of the counties in the highest shake zone areas based on the HAZUS analysis are also in the top ten counties with greatest housing unit gains. These include, Shawnee, Riley, and Geary Counties. Riley County is the location of one of the major universities in the State.

Although the probability of a significant damaging earthquake is unlikely, the presence of the Humboldt fault and historical occurrences along this fault indicate that the potential does exist. Communities in more earthquake prone areas of the State may wish to adopt seismic design standards for new development, particularly for critical and essential facilities to minimize impact.

Hazard Consequence Analysis

The information in **Table 3.58** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.58. 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).

3.3.6. Expansive Soils

Calculated Priority Risk Index	Planning Significance
2.65	Moderate

Description/Location

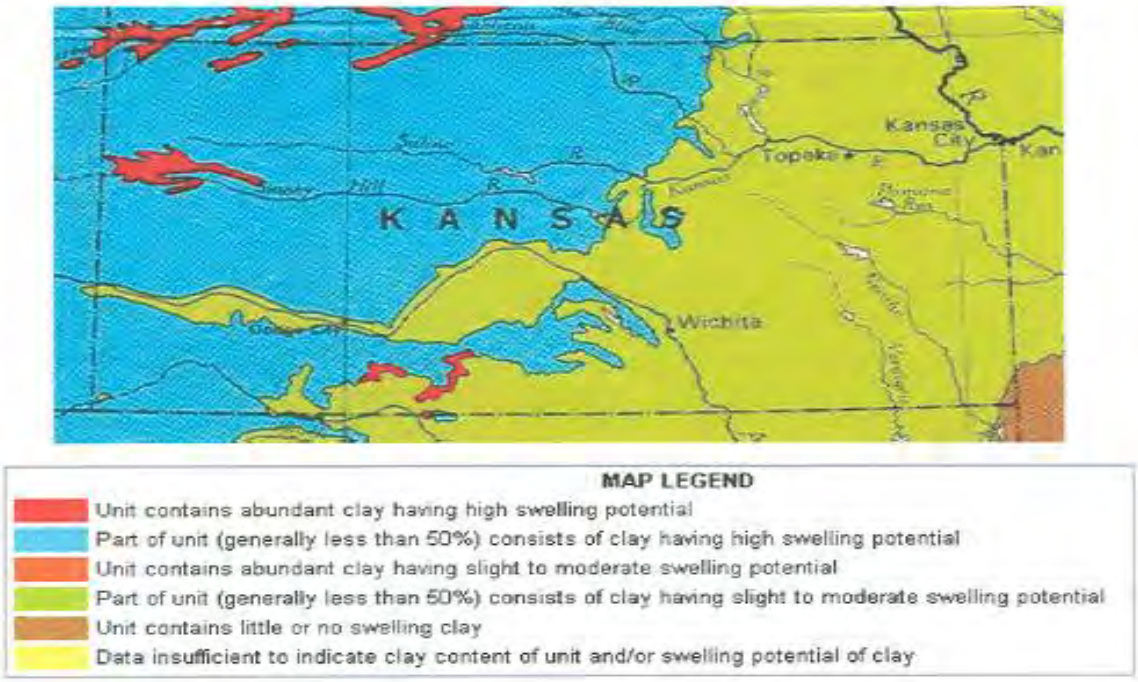
A relatively widespread geologic hazard for Kansas is the presence of soils that expand and shrink in relation to their water content. Expansive soils can cause physical damage to building foundations, roadways, and other components of the infrastructure when clay soils swell and shrink as a result of 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 State. Related hazard events are correlated with periods of drought in eastern Kansas and heavy rainfall in western Kansas. However, developed and developing communities in Kansas 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 State. As shown in **Figure 3.43**, nearly all of the State has clay containing soils with at least a slight potential for swelling and shrinking that could damage building foundations, roadways, and similar properties. The map indicates that the locations in the State with the soils having the higher swelling potential exist in the western and central counties.

Figure 3.43. Area of Kansas Vulnerable to Expansive Soils



Source: U.S. Geological Survey publication, http://arcvoid.com/surevoid_web/soil_maps/ks.html

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 2012 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

There are no expansive soil events on record in the State of Kansas to date. There is some data pertaining to expansive soil events around Kansas City, Missouri. That information is detailed below.

- **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.

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 ―**Highly Likely**” within the next three years.

State Vulnerability Analysis

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.

State Estimates of Potential Losses

Some counties in Kansas are at higher risk to expansive soils than others, but 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.

Development in Hazard Prone Areas

While the presence of clays with high swelling and shrinking potential are somewhat higher in the western part of the State, development has not and is not occurring at a rate to cause structural damages from this hazard to increase the estimate of relative risk. Damage from expansive soil to new construction is often mitigation 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.

Consequence 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 3.59** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.59. EMAP 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).

3.3.7. Extreme Temperatures

Calculated Priority Risk Index	Planning Significance
2.4	Moderate

Description/Location

Extreme temperature events, both hot and cold, can have severe impacts in Kansas on human morbidity 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. In Kansas, between 2000 and 2011 there was an average of 10 heat-related deaths per year. Heat waves in 2006 and 2011 were particularly severe causing respectively 21 and 37 deaths among Kansas residents. (source: Kansas Vital Statistics). 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 3.44** uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

Figure 3.44. 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.

Table 3.60 lists typical symptoms and health impacts of exposure to extreme heat.

Table 3.60. Typical Health Impacts of Extreme Heat

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

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

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 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; making consumption of fish hazardous. 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. In the United States, is estimated that 25,000 older adults die from hypothermia each year. Exposure to natural cold is reported as an underlying cause of death for an average of ten Kansas residents each year (Kansas Vital Statistics 2000-2011). 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 disorder, 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 3.45** 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 3.45. Wind Chill Chart

Wind (mph)	Temperature (°F)																	
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*

Source: National Weather Service

All of Kansas is susceptible to extreme temperatures. The heat risk to humans is generally uniform across the State but may be slightly higher in the east because of a relatively higher heat index.

Previous Occurrences

Since 1980, there were a number of major extreme temperature events that have caused death and damage in the Central United States, including Kansas. From June to September 1980, approximately 10,000 people died from heat-related conditions. Agricultural and related industries had an estimated $44 billion in damages. During a 1988 heat wave in the central United States, between 5,000 and 10,000 lives were lost to the heat, and the toll on agriculture was $56 billion. In July 1995, more than 1,000 people died in the heat wave that hit the Midwest.

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 125 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). Temperature extremes for each month are shown in **Table 3.61**. Also the average number of days with temperatures over 90 degrees has been recorded from 1981 to 2010 and displayed in **Figure 3.46**. It 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

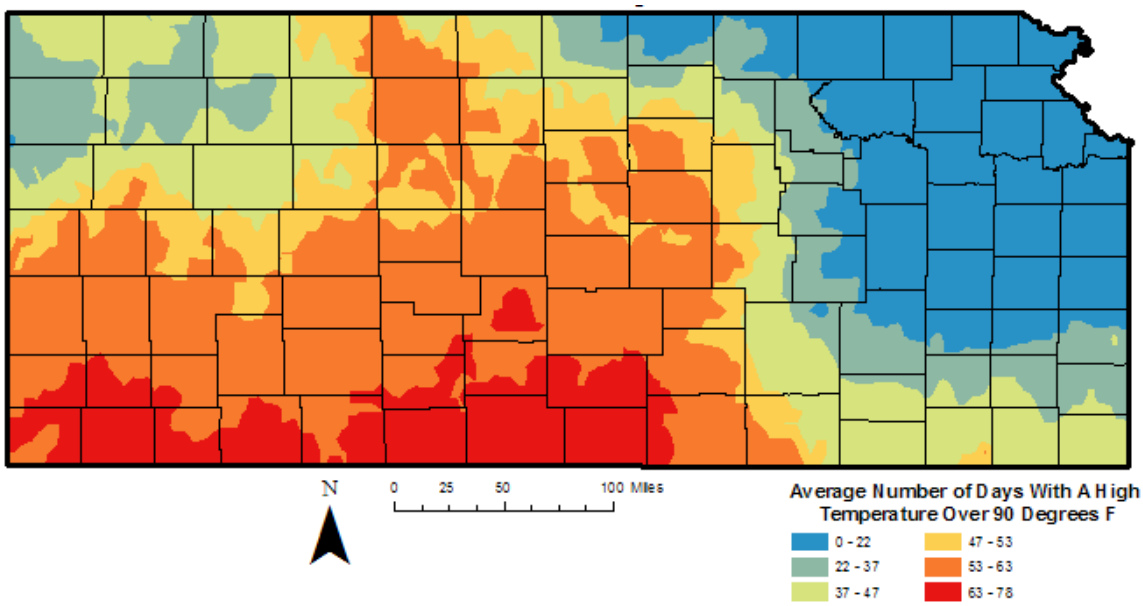
overnight minimum temperature averages. If the temperature does not drop overnight, it is more important in a global sense than the record highs. People, mainly those without air conditioning and crops need the temperature to drop during the overnight so that they can sustain the heat during the next day.

Table 3.61. Kansas Temperature Extremes

Month	Maximum °F	Year	Place	Minimum °F	Year	Place
January	88	1967	Kinsley	–35	1947	Centralia
February	92	1981	Aetna	–40	1905	Lebanon
March	100	1910	Hugoton	–25	1948	Oberlin*
April	107	1989	Hays	–2	1935	Dresden*
May	108	1939	Ellsworth*	14	1909	Wallace
June	116	1911	Clay Center*	30	1917	Irene*
July	121	1936	Alton*	32	1880	Unknown
August	119	1936	Wellington*	33	1910	St. Francis*
September	117	1947	Lincoln	15	1984	Kirwin Dam
October	104	1947	St. Francis	–3	1917	Wallace
November	96	1909	Kingman	–20	1887	Monument
December	90	1955	Ashland	–34	1989	Atwood

Source: Information Please Database, Pearson Education, Inc. www.infoplease.com/ipa/A0930179.html
* Also on earlier dates at the same time or other places.

Figure 3.46. Average Number of Days with High Temperatures Over 90, 1981 to 2010



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

Notable Extreme Temperature Events

- **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. In Topeka, the year of 2012 was ranked as the hottest on record. The average temperature from June through August was the 9th warmest on record and just a degree cooler than 2011. High temperatures averaged to be the 3rd warmest on record, trailing the Dust Bowl years of 1936 and 1934. Topeka had 24 days where the temperature was at least 100 degrees, which ties for the 6th most of any summer. The summer of 2012 was also the 3rd hottest summer on record for the contiguous U.S. since recordkeeping began in 1895. Only behind the summers of 2011 and 1936 have higher summer temperatures (source: National Weather Service, Goodland, KS 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).
- **Spring 2012:** After experiencing the 5th warmest winter on record, with a three month average temperature of 38.4 degrees from December 1st to February 29th, Wichita went on to witness the warmest spring in the city`s 124-year climate history. Wichita`s average temperature from March 1st to May 31st, which is considered meteorological spring, was 64.4 degrees. This torched the previous record of 59.9 degrees, recorded in 2006, by 4.5 degrees. The 64.4 degree average is an amazing 8.2 degrees above the 56.2 degree normal for spring (source: National Weather Service, Wichita, KS http://www.crh.noaa.gov/ict/scripts/archives.php?reqYear=2012).
- **Summer 2011:** Central, south central and southeast Kansas experienced one of the hottest summers on record. The Wichita area had an average high of 101.2. This ranks as the fifth extreme July heat wave after 1980, 1854, 1936, and 1934. On September 1, 2011, Wichita set a new record for the most 100 degree days in a year surpassing 1936 (source: National Weather Service, Wichita, KS http://www.crh.noaa.gov/ict/scripts/archives.php?reqYear=2011).
- **January 7, 2010:** An unusually cold Arctic air mass came across the area on January 6th and stayed through January 9th. This area has not seen a cold air mass like this since December 2005, and even February 1996 before that. Besides the cold temperatures, this Arctic air mass brought in very strong winds throughout the area on the evening of January 6th and on Thursday, January 7th. The strong winds combined with the very cold temperatures creating dangerous wind chills. Wind chills through this cold outbreak created dangerous situations for people, animals, and property that were outdoors for a long period of time. Several schools across the area were cancelled or delayed, waterline mains burst and slick driving conditions were reported.
- **December 9, 2009:** Wind chill values of -25 to -30 Fahrenheit were common on the morning of the 9th across all of northwest Kansas, southwest Nebraska and eastern Colorado. Air temperatures of -5 to -15 F combined with north winds to produce dangerously low wind chill readings.
- **April 2007:** The U.S. Department of Agriculture designated 68 Kansas counties primary natural disaster areas because of losses caused by unseasonably warm temperatures followed by prolonged freezing weather that occurred from April 4, 2007, through April 10, 2007. Fifteen contiguous counties were also eligible for assistance.
- **July 16-20, 2006:** From July 16-20, a deadly heat wave gripped much of central, south-central, and eastern Kansas. Temperatures soared into the 105-110 °F range. Five lives

were lost across south-central and southeast Kansas: three in Wichita, one in Iola, and another in Coffeyville. The heat unofficially claimed three other lives, two in Wichita and one in Coffeyville, and dozens of people across central, south-central, and southeast Kansas were treated for heat-related illnesses. For this particular year a total of 21 heat-related deaths were reported by the Kansas Department of Health and Environment. The same heat wave also caused two train derailments, which required rerouting of train traffic. The derailments were caused by —sunkinks": the metal tracks expanded from the heat. One train derailed north of Topeka toward Atchison, and the other derailed immediately east of Neosho Rapids. The train that derailed near Neosho Rapids had five cars that contained hazardous materials; none of them was compromised. That same year, a late freeze damaged at least 75% of the wheat crop.

- **July 2001:** Several cities experienced many days in which temperatures exceeded 100 degrees F. The most number of days with such high temperatures occurred in Liberal, Dodge City, and Medicine Lodge where temperatures exceeded 100 degrees for 19, 20, and 21 days, respectively. There were difficulties meeting increased electrical demand because of the concurrent outage of a generating station. In the Wichita area, there were 17 days in July that reached 100 °F or higher, nine of which were consecutive.
- **December 2000:** Much of the State experienced below normal temperatures from mid-late December into January.
- **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. From May 1, to September 30, 151 persons were treated as in-patients in Kansas hospitals with heat-related illnesses.
- **August 17, 1998:** Two high school football players, one in Butler County and one in Sedgwick County, suffered from heat stroke during practice and died the following morning.
- **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.
- **April 1995:** Extreme cold damaged wheat in a critical growth stage in Greeley and Wichita Counties. Crop damage was estimated at $2.5 million.
- **December 1983**: In the Topeka area, an unprecedented cold spell set temperature records every morning from December 18 to 25. A deep snow cover kept temperatures at or below

zero for a record-setting 95 consecutive hours from December 21 to 25. The lowest temperature of 17 degrees below zero occurred on December 22. Very strong winds accompanied the cold, producing deadly wind chill readings.

- **July 1980:** In the Wichita area, high temperatures cleared 100 °F 24 out of 31 days, including 18 consecutive days of 100 °F or higher. In the Topeka area, temperatures hit consecutive days of 100 °F or higher on 20 out of 31 days.

In **Table 3.62,** the USDA Risk Management Agency insured crop losses through the State of Kansas as a result of heat and hot wind conditions, freeze and frost conditions. The total paid for extreme temperatures are $807,735,332 as shown here by year, 2002-2011. It shows the highest year of crop losses from heat as 2011, then the years of 2002, 2008, and 2003. For freeze and frost, the highest year of crop losses was 2007. This information is also reported and annualized by county in **Table 3.64** in the State Estimates of Potential Losses Section. 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.

Table 3.62. Total Insured Crop Insurance Paid by Year, 2002-2011

Year	Crop Insurance Paid for Heat & Hot Wind	Crop Insurance Paid for Freeze and Frost	Total Crop Insurance Paid for Extreme Temperatures
2011	$243,893,940	1,425,217	$245,319,157
2010	$22,471,987	964,011	$23,435,998
2009	$4,003,615	30,537,672	$34,541,287
2008	$33,247,376	4,295,596	$37,542,972
2007	$7,768,633	242,077,499	$249,846,132
2006	$18,844,699	22,685,270	$41,529,969
2005	$13,932,515	18,307,765	$32,240,280
2004	$6,480,592	48,455,107	$54,935,699
2003	$27,409,335	1,373,942	$28,783,277
2002	$55,966,365	3,594,303	$59,560,668
Total	**$434,019,059**	**373,716,383**	**$807,735,442**

Source: USDA Risk Management Agency

Probability of Future Hazard Events

Based on the 16 notable events within a 32-year time period (1980–2012), an extreme temperature event occurs every 2 years on average. This hazard's CPRI probability is "**Likely**" within the next three years. An extreme heat event is more likely to occur in the months of June, July, August, and September, and an extreme cold event is more likely to occur in the months of November, December, January, February, and March.

Also the EPA has projected that with Climate Changes in the Great Plains, temperatures will continue to increase and affect all Kansas communities. It is predicted that people will isolate themselves in their houses with air conditioning or fans and only get outdoors as necessary and not participate in outdoor recreational activities as often.

Another future concern, is as young 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.

State Vulnerability Analysis

All Kansas communities are vulnerable to the impacts of extreme temperatures in rural and urban areas. 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. **Figure 3.47** shows the distribution of the elderly population (age 65 and up) and **Figure 3.48** shows the distribution of the population under the age of 5 in Kansas. The greatest population of under age 5 resides in the counties of Johnson, Sedgwick and Wyandotte in Kansas.

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. **Figure 3.49** shows the growing higher projection percentages of elderly population in Kansas through the year 2025. The Kansas Department on Aging and Disability Services has the *Kansas State Plan on Aging Federal Fiscal Years 2010–2013* located at *http://www.kdads.ks.gov/Publications/Publication_Index.html* which has details on mitigation actions to minimize risk exposure to the elderly population in the State.

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.

Figure 3.47. Distribution of Elderly Population, Census 2010

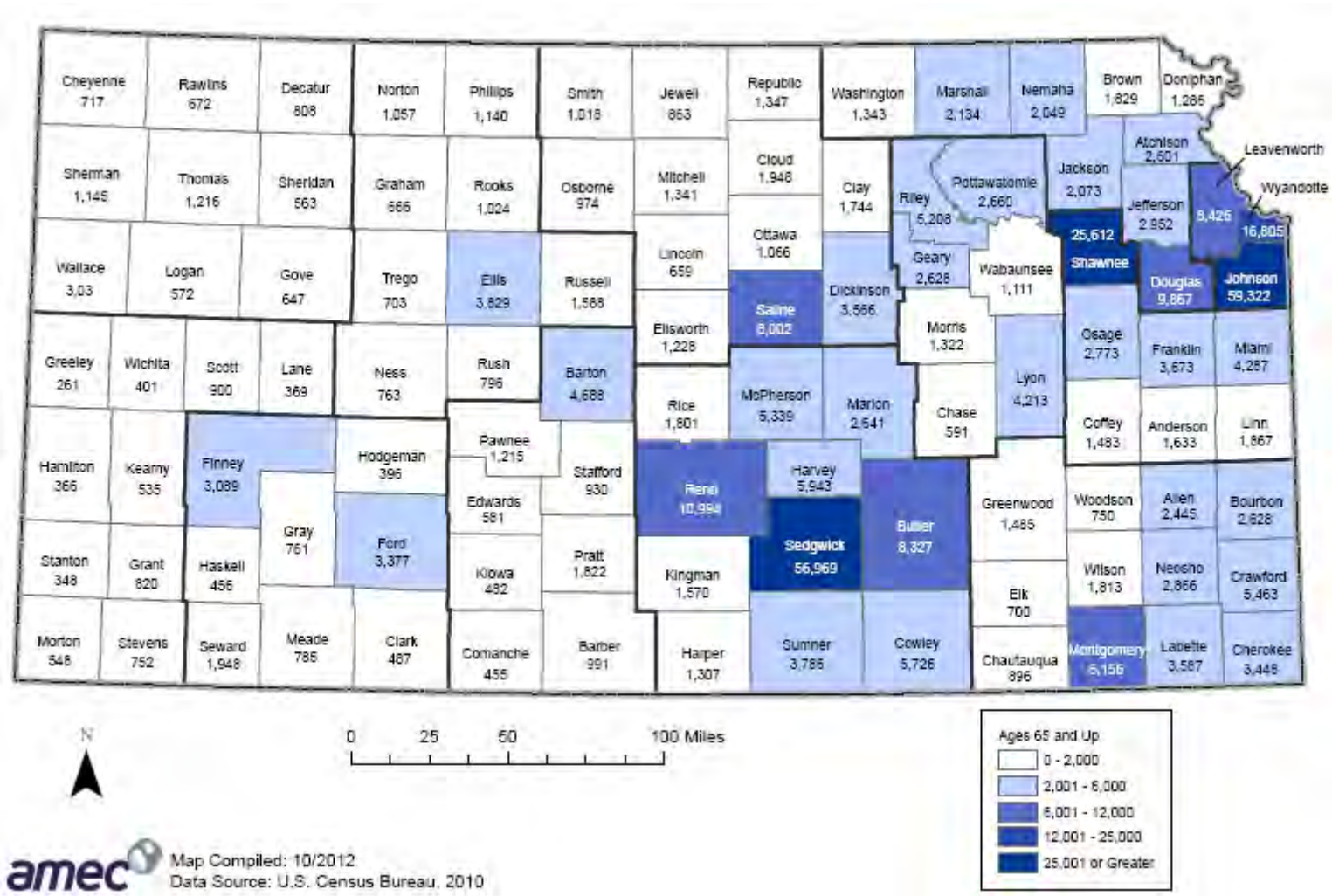


Figure 3.48. Distribution of Population Under 5, Census 2010

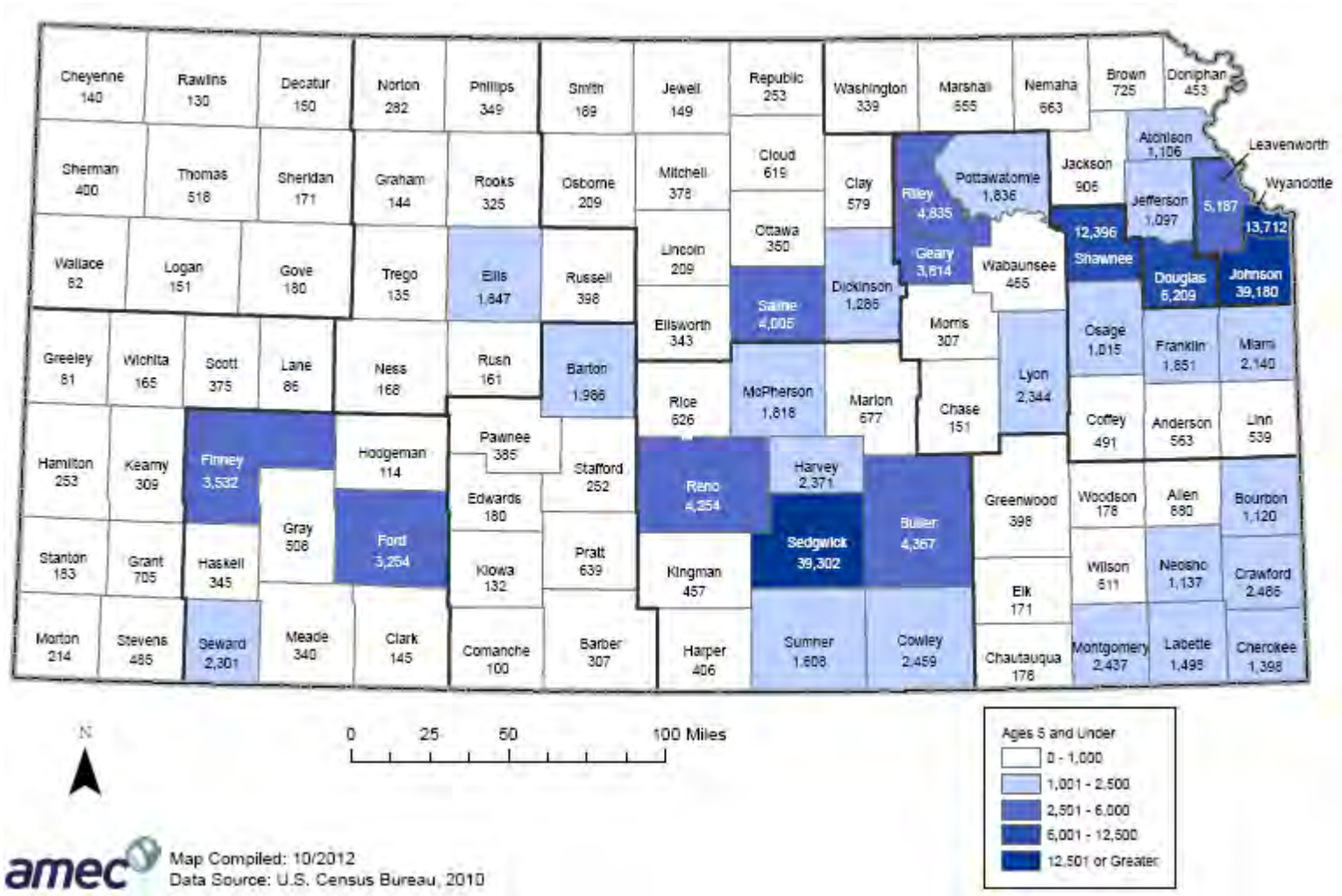
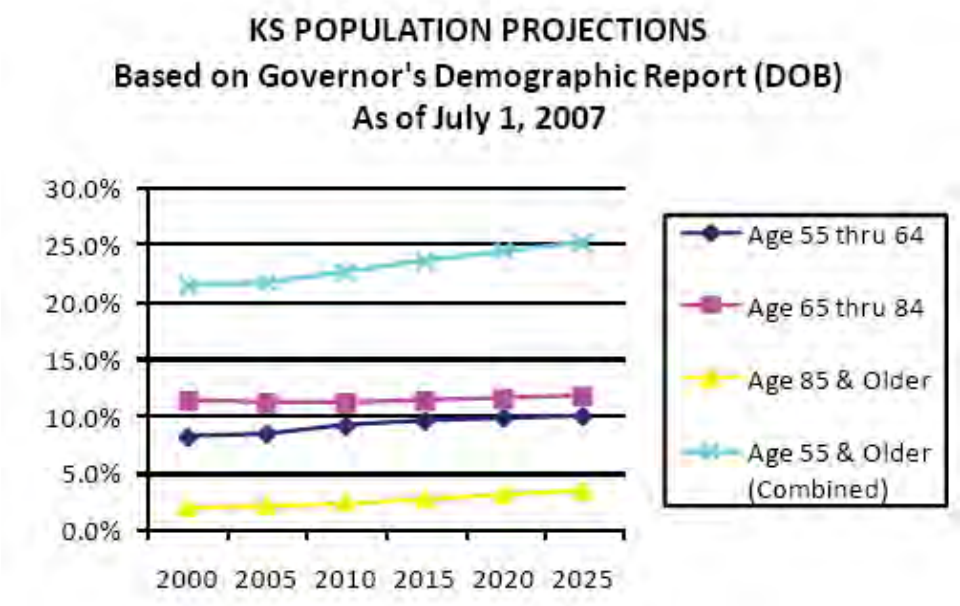


Figure 3.49. Distribution of Elderly Population Percentage Change Projections



Source: Kansas State Plan on Aging Federal Fiscal Years 2010-2013, http://www.kdads.ks.gov/Publications/State_Plan_2010-2013.pdf .

State Estimates of Potential Losses

Kansas's highest temperatures generally occur in June, July, August and September each summer. Thus, the majority of direct and indirect exposure to excessive heat that has caused fatalities also occurs during these months.

Table 3.63 shows there have been at least 125 fatalities of Kansas residents between the years of 2000-2011 and then annually at least 10 persons die from extreme heat. This table does not include the years of suppressed data to protect confidentiality. Suppressed means the number of deaths is less than 5 but greater than 0. The year of 2011 had the most recorded fatalities with 37.

Table 3.63. Recorded Kansas Extreme Heat Fatalities 2000-2011

Year	Number of Fatalities Accredited to Extreme Heat in Kansas
2000	10
2001	5
2002	Suppressed
2003	5
2004	Suppressed
2005	6
2006	21
2007	11

Year	Number of Fatalities Accredited to Extreme Heat in Kansas
2008	9
2009	10
2010	Suppressed
2011	37
9 Years Total	125

Source: Kansas Environmental Public Health Tracking Program

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.

Kansas has experienced $80,773,544 annually in 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. **Table 3.64** is a list of the total insured crop insurance paid and annualized insured crop insurance paid per county thus showing the differences of how extreme temperature conditions affected Kansas counties. Wyandotte County is the only county with no insured crop losses. 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.

Table 3.64. Total Insured Crop Insurance Paid per County from 2002-2011

County	Total Insured Crop Insurance Paid for Extreme Temperature Damages	Annualized Insured Crop Insurance Paid for Extreme Temperature Damages
Mitigation Planning Region A		
Cheyenne	$10,257,470	$1,025,747
Decatur	$6,307,588	$630,759
Gove	$6,712,895	$671,290
Logan	$3,995,080	$399,508
Rawlins	$11,829,788	$1,182,979
Sheridan	$18,956,603	$1,895,660
Sherman	$18,112,839	$1,811,284
Thomas	$14,623,117	$1,462,312
Wallace	$7,893,499	$789,350
Subtotal	**$98,688,879**	**$9,868,888**

Mitigation Planning Region B		
Ellis	$3,288,023	$328,802
Graham	$5,798,511	$579,851
Ness	$3,297,449	$329,745
Norton	$4,338,315	$433,832
Phillips	$1,994,257	$199,426
Rooks	$2,404,242	$240,424
Rush	$3,282,523	$328,252
Russell	$2,144,475	$214,448
Trego	$4,552,286	$455,229
Subtotal	**$31,100,081**	**$3,110,008**
Mitigation Planning Region C		
Grant	$20,159,900	$2,015,990
Greeley	$12,412,490	$1,241,249
Hamilton	$8,835,353	$883,535
Kearny	$8,008,522	$800,852
Lane	$4,940,461	$494,046
Morton	$12,904,919	$1,290,492
Scott	$12,746,903	$1,274,690
Stanton	$20,238,637	$2,023,864
Stevens	$23,263,071	$2,326,307
Wichita	$16,492,398	$1,649,240
Subtotal	**$140,002,654**	**$14,000,265**
Mitigation Planning Region D		
Clark	$879,477	$87,948
Finney	$21,614,064	$2,161,406
Ford	$15,542,646	$1,554,265
Gray	$26,214,157	$2,621,416
Haskell	$27,128,063	$2,712,806
Hodgeman	$6,200,407	$620,041
Meade	$4,999,014	$499,901
Seward	$9,351,749	$935,175
Subtotal	**$111,929,577**	**$11,192,958**
Mitigation Planning Region E		
Barber	$5,951,816	$595,182
Barton	$11,656,943	$1,165,694
Comanche	$1,616,942	$161,694
Edwards	$6,582,312	$658,231
Kiowa	$3,552,804	$355,280
Pawnee	$9,601,878	$960,188
Pratt	$11,587,287	$1,158,729
Stafford	$12,291,551	$1,229,155
Subtotal	**$62,841,533**	**$6,284,153**

Mitigation Planning Region F		
Clay	$4,252,458	$425,246
Cloud	$4,552,243	$455,224
Dickinson	$11,958,760	$1,195,876
Ellsworth	$5,510,904	$551,090
Jewell	$2,352,429	$235,243
Lincoln	$4,982,868	$498,287
Mitchell	$4,708,230	$470,823
Osborne	$2,649,068	$264,907
Ottawa	$8,472,384	$847,238
Republic	$3,636,517	$363,652
Saline	$12,462,289	$1,246,229
Smith	$1,994,718	$199,472
Subtotal	**$67,532,868**	**$6,753,287**
Mitigation Planning Region G		
Butler	$8,211,583	$821,158
Cowley	$8,331,321	$833,132
Harper	$23,112,054	$2,311,205
Harvey	$14,578,376	$1,457,838
Kingman	$13,794,923	$1,379,492
McPherson	$24,846,430	$2,484,643
Marion	$12,082,450	$1,208,245
Reno	$20,583,586	$2,058,359
Rice	$18,088,657	$1,808,866
Sedgwick	$17,353,061	$1,735,306
Sumner	$40,169,521	$4,016,952
Subtotal	**$201,151,962**	**$20,115,196**
Mitigation Planning Region H		
Allen	$3,345,864	$334,586
Bourbon	$776,560	$77,656
Chautauqua	$295,019	$29,502
Cherokee	$4,351,610	$435,161
Crawford	$3,126,224	$312,622
Elk	$475,269	$47,527
Greenwood	$1,713,862	$171,386
Labette	$4,878,576	$487,858
Montgomery	$3,761,417	$376,142
Neosho	$2,897,336	$289,734
Wilson	$4,595,784	$459,578
Woodson	$1,532,523	$153,252
Subtotal	**$31,750,044**	**$3,175,004**
Mitigation Planning Region I		
Chase	$1,260,818	$126,082
Geary	$1,298,854	$129,885
Lyon	$7,893,430	$789,343

Morris	$3,303,470	$330,347
Pottawatomie	$1,272,249	$127,225
Riley	$1,034,491	$103,449
Wabaunsee	$1,607,214	$160,721
Subtotal	**$17,670,526**	**$1,767,053**
Mitigation Planning Region J		
Anderson	$6,157,966	$615,797
Coffey	$5,964,306	$596,431
Franklin	$5,642,398	$564,240
Linn	$1,104,425	$110,443
Miami	$1,443,364	$144,336
Osage	$4,728,894	$472,889
Shawnee	$2,414,172	$241,417
Subtotal	**$27,455,525**	**$2,745,553**
Mitigation Planning Region K		
Atchison	$436,834	$43,683
Brown	$432,812	$43,281
Doniphan	$154,374	$15,437
Douglas	$3,594,057	$359,406
Jackson	$1,190,954	$119,095
Jefferson	$795,933	$79,593
Marshall	$3,453,809	$345,381
Nemaha	$1,791,745	$179,175
Washington	$3,876,511	$387,651
Subtotal	**$15,727,029**	**$1,572,703**
Mitigation Planning Region I		
Johnson	$1,410,575	$141,058
Leavenworth	$474,195	$47,420
Wyandotte	$0	$0
Subtotal	**$1,884,770**	**$188,477**
Statewide Total	**$807,735,442**	**$80,773,544**

Source: USDA Risk Management Agency

Development in Hazard Prone Areas

As the population in the above 65 year old category increases, counties could experience significant issues from extreme heat and cold. Since extreme temperatures affect the entire state, this is not a significant issue of concern for mitigating extreme temperatures.

Consequence Analysis

Extremes of heat and cold environmental conditions can be very detrimental to the health and comfort as human bodies attempt to maintain a state of *homeothermy* at a core temperature of about 98.6 degrees F. When exposed to extremes of heat and cold, human bodies have natural reactions to the extreme conditions.

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. Heat disorders share one common feature: the individual has been in the heat too long or exercised too much for his or her age and physical condition.

Studies indicate that, other things being equal, 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 3.65** lists conditions associated with heat, their symptoms and suggested first aid.

Table 3.65. Heat Disorders with Symptoms and First Aid

Heat Disorder	Symptoms	First Aid
Sunburn	Redness and pain. In severe cases swelling of skin, blisters, fever, headaches.	Apply ointments for mild cases if blisters appear and do not break. If http://www.nws.noaa.gov/os/heat/images/sunburn.jpgbreaking occurs, apply dry sterile dressing. Serious, extensive cases should be seen by physician.
Heat Cramps	Painful spasms usually in the muscles of legs and abdomen with heavy sweating.	Firm pressure on cramping muscles or gentle massage to relieve spasm. Give sips of water. If nausea occurs, discontinue water.
Heat Exhaustion	Heavy sweating; weakness; cold, pale, clammy skin; pulse thread; fainting and vomiting but may have normal temperature.	Get victim out of sun. Once inside, the person should lie down and loosen his or her clothing. Apply cool, wet cloths. Fan or move victim to air conditioned room. Offer sips of water. If nausea occurs, discontinue water. If vomiting continues, seek immediate medical attention.
Heat Stroke (or sunstroke)	High body temperature (106° F or higher), hot dry skin, rapid and strong pulse, possible unconsciousness.	HEAT STROKE IS A SEVERE MEDICAL EMERGENCY. SUMMON EMERGENCY MEDICAL ASSISTANCE OR GET THE VICTIM TO A HOSPITAL IMMEDIATELY. DELAY CAN BE FATAL**.** While waiting for emergency assistance, move the victim to a cooler environment reduce body temperature with cold bath or sponging. Use extreme caution. Remove clothing, use fans and air conditioners. If temperature rises again, repeat process. Do NOT give fluids. Persons on salt restrictive diets should consult a physician before increasing their salt intake.

The National Weather Service believes that extreme cold is a significant threat to persons living in this Midwest. Given its low frequency; humans, animals, etc., are not acclimated to extreme cold weather events. The most dramatic that suffer is on the general population mortality rate. The average mortality on a winter's day is about 15 percent higher than on a summer's day. Cold weather is directly responsible for deaths through such things as hypothermia, influenza and pneumonia. It is also an indirect factor in a number of ways such as death and injury from falls, accidents, carbon monoxide poisoning and house fires all of which are partially attributable to cold.

The information in **Table 3.66** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.66. EMAP 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 severe).

3.3.8. Flood

Calculated Priority Risk Index	Planning Significance
3.45	High

Description/Location

During the twentieth century, floods were the leading natural disaster in the United States, representing 40 percent of all natural disasters in terms of number of lives lost and property damaged. The U.S. Geological Survey reports that nationwide, floods kill an average of 140 people each year and cause $6 billion in property damage.

Kansas is vulnerable to both Flash Flooding and Riverine Flooding.

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, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil or impermeable surfaces

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

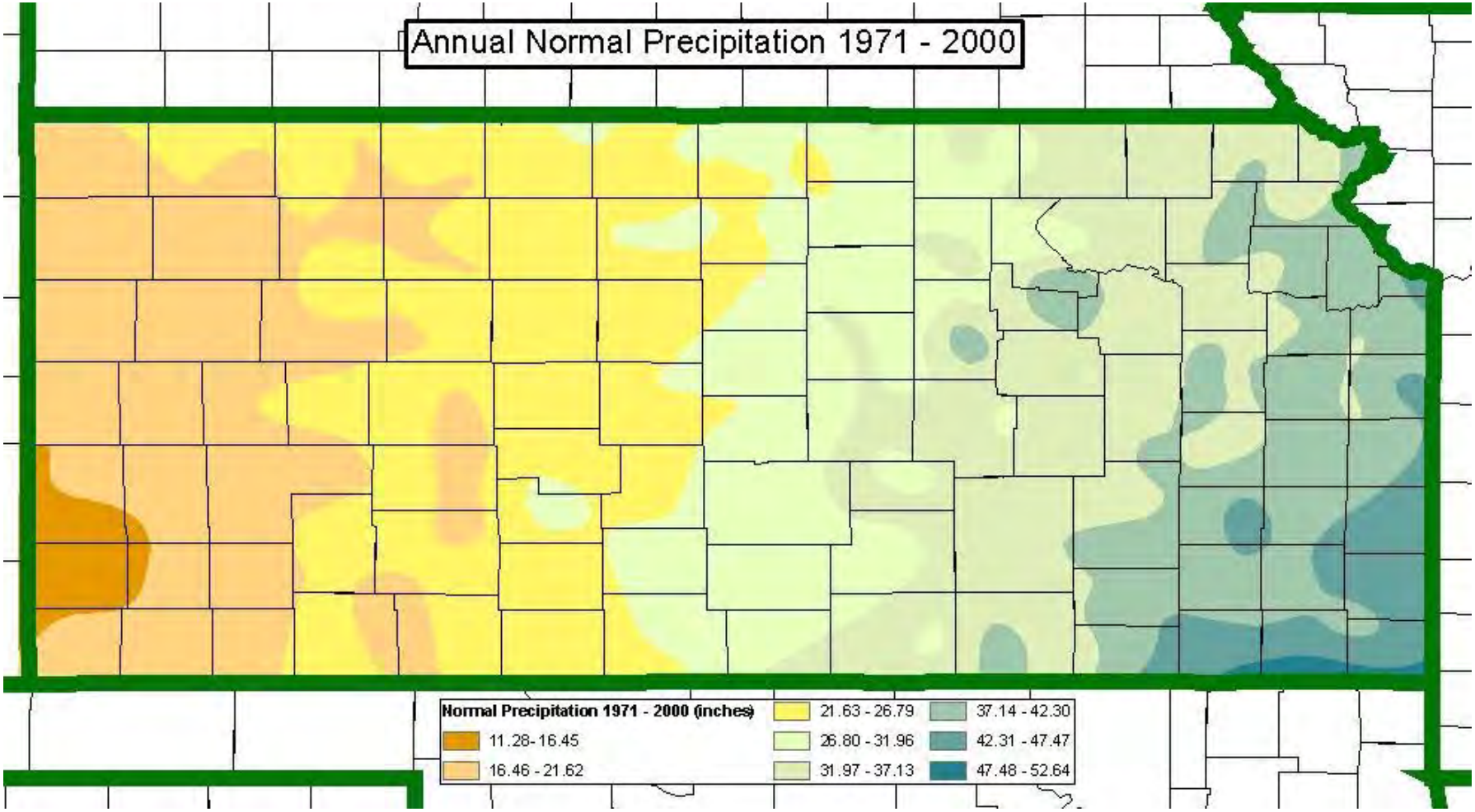
In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. This combined with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

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed

characteristics, modeling techniques, monitoring, and advanced warning systems increases the warning time for flash floods.

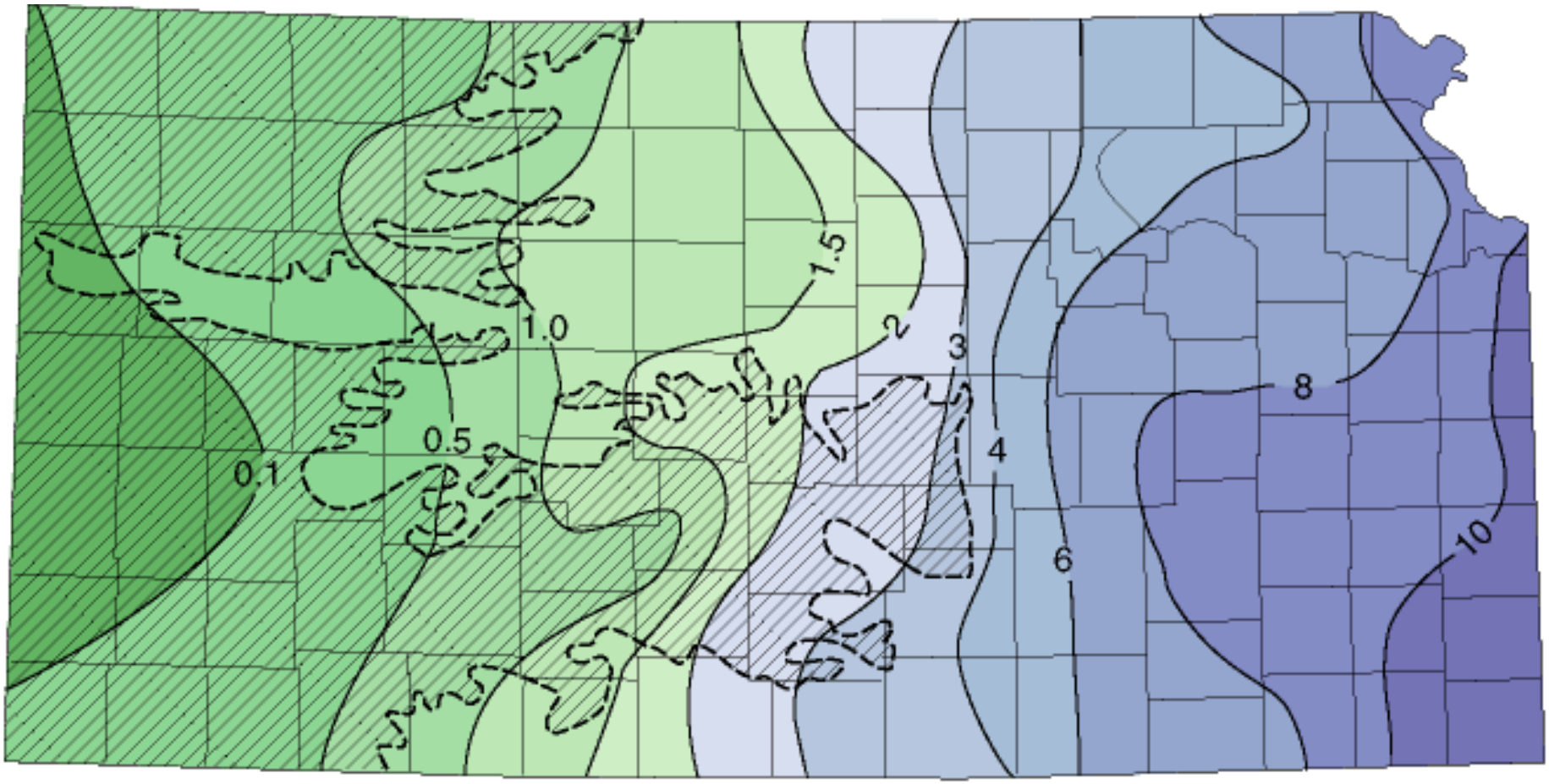
Flash flooding occurs in those locations of the in the planning area that are low-lying and/or do not have adequate drainage to carry away the amount of water that falls during intense rainfall events. The average annual precipitation varies significantly across the State. Precipitation in the eastern part of the State exceeds an average of 40 inches, while the average in the western part of the State is less than 20 inches. The map in **Figure 3.50** shows how the annual normal precipitation varies across the State. **Figure 3.51** that follows shows the distribution of water runoff in Kansas. Although the climatically controlled rainfall variation is significant, average annual runoff across the State varies much more than the precipitation. The average runoff ranges from approximately 10 inches in the east to 0.1 inch in the west. Both precipitation and runoff can impact flash flooding.

Figure 3.50. Annual Normal Precipitation in Kansas, 1971-2000



Source: K-State Research and Extension, http://www.ksre.ksu.edu/wdl/AnnualPrecipMaps.asp

Figure 3.51. Average Annual Runoff, in Inches



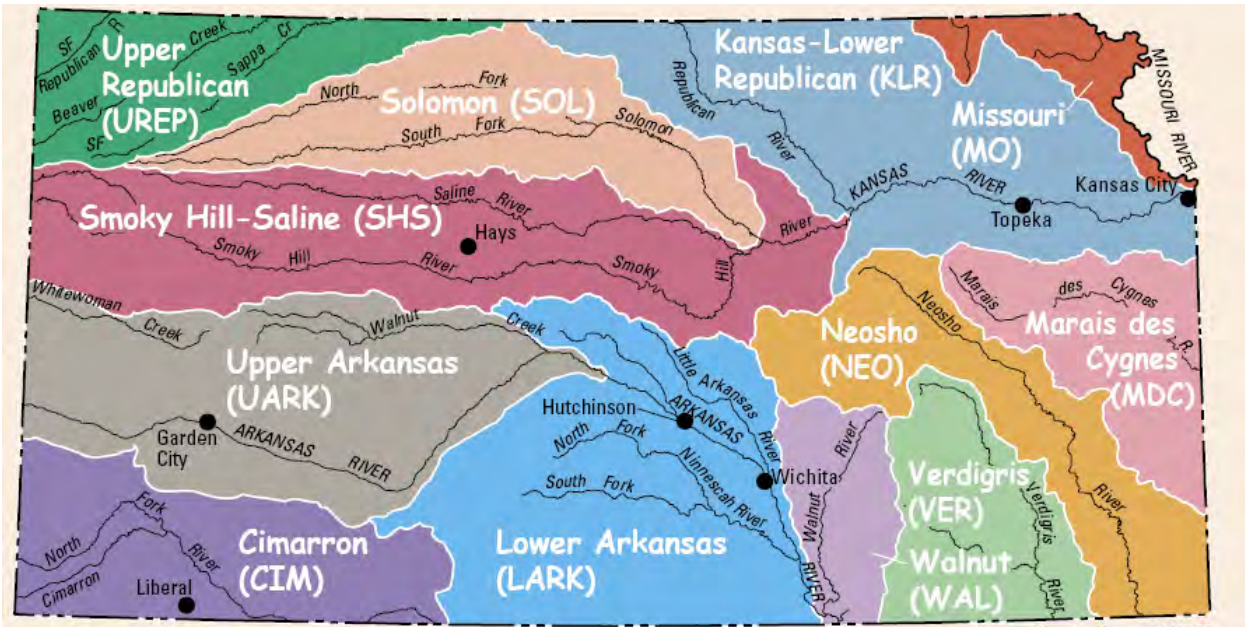
Source: Surface Water in Kansas and its Interactions with Groundwater, 2000, http://www.kgs.ku.edu/HighPlains/atlas/atswqn.htm: Note: The areas west of the dashed line show the extent of the High Plains aquifer in Kansas (Adapted from Wetter, 1987)

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 floodplain" 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.

A river basin is the land drained by a river and its branches. The surface waters of Kansas flow through 12 river basins of the State as shown in **Figure 3.52**. Within these basins, there are more than 134,000 total miles of interior streams and surface waterways.

Figure 3.52. Twelve Major River Basins in Kansas



Source: USGS Fact Sheet, Water Use in Kansas, 1990-2000 by Joan F. Kenny and Cristi V. Hansaen, http://pubs.usgs.gov/fs/2004/3133/pdf/fs04_3133.pdf.

The areas adjacent to surface waterways 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.

HAZUS MH 2.1 was utilized to update the State's Risk Assessment for riverine flooding. As discussed in **Section3.3.3**, Dam and Levee Failure, there are 45 Kansas Counties (out of 105 total) that are in various stages of development of Digital Flood Insurance Rate Maps. With less than half of the State with available DFIRMS, the State Hazard Mitigation Planning Team decided to utilize the latest version of HAZUS, released in February 2012, as a GIS-based tool to update the Riverine Flooding Risk Assessment. HAZUS produces a flood polygon and flood

depth grid that represents the base flood. While not as accurate as utilizing DFIRMs themselves, this approach ensures an —apples to apples" analysis to describe vulnerability in terms of the jurisdictions most threatened by riverine flooding, and most vulnerable to damage and loss associated with flooding events.

While riverine floods can and do occur at various levels, the one percent annual chance flood, has been chosen as the basis for this risk assessment. This level is the accepted standard for flood insurance purposes.

Results from the HAZUS analysis will be provided throughout this section to depict floodplain areas as well as varied vulnerability and potential loss estimates. The map in **Figure 3.53** provides a statewide overview of the one percent annual chance floodplains in Kansas, generated by HAZUS MH 2.1. **Figure 3.54** through **Figure 3.65** that follow depict the one percent annual chance floodplain areas for each of the 12 Mitigation Planning Regions in Kansas.

Figure 3.53. Kansas HAZUS One Percent Annual Chance Floodplain

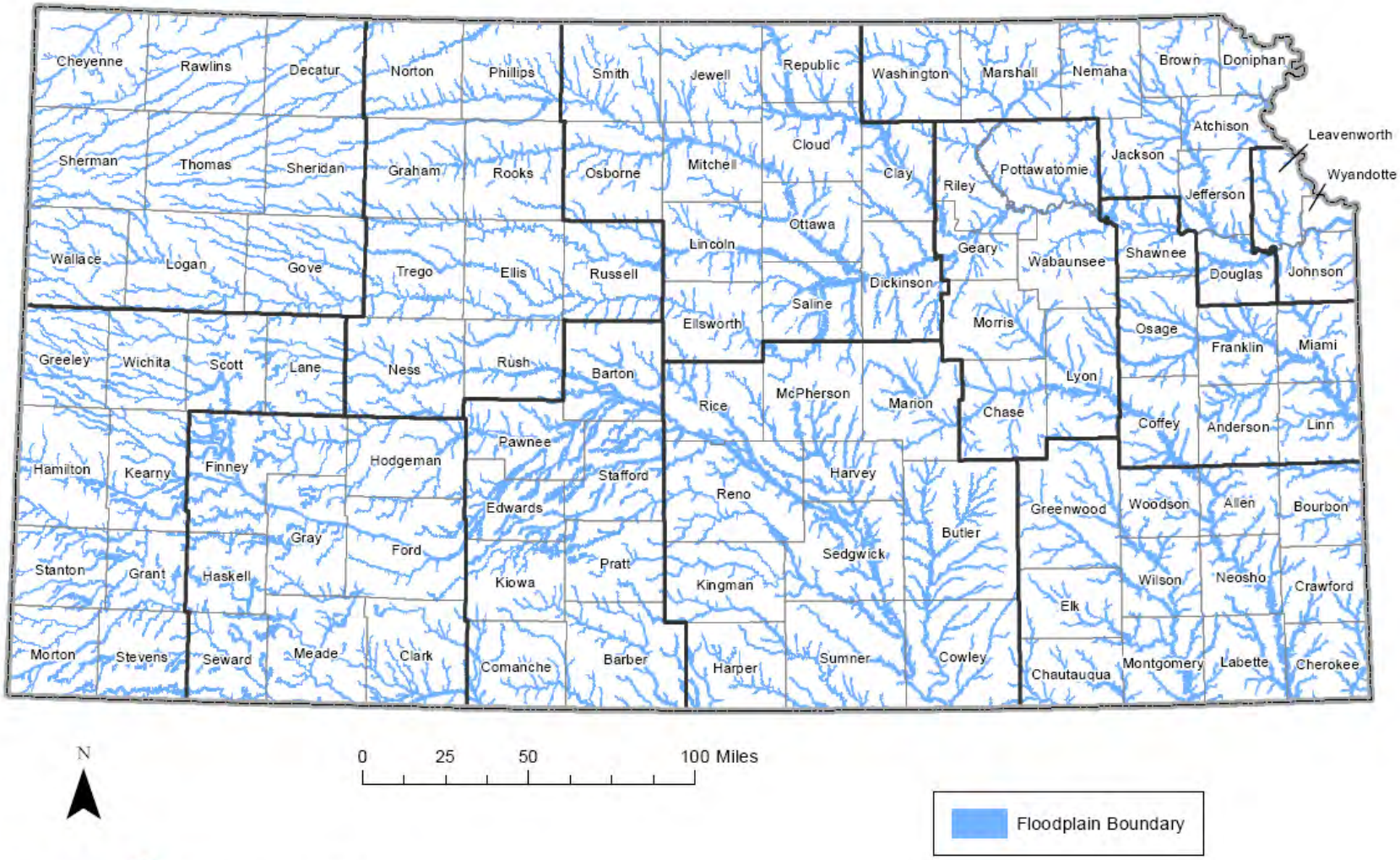


Figure 3.54. Mitigation Planning Region A HAZUS One Percent Annual Chance Floodplain

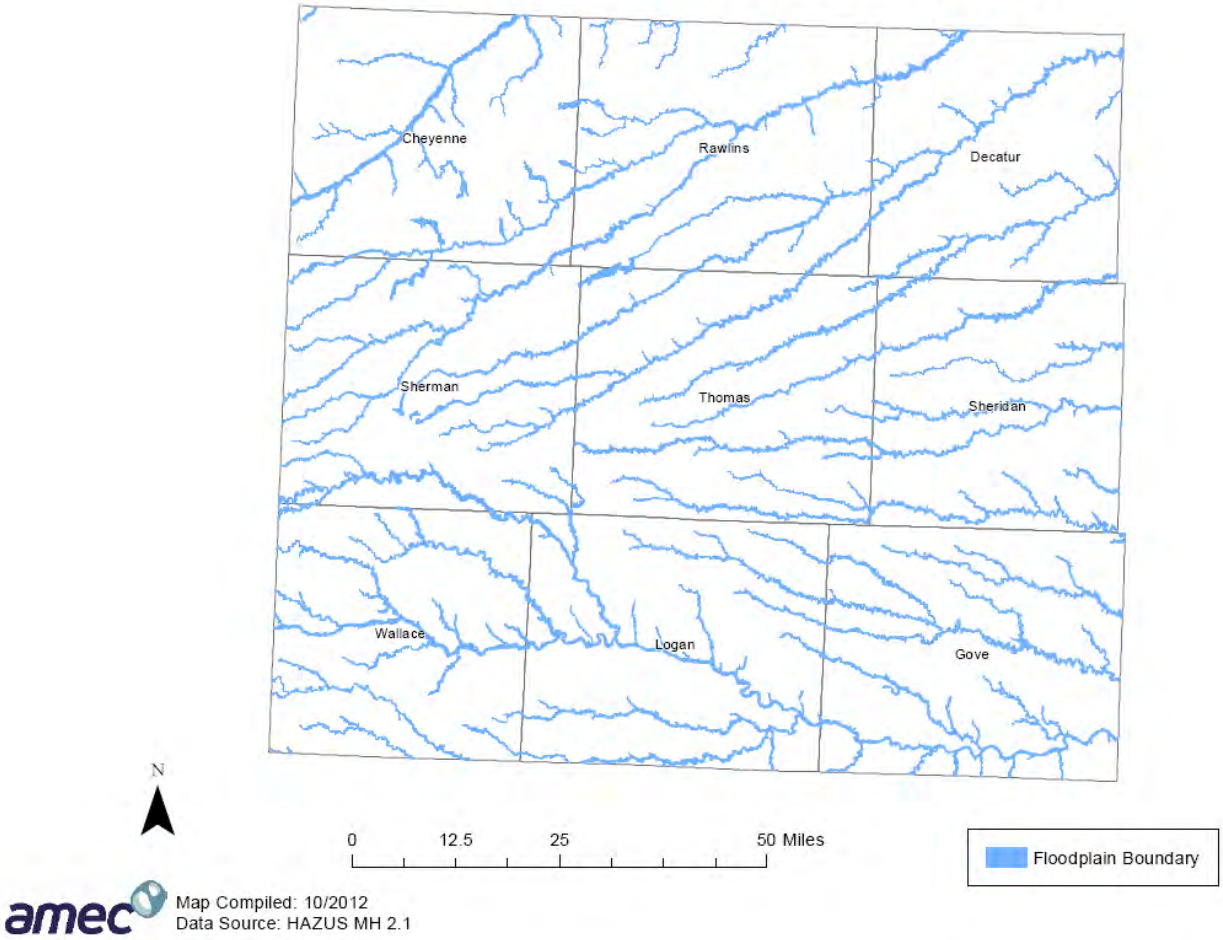


Figure 3.55. Mitigation Planning Region B HAZUS One Percent Annual Chance Floodplain

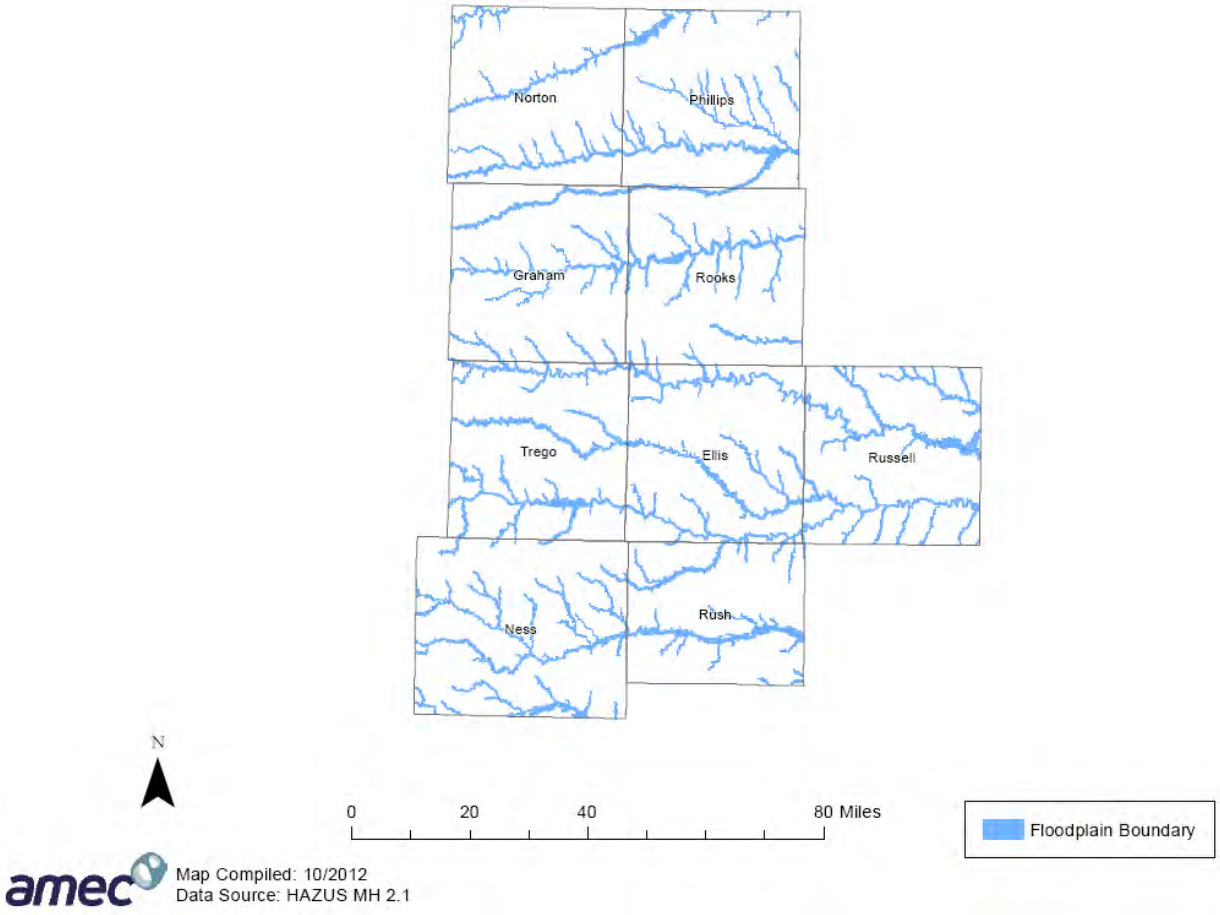


Figure 3.56. Mitigation Planning Region C HAZUS One Percent Annual Chance Floodplain

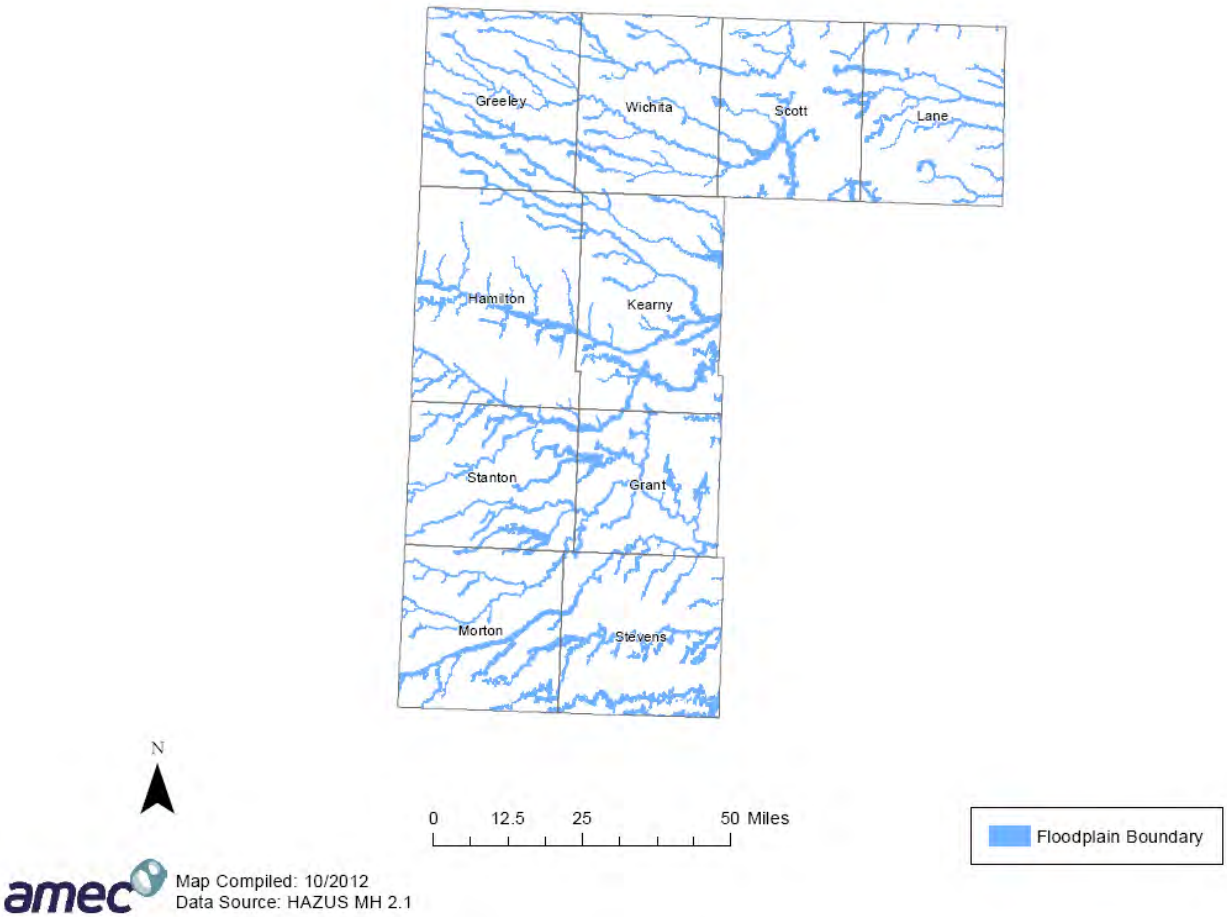


Figure 3.57. Mitigation Planning Region D HAZUS One Percent Annual Chance Floodplain

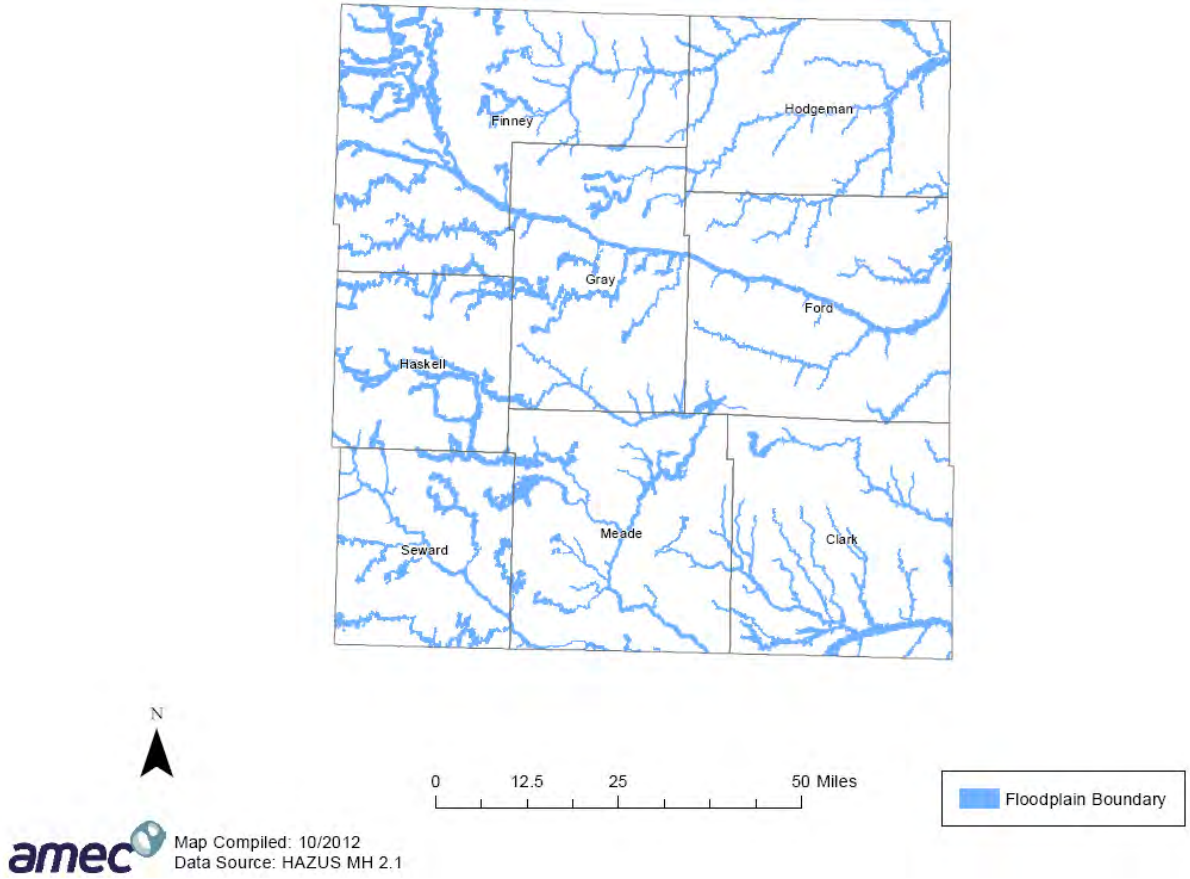


Figure 3.58. Mitigation Planning Region E HAZUS One Percent Annual Chance Floodplain

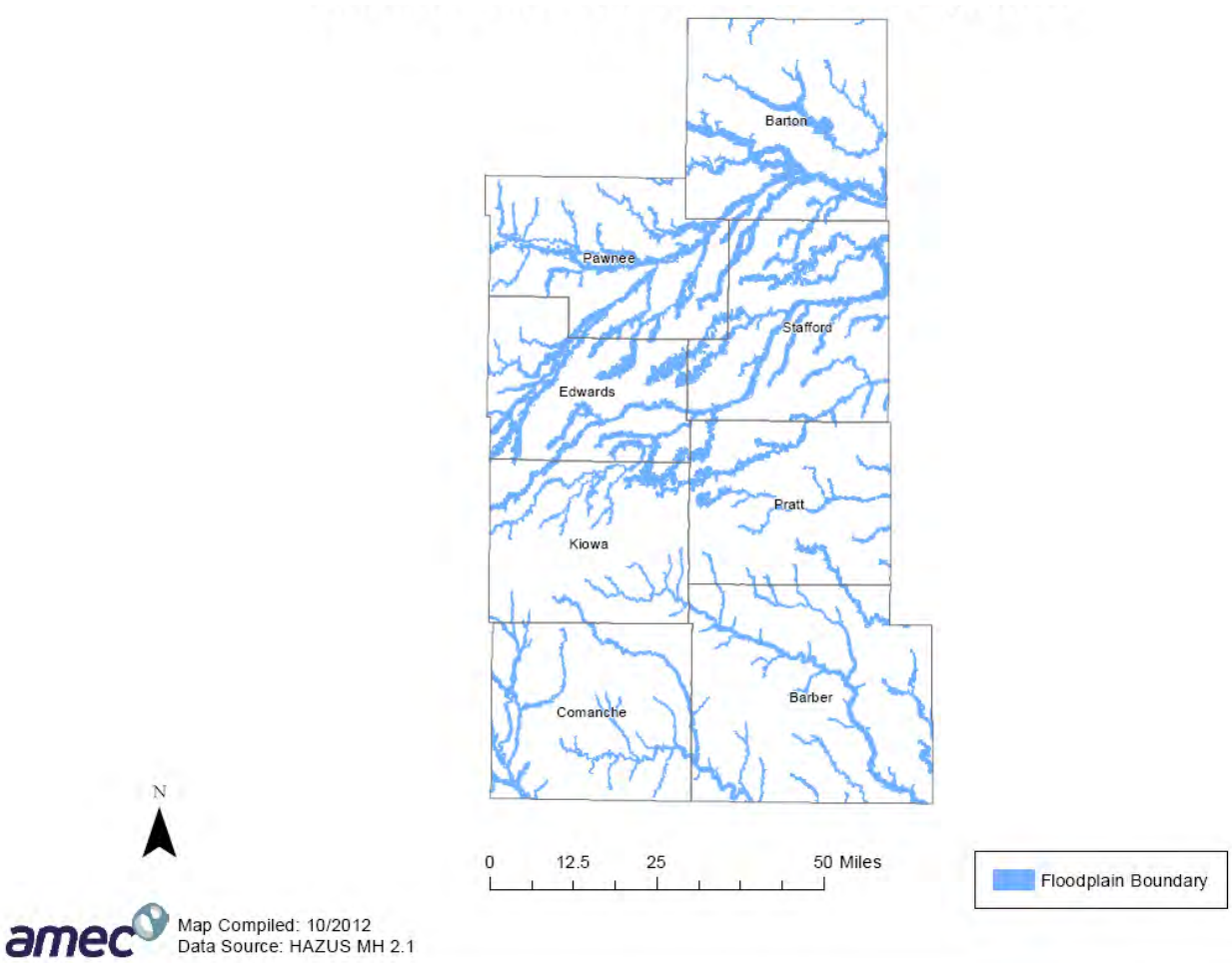


Figure 3.59. Mitigation Planning Region F HAZUS One Percent Annual Chance Floodplain

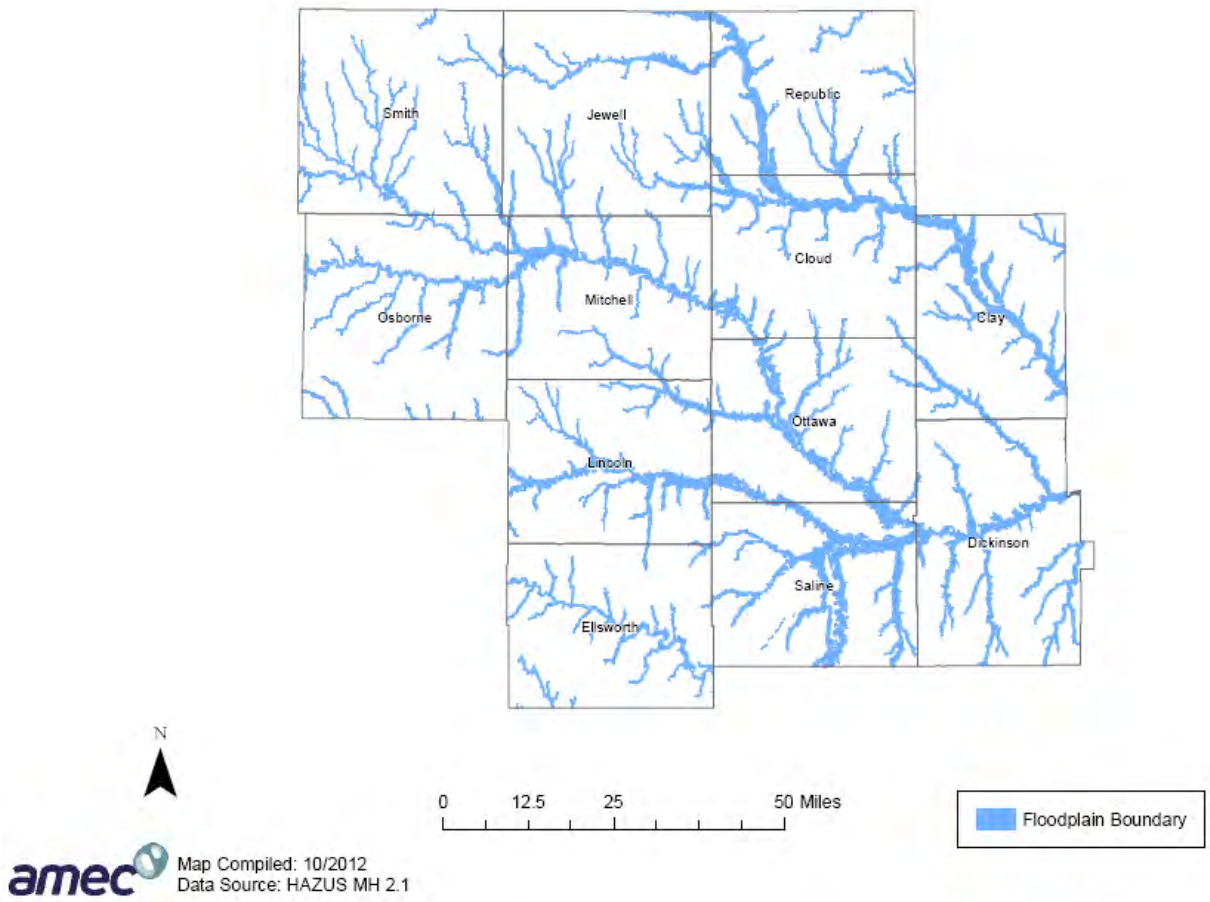


Figure 3.60. Mitigation Planning Region G HAZUS One Percent Annual Chance Floodplain

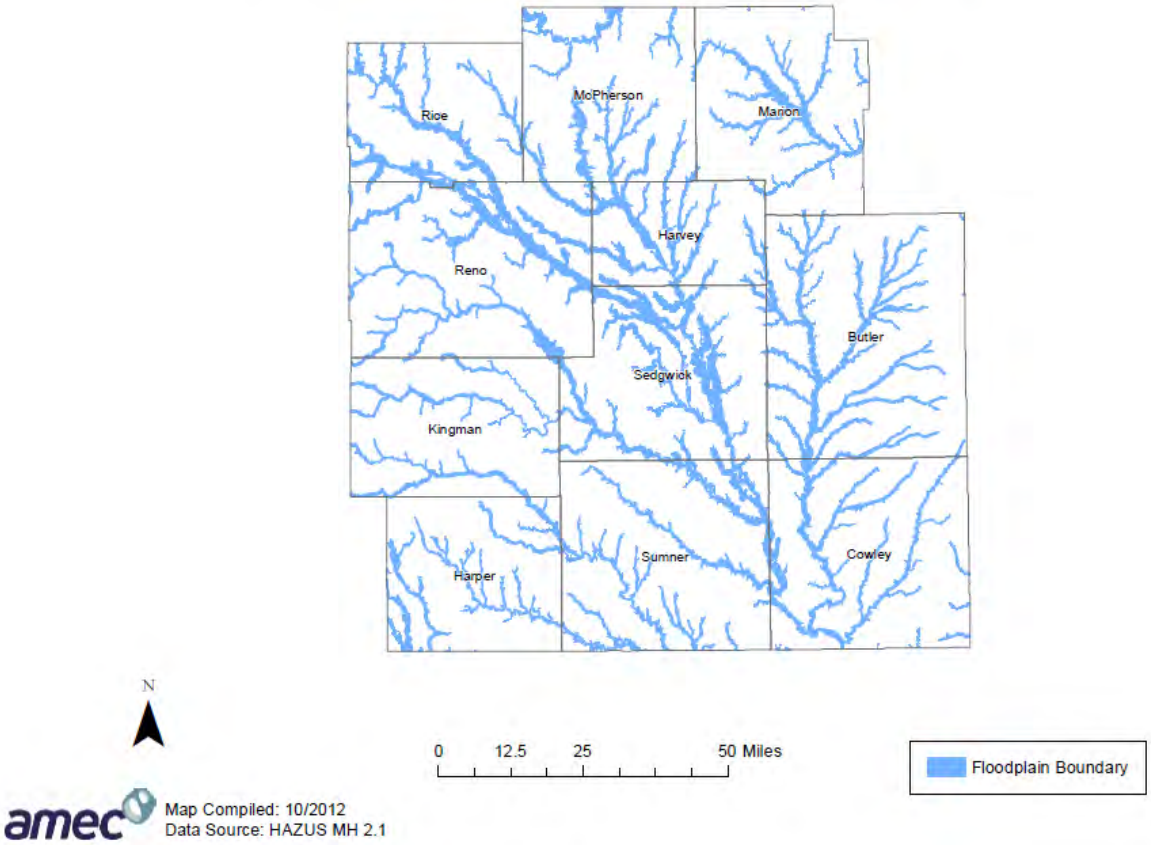


Figure 3.61. Mitigation Planning Region H HAZUS One Percent Annual Chance Floodplain

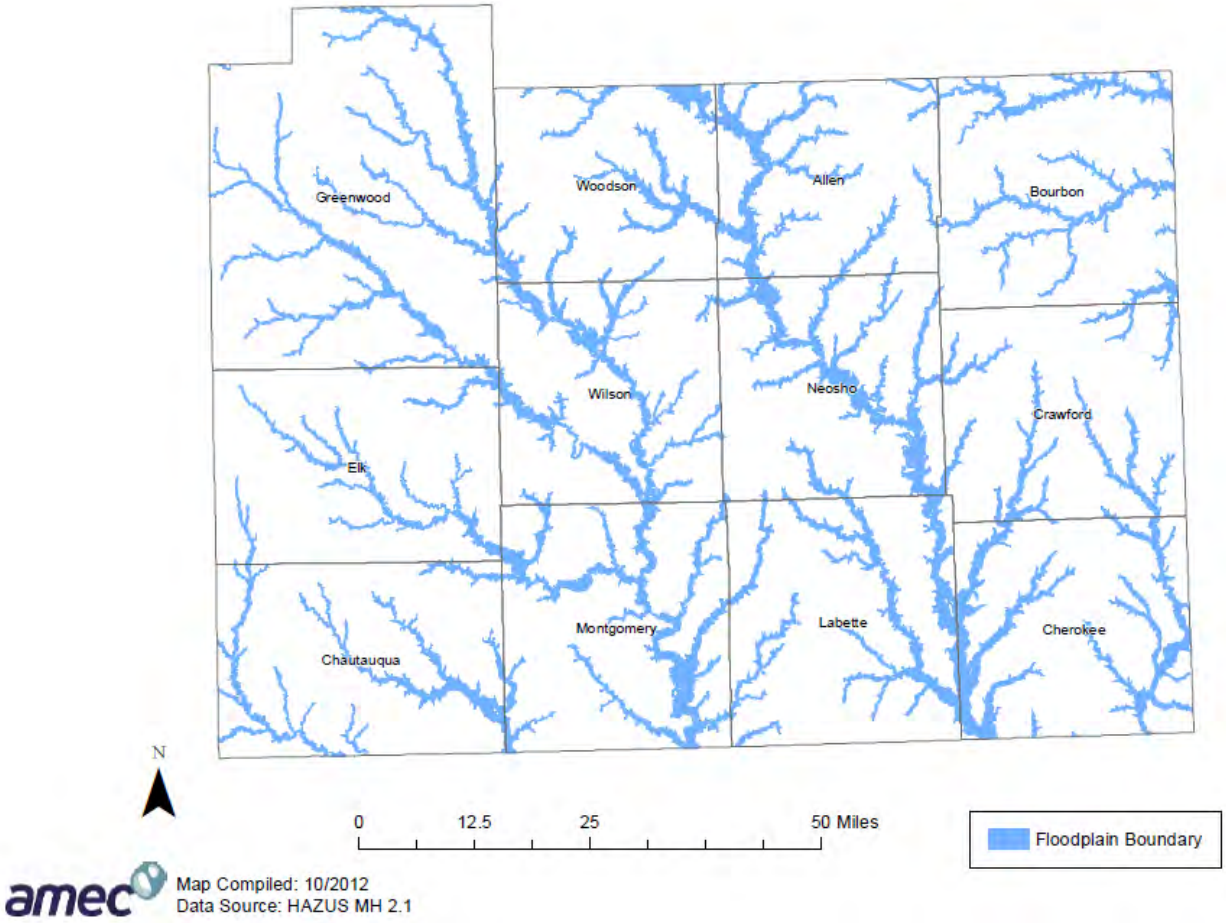


Figure 3.62. Mitigation Planning Region I HAZUS One Percent Annual Chance Floodplain

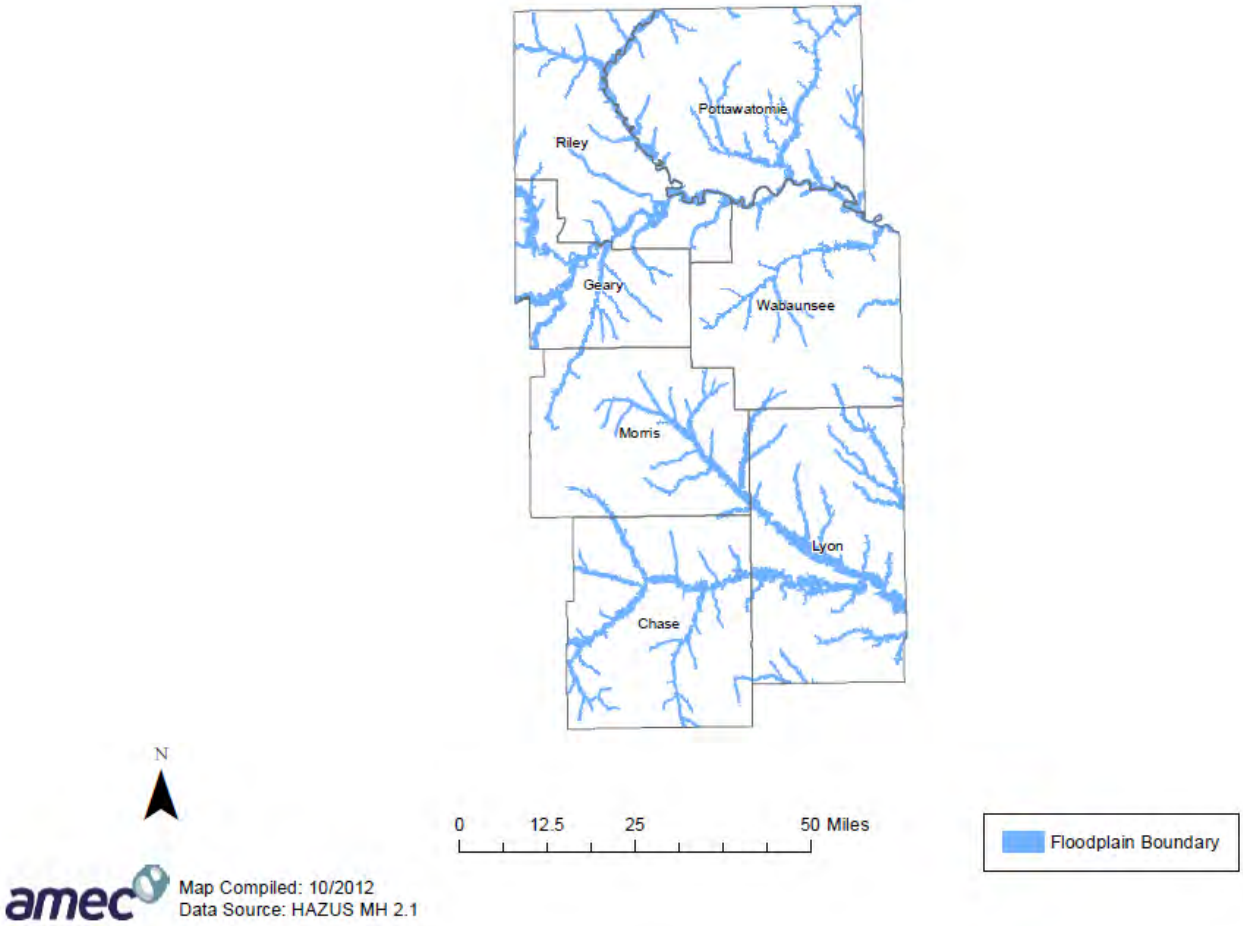


Figure 3.63. Mitigation Planning Region J HAZUS One Percent Annual Chance Floodplain

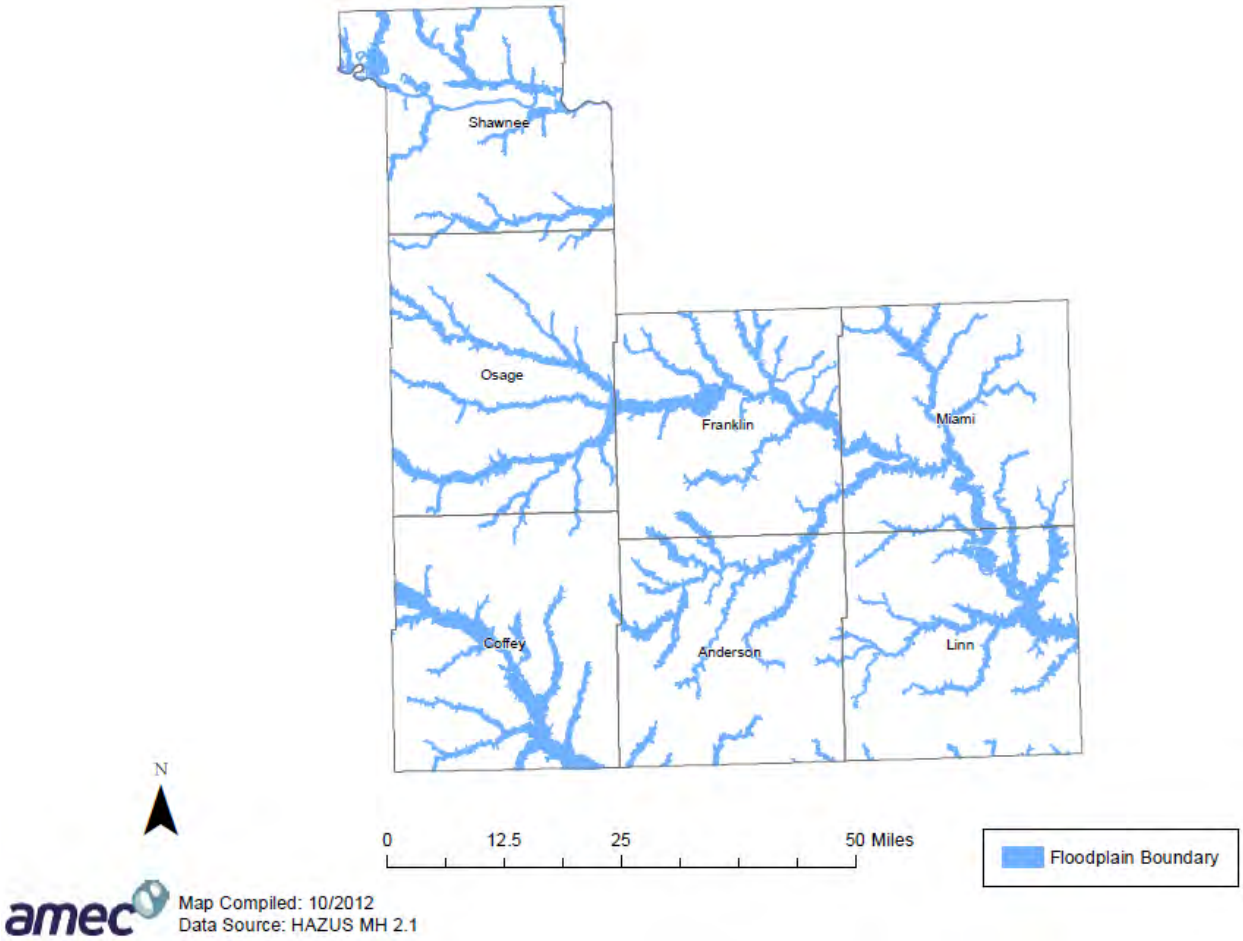


Figure 3.64. Mitigation Planning Region K HAZUS One Percent Annual Chance Floodplain

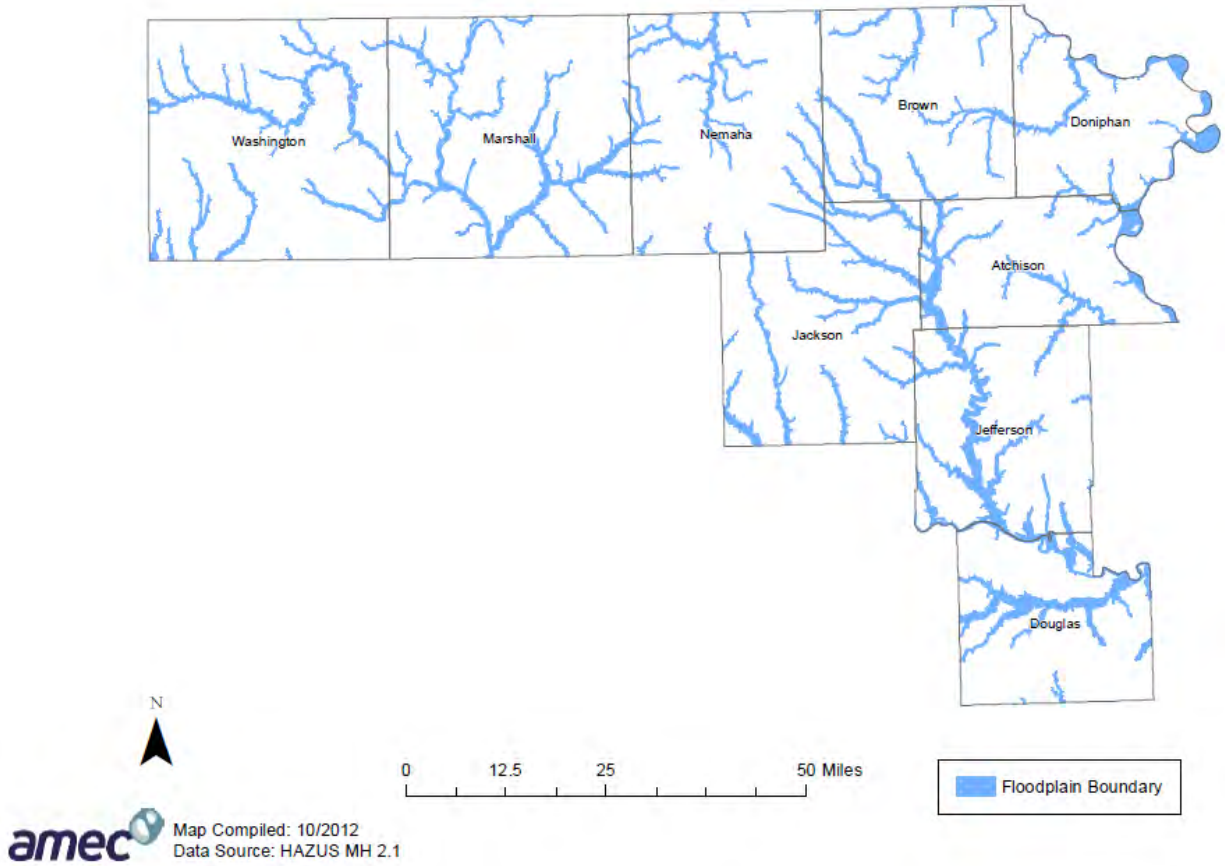
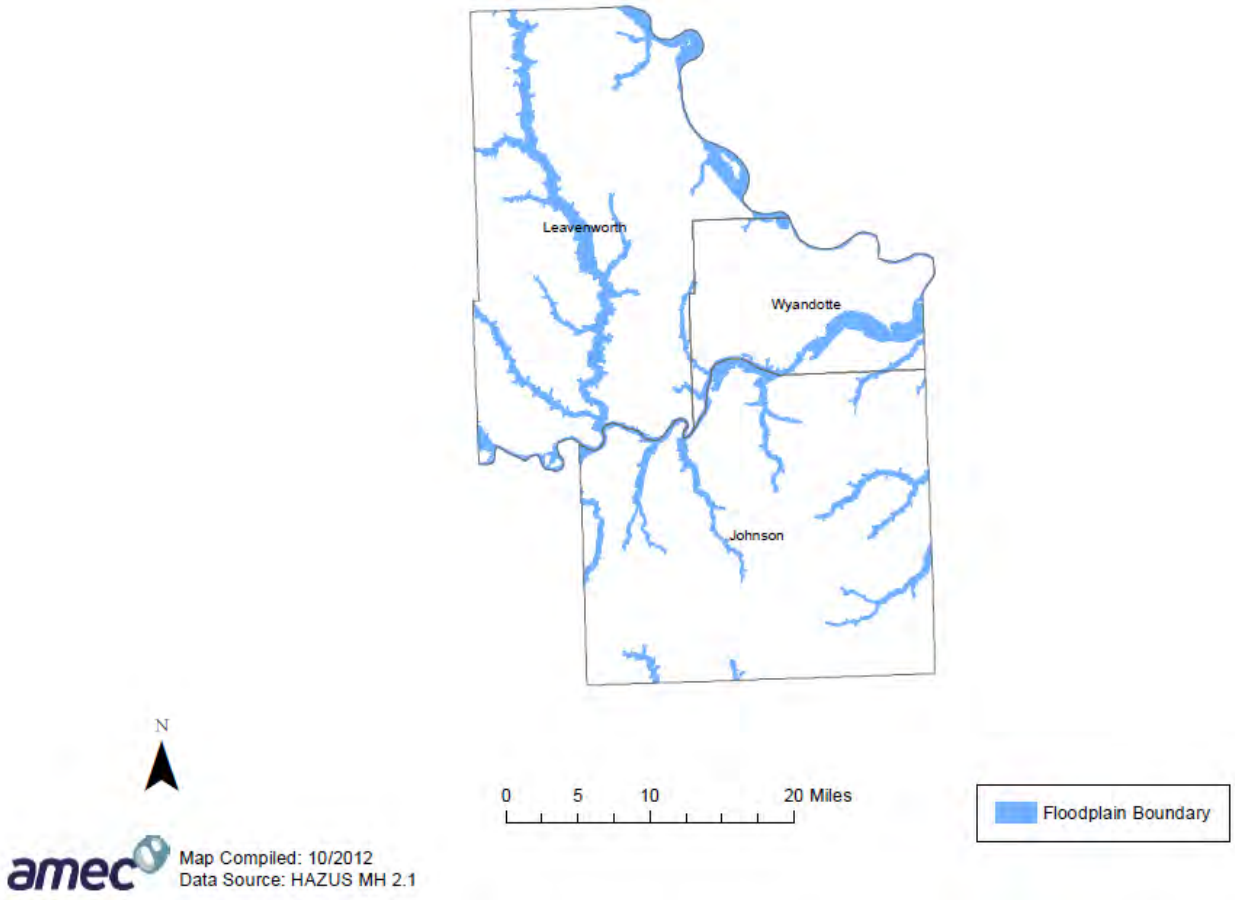


Figure 3.65. Mitigation Planning Region L HAZUS One Percent Annual Chance Floodplain



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. Details about some of these events as well as the Presidential Disaster Declarations that included flooding can be found on the following pages. Please note that some of the Presidential Disaster Declarations included flooding (primarily flash flooding) as a secondary cause of damages**.**

Since 1957, there have been 34 Major Presidential Disaster Declarations and one Emergency Declaration that included flooding in Kansas. The Declarations, counties involved and approximate costs are included in **Table 3.68**. Descriptions of some of the declared events as well as other notable flooding events follow the table.

Table 3.68. Kansas Presidential Declarations Involving Flooding

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
Major Disaster Declarations				
4063	05/24/2012 (4/14-4/15/2012)	Severe Storms, Tornadoes, Straight-line Winds and Flooding	Edwards, Ellsworth, Harper, Hodgeman, Jewell, Kiowa, Mitchell, Osborne, Rice, Rush, Russell, Sedgwick, Stafford and Sumner	$6,923,919
4035	09/23/2011 (6/1-8/1/2011)	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	$7,462,881
4010	07/29/2011 (5/19-6/4/2011)	Severe Storms, Straight-line Winds, Tornadoes and Flooding	Barton, Clay, Cloud, Hamilton, Jewell, Lincoln, Logan, Lyon, Marion, Mitchell, Morton, Osage, Osborne, Ottawa, Pottawatomie, Republic, Riley, Rooks, Rush, Russell, Sherman, Smith, Stafford, Stanton and Washington	$8,259,620
1932	08/10/2010 (6/7-7/21/2010)	Severe Storms, Flooding and Tornadoes	Atchison, Brown, Butler, Chase, Cheyenne, Clay, Cloud, Comanche, Decatur, Doniphan, Elk, Ellis, Franklin, Greenwood, Harvey, Jackson, Jewell, Kiowa, Lyon, Marion, Marshall, McPherson, Miami, Mitchell, Morris, Norton, Osage, Osborne, Pawnee, Phillips, Pottawatomie, Republic, Riley, Rooks, Rush, Sheridan, Smith, Wabaunsee, Washington, Wilson and Woodson	$9,279,257
1860	09/30/2009 (7/8-7/14/2009)	Severe Storms and Flooding	Anderson, Bourbon, Franklin, Linn and Sedgwick	$3,347,662
1849	06/25/2009 (4/25-5/16/2009)	Severe Storms, Flooding, Straight-line Winds, and Tornadoes	Anderson, Barber, Bourbon, Butler, Chase, Cherokee, Coffey, Cowley, Crawford, Elk, Finney, Greenwood, Harper, Harvey, Kingman, Labette, Linn, Lyon, Marion, Marshall, Montgomery, Morris, Neosho, Reno, Rice, Sumner, Wabaunsee and Wilson	$15,013,488
1808	10/31/2008	Severe Storms, Flooding, and Tornadoes	Anderson, Butler, Chase, Cowley, Greenwood, Harper, Harvey, Russell, and Sumner	$4,167,044

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
1776	07/09/2008	Severe Storms, Flooding, and Tornadoes	Barber, Barton, Bourbon, Brown, Butler, Chautauqua, Cherokee, Clark, Clay, Comanche, Cowley, Crawford, Decatur, Dickinson, Edwards, Elk, Ellis, Ellsworth, Franklin, Gove, Graham, Harper, Haskell, Hodgeman, Jackson, Jewell, Kingman, Kiowa, Lane, Linn, Logan, Mitchell, Montgomery, Ness, Norton, Osborne, Pawnee, Phillips, Pratt, Reno, Republic, Riley, Rooks, Rush, Saline, Seward, Sheridan, Smith, Stafford, Sumner, Thomas, Trego, Wallace and Wilson	$70,629,544
1711	7/2/2007 (6/26-30/2007)	Severe Storms and Flooding	Allen, Anderson, Bourbon, Butler, Chautauqua, Cherokee, Coffey, Cowley, Crawford, Edwards, Elk, Franklin, Greenwood, Harper, Labette, Linn, Miami, Montgomery, Neosho, Osage, Pawnee, Wilson, Woodson	$40,238,600
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
1600	8/23/2005 (6/30-7/1/2005)	Severe Storms and Flooding	Cherokee, Crawford, Neosho	$4,344,569
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	$16,688,650

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
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	$9,770,769
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
780	10/22/1986 (10/2-10/4/1986)	Severe Storms, Flooding	Allen, Bourbon, Chautauqua, Cherokee, Cowley, Elk, Labette, Montgomery, Neosho, Wilson	$2,344,121
714	6/22/1984 (6/7-6/9/1984)	Severe Storms, Tornadoes, Flooding	Atchison, Brown, Doniphan, Jackson, Nemaha, Pottawatomie	$5,002,299
663	6/28/1982	Severe Storms, Flooding	Jackson, Shawnee	$804,048
644	7/18/1981	Severe Storms, Flooding, Tornadoes	Barton, Douglas	$670,436
588	6/15/1979	Severe Storms, Flooding	Butler, Cowley	$1,056,090
539	9/20/1977	Severe Storms, Flooding	Atchison, Brown, Doniphan, Jackson, Jefferson, Johnson, Leavenworth, Nemaha, Shawnee, Wyandotte	$4,041,566
514	7/13/1976	Severe Storms, High Winds, Flooding	Butler, Cherokee, Crawford, Cowley, Elk, Greenwood, Labette, Neosho, Montgomery, Wilson	$1,794,942
442	6/10/1974	Severe Storms, Flooding	Lyon	$298,560
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

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost
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
201	6/23/1965	Flooding	Barton, Butler, Chase, Edwards, Finney, Ford, Grant, Gray, Greenwood, Hamilton, Harvey, Kearny, Lyon, Marion, McPherson, Pawnee, Reno, Rice, Sedgwick, Stafford, Stanton	$1,046,450
88	11/6/1958	Floods	Atchison, Clay, Cloud, Nemaha, Republic, Washington	$121,504
81	9/5/1957	Floods	n/a	$66,816
Emergency Declarations				
3324	6/25/2011	Flooding	Atchison, Doniphan, Leavenworth and Wyandotte	n/a

FEMA-4063-DR: Severe Storms, Tornadoes, Straight-line Winds and Flooding—May 24, 2012

From April 14-16, fourteen Kansas Counties received damages due to severe storms, tornadoes, straight-line winds, and flooding. Primary damages were to utilities, mainly from winds associated with this event. However, there were some flood damages, primarily from flash flooding. Total damages to public utilities were estimated to be nearly $7 Million. The impacted counties included: Edwards, Ellsworth , Harper , Hodgeman , Jewell , Kiowa , Mitchell, Osborne , Rice , Rush , Russell, Sedgwick , Stafford and Sumner Counties.

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 $7.4 million and primarily involved damages to roads and bridges. Additionally, approximately 400 of Elwood, Kansas' 1,200 residents in Doniphan County voluntarily evacuated. **Figure 3.66**, **Figure 3.67** and **Figure 3.68** show this flooding event.

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, NE to Wolcott, KS in Wyandotte County on both sides of the river were either overtopped or breached. Included in the overtoppings was Kansas Department of Corrections land below the Lansing Correctional Facility. The federal levee at Fort Leavenworth by Sherman Army Airfield was also breached Water reached the previously evacuated hangars.

Figure 3.66. Flooded Roads During the 2011 Missouri River Flooding

Source: Kansas Commission on Emergency Planning and Response, 2011 Annual Report: Managing the Risk,

Figure 3.67. 2011 Flooding in Atchison County, Kansas

Source: Kansas Division of Emergency Management

Figure 3.68. 2011 Flooding in Doniphan County, Kansas

Source: Kansas Division of Emergency Management

FEMA-4010-DR: Severe Storms, Straight-line Winds, Tornadoes, and Flooding—July 29, 2011

From May 10 to June 4, 2011 severe storms, straight-line winds, tornadoes, and flooding caused damages in 25 Kansas Counties. The primary impacts of this event were to public roads and bridges with an estimated $9.8 million in damages.

FEMA-1932-DR: Severe Storms, Flooding, and Tornadoes—August 10, 2010

From June 7 to July 21, 2010, severe storms, flooding, and tornadoes caused damages in 41 Kansas Counties. The primary impacts of this event were to public roads and bridges with an estimated $11.2 million in damages.

FEMA-1860-DR: Severe Storms and Flooding – September 30, 2009

On September 2, 2009, Governor Mark Parkinson requested a major disaster declaration because of severe storms, accompanied by large hail, lightning, high winds, and torrential rains during the period of July 8-14, 2009. The governor requested a declaration for Public Assistance for eight counties and hazard mitigation for all counties. The primary impacts of this event were to public buildings and equipment with an estimated $3.5 million in damages.

FEMA-1849-DR: Severe Storms, Flooding, Straight-line Winds, and Tornadoes—June 25, 2009 (April 25-May 15)

During the last week of April and beginning of May, severe storms and flooding impacted Kansas. Many roads and highways were inundated. In Greenwood County, a truck was swept off of a county road into the Verdigris River drowning one man. In Labette County, two people were found in Pumpkin Creek. It is believed their car was swept off a low water crossing. In Lyon County, two men had to be rescued after driving around road barricades.

FEMA 1808-DR: Severe Storms, Flooding, and Tornadoes—October 31, 2008 (Sept. 11-17)

During the period of September 11-17, 2009, severe storms accompanied by tornadoes, lightning and torrential rains resulted in flooding and flash flooding across south central and eastern Kansas. Rainfall amounts were generally around 5 inches, however isolated amounts reached up to 11.00 inches on the West side of Wichita, Kansas. Wichita Mid Continent Airport reported the greatest 24 hour rainfall total (10.31 inches) in its history. A volunteer firefighter from Argonia died attempting to rescue five teenagers who became trapped as they were rafting down the Chikaskia River. Water ran over numerous roads across the County. Kansas Highway 49 north of Conway Springs and Highway 42 near Suppersville were closed due to high water. Interstate 35 near Wellington was also closed. In the Riverdale area near Belle Plaine a water rescue was performed when a pickup truck tried to drive through two feet deep water and became stranded. Flooding along the Ninnescah River lead to evacuations in the Ponderosa Area west of the city of Belle Plaine. In Cowley County, Rapidly rising water along the Walnut River caused the Winfield Fairgrounds to flood. This flood caused the rapid evacuation of thousands of campers who had come to claim their spot for the annual Walnut Valley Festival. Muddy conditions caused by up to 3.50 inches of rainfall lead to many of the campers to be pulled or towed out of the affected area. The water inundated the main grandstand and most of the stages, causing superficial damage but mainly caused some minor road damage. In Anderson County, nearly 30 percent of all roads in the county were closed because of flood waters.

FEMA 1776-DR: Severe Storms, Flooding, and Tornadoes—July 9, 2008

Beginning May 22, 2008 and continuing through June 16, 2008, severe storms across Kansas produced large hail, lightning, high winds, tornadoes and torrential rains. The severe weather produced widespread flooding. Several high water rescues were reported as local law and fire

officials had to rescue individuals from on top of their vehicles and in one instance clinging to a tree. Street flooding was reported throughout the impacted areas.

FEMA-1711-DR: Severe Storms and Flooding—July 2, 2007 (June 26–30)

Beginning June 26 and continuing through June 30, 2007, strong storms across south central and southeast Kansas produced torrential rainfall and subsequent flooding/flash flooding. Some counties, which were still recovering from flooding in mid-May, received over a foot of rain.

Up to 21 inches of rain was reported near Fredonia (Wilson County). As of the morning of June 30, 16½ inches had fallen in 48 hours in Moline (Elk County), 12½ of which fell in 24 hours. Nine inches fell in four hours in Winfield (Cowley County) on the afternoon of June 29. Wilson County was one of the hardest hit counties. Initially, Neodesha was only accessible by boat and air. Both the water and sewer plants were compromised by the flooding, which resulted in a boil water order for the area. Approximately 3,000 people were without power in Fredonia for several days. In Miami County, the Kansas National Guard was sent to help with a mandatory evacuation of Osawatomie, one of the hardest hit communities in eastern Kansas. The town evacuated 40 percent of its 4,600 residents after Pottawatomie Creek and the Marais des Cygnes River rose out of their banks.

In Montgomery County, the heavy rains caused the Verdigris River to overflow its banks, top protective levees, and flood the town of Coffeyville. The river crested more than 10 feet above flood stage, setting a new record for the river. Approximately 2,000 citizens and more than 200 homes were affected. In addition, the Coffeyville Resources Refinery and Coffeyville Resources Nitrogen Fertilizers, LLC, and many local businesses were flooded. As floodwaters rose, officials at Coffeyville Resources ordered the facilities to shut down and be evacuated. Despite their efforts to secure the refinery, an estimated 71,000 gallons of crude oil and a small amount of oil from the refinery‘s sewer system were swept away by flood waters. During the plant shutdown, the pump system from the east tank storage facility was shut down, but oil continued to flow because of an elevation difference, causing the main oil storage tank in the refinery to overflow (see **Figure 3.69**). The U.S. Environmental Protection Agency conducted monitoring for the presence of volatile organic compounds in flood waters in Coffeyville and downstream, but indicated the presence of these compounds was not at a —level of concern.” Contamination and health issues led local officials to prevent many people from returning to their flood damaged homes before it was determined safe.

Figure 3.69. Aerial photo of the oil contaminated flood water in Coffeyville in 2007

Source: 2010 Kansas Hazard Mitigation Plan

FEMA-1615-DR: Severe Storms and Flooding—November 21, 2005 (October 1–2)

A series of storms moved over the same locations in northeast Kansas again and again, until finally some spots in the area had received as much as a foot of rainfall. The rainfall caused many road closures because of flooding and brought flooding to urban and rural areas as several local creeks roared out of their banks. Rossville in Shawnee County was likely the hardest hit: 80 percent of the geographical area was flooded. Many locations in Topeka reported flooding and road closures. Jackson and Jefferson Counties also had many road closures and road damage.

FEMA-1258-DR: Severe Storms and Flooding— October/November 1998 (October 30–November 15)

From October 30 to November 15, storms generated by Hurricane Mitch impacted south central Kansas with heavy rains and flooding. The Arkansas, Cottonwood, Whitewater, and Walnut Rivers recorded all-time record levels. Major flooding occurred through west Wichita along the Cowskin Creek. Augusta, in western Butler County, was especially hard hit. Flooding was widespread, inundating many roads. There were 5,300 people evacuated. There were two injuries, one fatality, and $37.8 million dollars in damage.

FEMA-1254-DR: Severe Storms, Flooding, and Tornadoes—October 1998 (October 1–8)

From October 1-8, extensive thunderstorms with strong wind gusts, heavy rains, hail, tornadoes, and flooding impacted one county in southwestern Kansas and several counties along the eastern edge of the State. Many low lying roads were blocked by flash flooding. The storms damaged over 500 residential structures and impacted numerous businesses. There were two fatalities.

FEMA-1000-DR: Flooding, Severe Storms—Great Flood of 1993—July 22, 1993

About 40 inches of rain fell during the first seven months of the year in northeast Kansas. Runoff resulted in further flooding throughout the lower Missouri River basin in central and east Kansas. One of the most devastating floods in U.S. history (a once in 100-500-year event), this event put millions of acres of farmland under water for weeks, damaged roads, and made rivers un-navigable. Waters overtopped or destroyed numerous levees and eroded valuable topsoil. Fifty-six Kansas counties, (more than half the counties in the State) were included in the federal disaster declaration. The flood caused a total of 47 deaths in nine states, including two in Kansas. A high percentage of crop acres in the Kansas City District floodplains suffered losses because of the overtopping of 9 of 15 units in the federally-constructed Missouri River Levee System and virtually all the nonfederal farm levees in the district. More than 1.4 million crop acres were classified as failed, which resulted in $359 million in damage. Damage to property was estimated at $15 to $20 billion across all nine states (Corps 1994).

Damage to cities and small towns in the Kansas City District was estimated at $661 million. Damage to the public sector (infrastructure) was estimated at $274 million. The total cost of repairing federal levees was estimated at $41.9 million and nonfederal levees at $300 million (Corps 1994). Damage prevented by Kansas District reservoirs was estimated at $4 billion, while damage prevented by local protection levees, including those at Kansas City and Topeka, was estimated at $4.7 billion. Levees in the Missouri River Levee System, which primarily protect agricultural land, prevented an estimated $188.3 million in damage (Corps 1994).

FEMA-644-DR: Severe Storms, Flooding, Tornadoes—July 18, 1981 (June 14)

On the afternoon of June 14, a series of intense thunderstorms produced 5 to 20 inches of precipitation in about 12 hours near Great Bend. The storm affected about 300 square miles of tributaries to the Arkansas River upstream from Great Bend and caused approximately $42 million in damage. The recurrence interval was likely greater than 100 years.

FEMA-539-DR: Severe Storms, Flooding—September 20, 1977 (September 12–13)

This event in the Kansas City area resulted in 25 fatalities and approximately $50 million in property damage. As much as 11 inches of precipitation fell in 24 hours, which resulted in peak discharges with recurrence intervals greater than 100 years on most streams in the metropolitan area.

FEMA-201-DR: Flooding—June 23, 1965 (June 17–25)

This flood affected the Arkansas, Little Arkansas, Solomon, Marais des Cygnes, and Big Blue river basins, causing approximately $16 million in damages, most of which was to cropland.

July 10–13, 1951

In July 1951, excessive rain caused serious flooding in the Kansas, Missouri, Verdigris, Arkansas, and Neosho river basins, extending over half of the State. Flooding on the Kansas River and the downstream Missouri River occurred following an average rainfall of 6.4 inches in May, 9.6 inches in June, and a stretch of four days in mid-July with as much as 18.5 inches over the Osage-Marais Des Cygnes and the Kansas River. The Kansas River was above flood stage for 10 straight days. There were 24,000 people evacuated. Fifteen lives were lost as a result of this flood. Damage was estimated at $800 million, 42 percent of which was attributed to the loss of business income outside the flooded area, emergency aid, and relief. Urban damage accounted for 39 percent and rural losses the remaining 19 percent.

May 28–June 6, 1935

An intense storm caused these floods in northwestern Kansas. There were 10 deaths on the Republican and Upper Kansas Rivers.

May–June 1903

Flooding occurred in the Republican and Kansas River basins. In Topeka, it forced 4,000 people from their homes and killed 38. All of north Topeka was under water, up to 10 feet in some places. The Kansas River expanded to 2-3 miles wide and destroyed three bridges.

Other Notable Flood Events

- **April, 30, 2012:** Very heavy rain and flooding occurred in south east Kansas. Highway 400 was closed about 10 miles east of Parsons, water covered Highway 160 about 2 miles south east of Altamont, and several streets were flooded in Parsons. Several streets were flooded in Cherryvale. In Chetopa, a dozen homes were flooded. Big Creek was out of its banks and southern portions of Independence were flooded. This event also resulted in one fatality as a result of a car being swept off a county road south of Independence.
- **August 4, 2011**: Heavy rainfall in the amount of 2.10 inches in 45 minutes caused flash flooding in Colby, Kansas (Thomas County). A police car was damaged as it had to be abandoned due to flooded streets.
- **May/June, 2011:** Heavy rain over a two-week period in north central Kansas caused widespread rural flooding. Over a nine-day period, up to 9.57 inches of rain fell. Creeks, streams, and some main stem rivers went into flood stage, including the Solomon at Glen Elder and Beloit, North Fork Solomon at Portis, and South Fork Solomon at Woodston and Osborne. In Riley County about 200 people were evacuated from a low-lying area along Wildcat Creek in Manhattan. In Pottawatomie, three families were evacuated from flood

areas along Pottawatomie Creek near Louisville. In Clay County, 15 homes were flooded in Morganville and another three were evacuated in Clay Center.

- **April 15, 2010:** Heavy rain in Rooks County caused flash flooding in Plainville. Over 2.5 inches fell in a short amount of time causing water to run over street curbs and spill into some local shops and stores.
- **April 26, 2009**: Heavy rainfall from numerous thunderstorms during the afternoon, evening, and overnight hours on the 26th produced widespread flooding across much of Harper County. Rainfall amounts across the county ranged from 3 to 6 inches. Numerous roads were closed countywide. It is estimated that around 100 homes were flooded or received some form of water damage in the Anthony area, along with several other homes and businesses across the county. Portions of the elementary school and hospital in Harper were flooded. Three water rescues took place, one of which produced an injury near Third Lake Road when a vehicle attempted to cross a flooded roadway. Crop damage estimates are unknown, and property damage values are rough estimates. The Wichita Eagle, Harper Advocate, Anthony Republican and the Hutchinson News contributed to this report.
- **September 12, 2008:** Nine to twelve inches of rainfall during the morning commute hours caused widespread street flooding of roadways up to 2 to 3 feet deep on the west side of the city of Wichita. Law enforcement officials reported 150 people were rescued from vehicles or evacuated because of the high water. There were 114 homes reported to have some type of surface flooding because of the heavy rainfall and sewers and sump pumps backed up into 141 more homes. The large amount of rainfall caused the Cowskin/Calfskin Creek to once again come out of its banks, flooding homes in the Dells and Hidden Lakes Subdivision. Thirty-five people were evacuated from the Park West Retirement home along the banks of the creek. Calls about stalled vehicles overwhelmed towing businesses across the city.
- **May 22, 2008:** Street flooding with water up to one foot deep was reported in the city of Norton via the National Spotter Network. Radar also indicated extremely heavy rainfall occurring across much of central Norton County at this time. Local newspapers later stated that Norton County roads incurred an estimated $500,000 in damage as a result of the heavy rainfall and flooding in the area.
- **May 27, 2007:** Numerous, slow-moving thunderstorms produced widespread 4 to 7 inch rainfall amounts across primarily the northwestern two-thirds of Saline County from the evening hours on May 23rd, to the early morning hours on May 24th. Excessive runoff from this heavy rain caused widespread countywide flooding for days. Numerous rural and city roads were closed because of high water. The Mulberry Creek reached record flood stage during the late afternoon hours of the 24th, resulting in road closures and evacuations across portions of Salina. Mandatory evacuations were needed in the communities of Hedville and Bavaria, because of the rapidly rising Mulberry and Spring Creeks. The rising Smoky Hill River effectively closed all roads leading in and out of New Cambria. Some water rescues were needed across the county, but there were no reported injuries. Numerous homes and businesses received extensive flood damage, as well as various roads and one bridge across the county. Additionally, the Salina Municipal Airport terminal building received fairly extensive flood damage. Roughly $3.5 million in public damages was suffered across the Saline County, with likely around $3 million in private damages.
- **May 5, 2007:** Flash flooding was reported throughout Barton County. Highway 96, nine miles west of Great Bend was closed as water started flowing over the road. An observer in

the area reported 3.22 inches of rain in just 3 hours. Highway 56 in Pawnee Rock was closed because of flood water. In Hoisington the intersection of 3rd Street and Main was closed because of high water. An observer reported approximately 3 inches of rain in 3 hours in that part of Barton County. Seventy to eighty homes were flooded on the north side of Ellinwood. According to Barton County Emergency Management, the county documented roughly 30 million dollars in damage. This includes damages to private property including crop damage, damage to farm equipment, farmsteads and public roads. The Great Bend Tribune contributed to this narrative.

- **May 2006:** Three inches of rain fell in west central Anderson County on May 21. Streams rose out of their banks and water flowed over rural roads. Debris blocked storm drains in Topeka on May 29. Portions of I-70 in west Topeka were closed because of water on the roadway. Flash flooding occurred in central Washington County on May 29 when 4.65 inches of rain fell in less than two hours. On May 30 and 31, flash flooding occurred in Lyon, Osage, Anderson, Coffey, Ottawa, and Republic Counties. Hardest hit was the city of Emporia, where widespread street flooding affected the city. There were water rescues of stranded motorists, and many homes and businesses were flooded.
- **June 8-9, 2005**: Ten to fifteen inches of rain caused widespread flash flooding in Harvey, Butler, and northern Sedgwick Counties. Receiving 12-15 inches of rain in a 10-hour period, Harvey County was inundated with flash flooding that left most roads and highways barricaded. Damage was estimated at $1.5 million. The flash flooding in Harvey County spread south across the county border into northern Sedgwick County, where 19 homes, 12 of them mobile variants, were flooded. Damage was estimated at $150,000.
- **June 3-15, 2005:** Cheyenne, Edwards, Harper, Haskell, Linn, Rush, and Stanton Counties were designated as primary disaster areas by the U.S. Department of Agriculture because of losses caused by excessive rain, flash flooding, and flooding. Twenty-nine contiguous counties were also eligible for assistance.
- **August 30, 2003:** A flash flood on Jacob Creek inundated a quarter mile section of the interstate 12 miles southwest of Emporia. Seven vehicles were swept off the turnpike. Six people were killed.
- **April 2002:** As a result of severe storms, tornadoes, and flooding, the Small Business Administration declared a disaster for businesses in Bourbon, Cherokee, Crawford, and Linn counties.
- **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.
- **February 2001:** Heavy rains in eastern Kansas closed roads in Neosho and Allen Counties and nearly isolated Easton in Leavenworth County. One person was killed in Mayetta.
- 1999: Flooding in northeast Kansas caused about $2 Million in damage.
- **September 12, 1997:** A major flash flood swept through parts of Dodge City. Around 200 homes and businesses in Dodge City were damaged from flooding waters. One thousand citizens had to be evacuated, but no injuries or deaths were reported. The flooding was the result of extremely heavy rain that fell in just a short period of time. There were numerous

reports of 5 to 6 inches of rainfall. One location reported 9.5 inches just south of the city limits.

- **October 1986:** A significant amount of flooding occurred in the southeast part of the State (Marmaton, Little Osage, Marais des Cygnes, and Arkansas River basins).
- **July 2-4, 1976:** Flooding was severe in the downstream reaches of the Verdigris River Basin as a result of an intense storm over southeastern Kansas. The storm produced 24-hour precipitation that totaled about 6-13 inches and two-day precipitation of as much as 16 inches. The most severe flooding was confined to the main stem and tributaries of the Elk River and tributaries of the Fall and Lower Verdigris Rivers. There was one death on the Verdigris River.
- **September–October 1973:** A series of severe floods occurred on streams throughout the central and east-central parts of the State between late September and early October. As much as 11 inches of rain fell over four days. Several locations reported precipitation in excess of 7 inches on September 26. The flooding was most severe in Rattlesnake and Cow Creeks in the south-central part of the State and in the Smoky Hill River, its tributaries, and tributaries of the Republican River in north-central Kansas.
- **1968:** There were three deaths on the Arkansas River.
- **June 1844:** A large storm caused flooding that affected most of the north-central and northeast parts of the State (Kansas and Marais des Cygnes River basins). The recurrence interval was likely much greater than 100 years.

Historical Crop Losses Due to Flooding

The State acquired data from the United States Department of Agriculture‘s Risk Management Agency to provide crop loss data based on crop insurance payments. Data was requested for the 10-year period from 2002 to 2011. During this period, $321,995,951 in crop insurance payments was made to Kansas farmers as a result of flood, excess moisture/precipitation/rain, and hurricane/tropical depression. This translates to $32,199,595 annually. The most damaging year during this time-frame was 2007 which coincides with Presidential Declaration 1711 for major flooding in Southeast Kansas. **Table 3.69** provides the crop insurance payments by year for this ten-year period. 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.

Table 3.69. USDA Risk Management Agency Crop Insurance Payments Due to Flood, Excess Moisture/Precipitation/Rain, and Hurricane/Tropical Depression

Year	Crop Insurance Paid
2011	$16,554,331
2010	$51,325,423
2009	$69,363,919
2008	$58,422,531
2007	$86,141,405
2006	$1,510,143
2005	$15,082,104
2004	$16,276,418
2003	$4,944,342
2002	$2,375,336
Total	**$321,995,951**

Source: USDA Risk Management Agency, 2012;

Probability of Future Hazard Events

Considering both riverine and flash flood events in Kansas, according to the National Climatic Data Center Storm Events database, there were 1,140 events in Kansas between 10/1/2006 and 7/31/2012. Total property damage for these events is estimated at $283,454,000. There were 8 deaths and 2 injuries in this time period. This suggests that when considering both riverine and flash flooding, Kansas experiences an average of 190 flood events, $47.2 million in flood losses, 1.3 flood-related deaths, and 0.3 flood-related injuries each year.

Additionally, when considering only riverine flooding, there is a 1 percent chance of occurrence in any given year for flooding to occur in identified special flood hazard areas.

Based on this information, at least one Kansas river experiences severe flooding each year and when also considering flash flooding, Kansas experiences over 100 events each year. Therefore, this hazard‘s probability is **—Highly Likely”** within the calendar year.

State Vulnerability Analysis

To determine vulnerability to flooding and the jurisdictions most threatened by flooding and most vulnerable to damage and losses, the State analyzed data from several sources including:

- NCDC Storm Events Database
- USDA Risk Management Agency Crop Loss Statistics
- HAZUS MH 2.1 100-year Food Scenario
- NFIP Flood Insurance Claims
- Repetitive Loss Properties/Severe Repetitive Loss Properties

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 10/1/2006 to 7/31/2012. Although an access database is available for download, the data only goes through 11/30/2011. Since over 6 years of data is available in the online version, and since flash flooding generally occurs annually in prone areas, the State decided to use this more current data to analyze flash flooding events across the State.

The NCDC Storm Events Database has two classifications for flood events: flash flood and flood. Therefore, for this analysis, the flash flood event type was selected. For the period from 10/1/2006 to 7/31/2012, there were 722 recorded flash flood events. **Table 3.70** provides the number of events by county, organized by Mitigation Planning Region. The amount of associated property damages is also provided. However, upon examination, it appears that damages from riverine flood amounts are included with the events designated as flash flood. Therefore, these damages may not be an accurate reflection of damages attributed only to flash flooding. Additionally, this database captures only reported damages. The counties with no damages indicated most likely have had some damages due to flash flooding. However, these damages may not have been reported.

Table 3.70. NCDC Flash Flood Events 10/1/2006 to 7/31/2012

County	# of Flash Flood Events	Property Damages
Mitigation Planning Region A		
Cheyenne	7	$98,500
Decatur	3	$0
Gove	12	$21,000
Logan	10	$10,000
Rawlins	4	$150,000
Sheridan	3	$100,000
Sherman	7	$25,500
Thomas	4	$20,000
Wallace	5	$0
Subtotal	**55**	**$425,000**
Mitigation Planning Region B		
Ellis	0	$0
Graham	5	$0
Ness	0	$0
Norton	3	$500,000
Phillips	7	$270,000
Rooks	10	$154,000
Rush	1	$0
Russell	7	$10,200
Trego	0	$0
Subtotal	**33**	**$934,200**
Mitigation Planning Region C		
Grant	0	$0
Greeley	2	$0
Hamilton	0	$0
Kearny	0	$0
Lane	0	$0
Morton	0	$0
Scott	0	$0
Stanton	0	$0
Stevens	0	$0
Wichita	1	$0
Subtotal	**3**	**$0**
Mitigation Planning Region D		
Clark	0	$0
Finney	0	$0
Ford	1	$100,000
Gray	0	$0
Haskell	0	$0
Hodgeman	0	$0
Meade	0	$0

County	# of Flash Flood Events	Property Damages
Seward	0	$0
Subtotal	**1**	**$100,000**
Mitigation Planning Region E		
Barber	0	$0
Barton	7	$30,007,300
Comanche	0	$0
Edwards	0	$0
Kiowa	0	$0
Pawnee	1	$1,000
Pratt	0	$0
Stafford	1	$0
Subtotal	**9**	**$30,008,300**
Mitigation Planning Region f		
Clay	11	$1,720,000
Cloud	7	$50,000
Dickinson	12	$671,000
Ellsworth	3	$4,850,000
Jewell	4	$105,000
Lincoln	5	$178,000
Mitchell	7	$175,000
Osborne	6	$150,000
Ottawa	8	$100,000
Republic	10	$172,000
Saline	4	$0
Smith	6	$245,000
Subtotal	**83**	**$8,416,000**
Mitigation Planning Region G		
Butler	12	$1,195,600
Cowley	9	$616,000
Harper	5	$6,360,000
Harvey	2	$5,100
Kingman	0	$0
Marion	8	$152,300
McPherson	2	$66,000
Reno	3	$2,550,000
Rice	1	$2,000
Sedgwick	15	$4,470,000
Sumner	10	$51,200
Subtotal	**67**	**$15,468,200**
Mitigation Planning Region H		
Allen	7	$6,080,200
Bourbon	29	$125,000
Chautauqua	5	$148,100

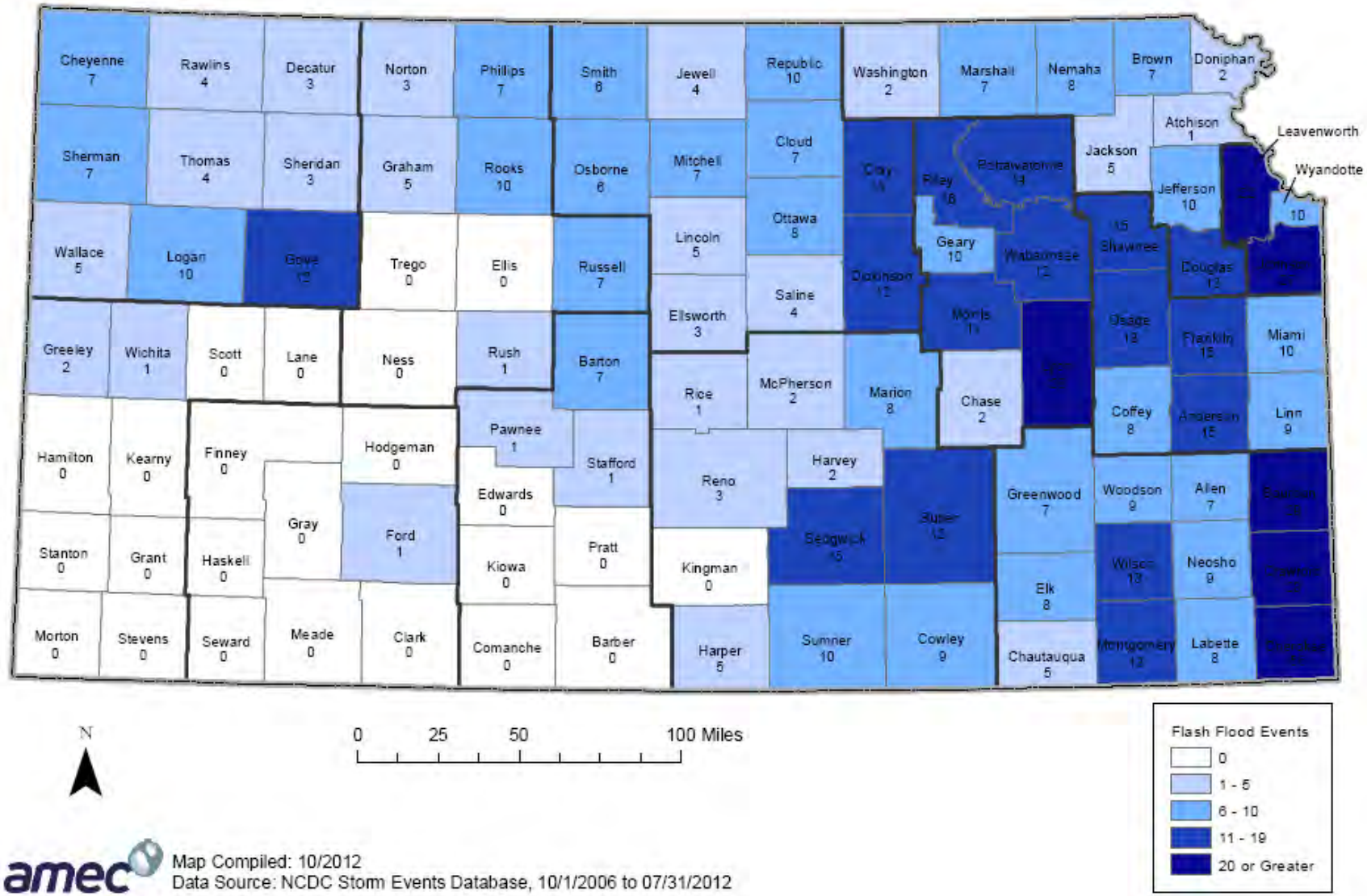
County	# of Flash Flood Events	Property Damages
Cherokee	56	$2,155,000
Crawford	23	$135,000
Elk	8	$27,000,200
Greenwood	7	$35,200
Labette	8	$900,000
Montgomery	13	$81,655,200
Neosho	9	$12,082,200
Wilson	13	$21,825,300
Woodson	9	$71,500
Subtotal	**187**	**$152,212,900**
Mitigation Planning Region I		
Chase	2	$35,000
Geary	10	$350,000
Lyon	20	$260,000
Morris	11	$202,000
Pottawatomie	14	$490,000
Riley	16	$460,000
Wabaunsee	12	$161,000
Subtotal	**85**	**$1,958,000**
Mitigation Planning Region J		
Anderson	15	$515,000
Coffey	8	$310,000
Franklin	15	$294,000
Linn	9	$0
Miami	10	$0
Osage	13	$1,426,000
Shawnee	15	$3,906,000
Subtotal	**85**	**$6,451,000**
Mitigation Planning Region K		
Atchison	1	$0
Brown	7	$2,001,000
Doniphan	2	$0
Douglas	13	$185,000
Jackson	5	$350,000
Jefferson	10	$70,000
Marshall	7	$150,000
Nemaha	8	$450,000
Washington	2	$20,000
Subtotal	**55**	**$3,226,000**
Mitigation Planning Region L		
Johnson	27	$0
Leavenworth	22	$2,500
Wyandotte	10	$35,000

County	# of Flash Flood Events	Property Damages
Subtotal	**59**	**$37,500**
Statewide		
Statewide Totals	**722**	**$219,237,100**

Source: NCDC Storm Events Database, http://www.ncdc.noaa.gov/stormevents/

The map in **Figure 3.70** displays the number of flash flood events by county for the period from 10/01/2006 to 7/31/2012.

Figure 3.70. Flash Flood Events by County 10/01/2006 to 7/31/2012



USDA Risk Management Agency Crop Insurance Payments

Table 3.71 provides total crop insurance payments and annualized crop insurance payments for flood damage for each county by Mitigation Planning Region over the 10-year period from 2002 to 2011. The USDA does not differentiate damages from riverine flooding and flash flooding. So, 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 A				
Cheyenne	$52,458,000	$261,897	$26,190	0.05%
Decatur	$49,747,000	$577,683	$57,768	0.12%
Gove	$59,084,000	$509,753	$50,975	0.09%
Logan	$47,558,000	$836,799	$83,680	0.18%
Rawlins	$59,406,000	$566,774	$56,677	0.10%
Sheridan	$95,542,000	$576,345	$57,635	0.06%
Sherman	$108,370,000	$650,920	$65,092	0.06%
Thomas	$129,521,000	$1,029,764	$102,976	0.08%
Wallace	$47,203,000	$212,376	$21,238	0.04%
Subtotal	**$648,889,000**	**$5,222,311**	**$522,231**	
Mitigation Planning Region B				
Ellis	$27,729,000	$490,084	$49,008	0.18%
Graham	$42,105,000	$1,474,007	$147,401	0.35%
Ness	$37,636,000	$313,680	$31,368	0.08%
Norton	$42,614,000	$1,145,224	$114,522	0.27%
Phillips	$41,104,000	$822,072	$82,207	0.20%
Rooks	$46,688,000	$1,107,301	$110,730	0.24%
Rush	$33,863,000	$702,521	$70,252	0.21%
Russell	$23,659,000	$578,035	$57,804	0.24%
Trego	$30,057,000	$548,567	$54,857	0.18%
Subtotal	**$325,455,000**	**$7,181,491**	**$718,149**	
Mitigation Planning Region C				
Grant	$63,853,000	$508,829	$50,883	0.08%
Greeley	$64,552,000	$984,698	$98,470	0.15%
Hamilton	$51,817,000	$1,198,225	$119,823	0.23%
Kearny	$66,321,000	$885,985	$88,599	0.13%

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
Lane	$31,082,000	$465,140	$46,514	0.15%
Morton	$42,645,000	$1,559,057	$155,906	0.37%
Scott	$71,718,000	$630,929	$63,093	0.09%
Stanton	$76,592,000	$1,143,786	$114,379	0.15%
Stevens	$124,066,000	$826,292	$82,629	0.07%
Wichita	Not Reported	$289,488	$28,949	Not Reported
Subtotal	**$592,646,000**	**$8,492,429**	**$849,243**	
Mitigation Planning Region D				
Clark	$15,466,000	$107,302	$10,730	0.07%
Finney	$140,746,000	$763,450	$76,345	0.05%
Ford	$87,004,000	$669,946	$66,995	0.08%
Gray	$109,340,000	$393,483	$39,348	0.04%
Haskell	$116,154,000	$902,021	$90,202	0.08%
Hodgeman	$41,068,000	$454,903	$45,490	0.11%
Meade	$91,206,000	$403,413	$40,341	0.04%
Seward	$81,688,000	$985,162	$98,516	0.12%
Subtotal	**$682,672,000**	**$4,679,680**	**$467,968**	
Mitigation Planning Region E				
Barber	$15,969,000	$2,545,113	$254,511	1.59%
Barton	$65,249,000	$2,687,129	$268,713	0.41%
Comanche	$13,395,000	$198,699	$19,870	0.15%
Edwards	$73,732,000	$1,204,340	$120,434	0.16%
Kiowa	$34,681,000	$628,129	$62,813	0.18%
Pawnee	$67,357,000	$1,250,807	$125,081	0.19%
Pratt	$62,967,000	$4,927,894	$492,789	0.78%
Stafford	$74,613,000	$4,239,320	$423,932	0.57%
Subtotal	**$407,963,000**	**$17,681,431**	**$1,768,143**	
Mitigation Planning Region F				
Clay	$47,769,000	$2,307,840	$230,784	0.48%
Cloud	$55,096,000	$1,294,676	$129,468	0.23%
Dickinson	$50,121,000	$1,348,641	$134,864	0.27%
Ellsworth	$19,376,000	$1,219,370	$121,937	0.63%
Jewell	$61,168,000	$1,220,035	$122,004	0.20%
Lincoln	$32,667,000	$1,402,649	$140,265	0.43%
Mitchell	$61,762,000	$920,561	$92,056	0.15%
Osborne	$37,801,000	$1,248,439	$124,844	0.33%
Ottawa	$35,560,000	$1,361,199	$136,120	0.38%
Republic	$79,639,000	$1,222,291	$122,229	0.15%
Saline	$26,903,000	$4,050,208	$405,021	1.51%
Smith	$54,022,000	$1,568,748	$156,875	0.29%
Subtotal	**$561,884,000**	**$19,164,657**	**$1,916,466**	

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 G				
Butler	$41,249,000	$6,094,994	$609,499	1.48%
Cowley	$23,126,000	$9,028,552	$902,855	3.90%
Harper	$17,809,000	$12,795,529	$1,279,553	7.18%
Harvey	$49,189,000	$3,012,491	$301,249	0.61%
Kingman	$25,749,000	$5,665,421	$566,542	2.20%
Marion	$43,687,000	$2,278,029	$227,803	0.52%
McPherson	$57,227,000	$3,224,326	$322,433	0.56%
Reno	$69,497,000	$9,111,736	$911,174	1.31%
Rice	$53,225,000	$5,836,852	$583,685	1.10%
Sedgwick	$56,918,000	$10,977,987	$1,097,799	1.93%
Sumner	$50,711,000	$31,399,138	$3,139,914	6.19%
Subtotal	**$488,387,000**	**$99,425,055**	**$9,942,506**	
Mitigation Planning Region H				
Allen	$15,462,000	$7,982,055	$798,206	5.16%
Bourbon	$9,918,000	$2,806,791	$280,679	2.83%
Chautauqua	$4,971,000	$863,520	$86,352	1.74%
Cherokee	$53,420,000	$13,778,492	$1,377,849	2.58%
Crawford	$34,463,000	$7,962,886	$796,289	2.31%
Elk	Not Reported	$1,069,536	$106,954	Not Reported
Greenwood	$8,087,000	$2,631,378	$263,138	3.25%
Labette	$22,765,000	$13,326,554	$1,332,655	5.85%
Montgomery	$16,616,000	$10,566,250	$1,056,625	6.36%
Neosho	$17,811,000	$10,762,454	$1,076,245	6.04%
Wilson	$26,882,000	$12,179,233	$1,217,923	4.53%
Woodson	$14,486,000	$3,391,458	$339,146	2.34%
Subtotal	**$224,881,000**	**$87,320,607**	**$8,732,061**	
Mitigation Planning Region I				
Chase	$6,222,000	$841,737	$84,174	1.35%
Geary	$11,039,000	$145,781	$14,578	0.13%
Lyon	$24,554,000	$5,535,120	$553,512	2.25%
Morris	$21,783,000	$676,849	$67,685	0.31%
Pottawatomie	$30,455,000	$1,503,286	$150,329	0.49%
Riley	$23,622,000	$633,763	$63,376	0.27%
Wabaunsee	$17,358,000	$816,922	$81,692	0.47%
Subtotal	**$135,033,000**	**$10,153,458**	**$1,015,346**	
Mitigation Planning Region J				
Anderson	$33,029,000	$5,622,495	$562,250	1.70%
Coffey	$25,497,000	$4,744,041	$474,404	1.86%
Franklin	$32,349,000	$5,325,613	$532,561	1.65%

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
Linn	$13,053,000	$5,119,649	$511,965	3.92%
Miami	$27,726,000	$4,307,798	$430,780	1.55%
Osage	$27,618,000	$3,879,506	$387,951	1.40%
Shawnee	$32,959,000	$1,362,345	$136,235	0.41%
Subtotal	**$192,231,000**	**$30,361,447**	**$3,036,145**	
Mitigation Planning Region K				
Atchison	$42,536,000	$3,632,145	$363,215	0.85%
Brown	$86,532,000	$1,250,556	$125,056	0.14%
Doniphan	$67,800,000	$9,946,527	$994,653	1.47%
Douglas	$27,973,000	$1,839,185	$183,919	0.66%
Jackson	$21,169,000	$1,429,503	$142,950	0.68%
Jefferson	$33,429,000	$1,392,973	$139,297	0.42%
Marshall	$81,815,000	$3,383,451	$338,345	0.41%
Nemaha	$67,091,000	$1,999,716	$199,972	0.30%
Washington	$65,762,000	$1,482,872	$148,287	0.23%
Subtotal	**$494,107,000**	**$26,356,928**	**$2,635,693**	
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
Subtotal	**$50,455,000**	**$4,361,469**	**$436,147**	
Other				
Undisclosed Counties		$1,594,989	$159,499	
Statewide Total	**$4,804,603,000**	**$321,995,952**	**$32,199,595**	

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 1-Percent Annual Chance Food Scenario

According to the HAZUS MH2 2.1 one percent annual chance flood scenario results, there are 49,759 buildings in the one percent annual chance floodplain. Additionally, the statewide population vulnerable to displacement from the one percent annual chance flood scenario is 203,707. **Table 3.72** provides the HAZUS results for the number of vulnerable buildings and population vulnerable to displacement for each county in Kansas, organized by mitigation planning region. According to this analysis, the counties with the most vulnerable buildings and population vulnerable to displacement are Sedgwick, Reno, and Saline Counties.

Please note: HAZUS determines the displaced population based on the inundation area, not necessarily impacted buildings. As a result, there may be population vulnerable to displacement even if the structure is not vulnerable to damage. 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.

Table 3.72. Vulnerable Buildings and Population, HAZUS one percent annual chance flood Scenario

County	Vulnerable Buildings	Population Vulnerable to Displacement*
Mitigation Planning Region A		
Cheyenne	0	47
Decatur	5	85
Gove	0	54
Logan	0	37
Rawlins	16	103
Sheridan	0	49
Sherman	0	41
Thomas	15	142
Wallace	1	37
Subtotal	**37**	**595**
Mitigation Planning Region B		
Ellis	693	3,805
Graham	14	96
Ness	3	62
Norton	9	426
Phillips	0	83
Rooks	2	79
Rush	49	292
Russell	9	100
Trego	0	38
Subtotal	**779**	**4,981**
Mitigation Planning Region C		
Grant	11	172
Greeley	6	56
Hamilton	58	276
Kearny	0	76
Lane	0	27
Morton	0	62
Scott	39	199
Stanton	0	36
Stevens	324	1,261
Wichita	5	46
Subtotal	**443**	**2,211**
Mitigation Planning Region D		
Clark	4	56

County	Vulnerable Buildings	Population Vulnerable to Displacement*
Finney	1,592	7,924
Ford	424	2,008
Gray	7	127
Haskell	17	201
Hodgeman	23	150
Meade	3	90
Seward	279	1,394
Subtotal	**2,349**	**11,950**
Mitigation Planning Region E		
Barber	43	233
Barton	2,440	7,682
Comanche	0	43
Edwards	120	453
Kiowa	0	26
Pawnee	58	430
Pratt	0	157
Stafford	148	564
Subtotal	**2,809**	**9,588**
Mitigation Planning Region F		
Clay	25	328
Cloud	77	385
Dickinson	493	2,022
Ellsworth	14	109
Jewell	45	217
Lincoln	45	207
Mitchell	32	219
Osborne	15	166
Ottawa	47	383
Republic	29	156
Saline	4,470	15,737
Smith	0	50
Subtotal	**5,292**	**19,979**
Mitigation Planning Region G		
Butler	272	2,544
Cowley	375	1,712
Harper	5	125
Harvey	310	2,124
Kingman	49	297
Marion	99	761
McPherson	218	1,412
Reno	4,736	15,516
Rice	162	672
Sedgwick	23,266	81,987
Sumner	103	884

County	Vulnerable Buildings	Population Vulnerable to Displacement*
Subtotal	**29,595**	**108,034**
Mitigation Planning Region H		
Allen	45	546
Bourbon	3	362
Chautauqua	9	192
Cherokee	67	901
Crawford	70	750
Elk	1	101
Greenwood	28	291
Labette	200	1,096
Montgomery	86	895
Neosho	21	285
Wilson	8	292
Woodson	1	117
Subtotal	**539**	**5,828**
Mitigation Planning Region I		
Chase	27	219
Geary	98	469
Lyon	28	725
Morris	163	614
Pottawatomie	29	462
Riley	128	740
Wabaunsee	3	149
Subtotal	**476**	**3,378**
Mitigation Planning Region J		
Anderson	7	276
Coffey	23	315
Franklin	101	1,090
Linn	3	342
Miami	103	886
Osage	0	479
Shawnee	3,237	13,283
Subtotal	**3,474**	**16,671**
Mitigation Planning Region K		
Atchison	52	357
Brown	4	157
Doniphan	222	1,425
Douglas	67	897
Jackson	7	425
Jefferson	28	540
Marshall	55	411
Nemaha	0	211
Washington	8	187

County	Vulnerable Buildings	Population Vulnerable to Displacement*
Subtotal	443	4,610
Mitigation Planning Region L		
Johnson	1,896	8,853
Leavenworth	97	1,541
Wyandotte	1,530	5,578
Subtotal	**3,523**	**15,972**
Statewide Totals	**49,759**	**203,797**

Source: HAZUS MH 2.1
*Note: HAZUS takes into accout Population that may be vulnerable to displacement as a result of precautionary evacuation or flooded access even if no buildings are reported as vulnerable.

NFIP Flood Insurance Claims Analysis

The State analyzed National Flood Insurance Program (NFIP) flood-loss data to determine areas of Kansas with the greatest flood risk. Kansas NFIP participation and flood loss statistics were obtained from FEMA's Policy and Claim Statistics for Flood Insurance (which provides losses from 1978 to the present). As of October 2012, 446 communities were National Flood Insurance Program (NFIP) participants, including 69 that do not have special flood hazard areas and 121 that are only minimally flood-prone. Additionally, there were 286 Kansas communities that did not participate in the NFIP; of those, 79 are mapped Kansas communities that have designated flood hazard areas. This includes six suspended communities and two that have withdrawn. There are likely other communities in Kansas that have flood hazard areas, but have not yet been mapped by FEMA to show where those hazard areas are.

Kansas flood-loss information was culled from FEMA's —Policy and Loss Data by Community with County and State Data," which documents losses from 1978 through August 31, 2012. 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.

Despite these limitations, the data depicts a pattern of historical flood losses in the State. The greatest losses have been in Sedgwick, Wyandotte, Butler, and Johnson Counties. **Table 3.73** shows the details of NFIP policy and loss statistics for each county in Kansas, organized by Mitigation Planning Region. Loss statistics include losses from 1978 through August 31, 2012.

Table 3.73. Kansas NFIP Policy and Loss Statistics (As of August 31, 2012)

County	# of Policies in Force	Insurance in Force	# of Closed Losses	Total Payments
Mitigation Planning Region A				
Cheyenne	0	$0	0	$0
Decatur	0	$0	0	$0
Gove	0	$0	0	$0
Logan	0	$0	0	$0
Rawlins	6	$633,500	0	$0
Sheridan	2	$500,000	0	$0
Sherman	6	$576,800	0	$0
Thomas	31	$3,628,100	0	$0
Wallace	1	$37,300	0	$0
Subtotal	**46**	**$5,375,700**	**0**	**$0**
Mitigation Planning Region B				
Ellis	603	$52,835,500	51	$294,034
Graham	0	$0	0	$0
Ness	28	$2,012,200	0	$0
Norton	5	$455,600	0	$0
Phillips	2	$385,000	1	$13,633
Rooks	4	$189,600	0	$0
Rush	14	$549,900	1	$8,434
Russell	4	$264,000	0	$0
Trego	0	$0	0	$0
Subtotal	**660**	**$56,691,800**	**53**	**$316,101**
Mitigation Planning Region C				
Grant	0	$0	0	$0
Greeley	0	$0	0	$0
Hamilton	20	$3,813,100	1	$700
Kearny	25	$2,310,200	0	$0
Lane	2	$200,000	0	$0
Morton	0	$0	0	$0
Scott	0	$0	1	$31,887
Stanton	0	$0	1	$1,219
Stevens	0	$0	0	$0
Wichita	0	$0	0	$0
Subtotal	**47**	**$6,323,300**	**3**	**$33,806**
Mitigation Planning Region D				
Clark	0	$0	0	$0
Finney	78	$13,506,700	5	$8,762
Ford	135	$14,342,500	25	$103,185
Gray	10	$652,300	0	$0
Haskell	0	$0	0	$0
Hodgeman	1	$15,000	1	$2,493

County	# of Policies in Force	Insurance in Force	# of Closed Losses	Total Payments
Meade	0	$0	0	$0
Seward	68	$9,260,000	18	$32,654
Subtotal	**292**	**$37,776,500**	**49**	**$147,094**
Mitigation Planning Region E				
Barber	11	$2,187,300	1	$1,219
Barton	259	$21,300,300	445	$2,439,151
Comanche	1	$130,000	0	$0
Edwards	142	$9,512,100	1	$1,108
Kiowa	4	$289,000	0	$0
Pawnee	51	$3,526,500	2	$4,144
Pratt	31	$3,214,700	5	$2,009
Stafford	0	$0	0	$0
Subtotal	**499**	**$40,159,900**	**454**	**$2,447,631**
Mitigation Planning Region F				
Clay	18	$747,500	2	$1,712
Cloud	32	$1,764,000	1	$1,105
Dickinson	226	$20,593,200	48	$176,722
Ellsworth	37	$1,668,400	6	$54,534
Jewell	2	$182,000	1	$11,856
Lincoln	1	$45,000	1	$1,276
Mitchell	44	$2,928,200	9	$63,097
Osborne	9	$358,200	6	$167,600
Ottawa	159	$11,050,300	23	$138,307
Republic	23	$2,586,100	3	$86,633
Saline	397	$65,995,000	149	$4,469,446
Smith	1	$350,000	0	$0
Subtotal	**949**	**$108,267,900**	**249**	**$5,172,288**
Mitigation Planning Region G				
Butler	422	$76,507,800	367	$9,656,748
Cowley	126	$17,245,200	96	$1,543,241
Harper	17	$363,800	0	$0
Harvey	315	$44,443,100	235	$2,445,494
Kingman	73	$6,546,600	1	$5,956
Marion	48	$4,166,400	7	$44,969
McPherson	181	$26,437,800	15	$51,916
Reno	336	$41,289,100	40	$461,239
Rice	124	$9,777,000	8	$233,594
Sedgwick	2,208	$378,197,300	548	$10,592,860
Sumner	223	$26,073,200	139	$2,188,834
Subtotal	**4073**	**$631,047,300**	**1456**	**$27,224,851**
Mitigation Planning Region H				
Allen	131	$15,930,500	74	$2,716,750

County	# of Policies in Force	Insurance in Force	# of Closed Losses	Total Payments
Bourbon	39	$6,833,400	51	$2,421,935
Chautauqua	3	$231,000	0	$0
Cherokee	120	$15,882,900	58	$699,011
Crawford	165	$23,633,800	94	$1,508,156
Elk	8	$282,500	1	$25,000
Greenwood	12	$880,400	3	$5,931
Labette	165	$18,639,300	70	$1,013,769
Montgomery	248	$38,089,300	228	$5,175,681
Neosho	136	$14,506,900	54	$1,169,996
Wilson	86	$11,392,000	50	$780,146
Woodson	1	$63,500	0	$0
Subtotal	**1114**	**$146,365,500**	**683**	**$15,516,375**
Mitigation Planning Region I				
Chase	37	$2,058,800	22	$254,843
Geary	107	$22,862,800	23	$254,485
Lyon	88	$12,259,300	46	$876,190
Morris	7	$598,300	0	$0
Pottawatomie	479	$106,802,200	222	$3,836,564
Riley	159	$25,165,600	73	$1,024,466
Wabaunsee	55	$8,370,700	2	$8,060
Subtotal	**932**	**$178,117,700**	**388**	**$6,254,608**
Mitigation Planning Region J				
Anderson	11	$860,200	3	$220,554
Coffey	33	$3,656,700	1	$2,625
Franklin	66	$13,545,000	11	$186,677
Linn	25	$4,600,200	0	$0
Miami	100	$16,120,800	14	$613,221
Osage	53	$4,450,300	9	$134,577
Shawnee	1611	$282,709,800	202	$3,000,649
Subtotal	**1899**	**$325,943,000**	**240**	**$4,158,303**
Mitigation Planning Region K				
Atchison	11	$2,907,500	1	$15,391
Brown	21	$1,010,200	0	$0
Doniphan	280	$48,430,300	63	$687,258
Douglas	617	$120,122,200	82	$739,540
Jackson	21	$3,769,300	3	$119,609
Jefferson	97	$14,528,300	43	$600,152
Marshall	10	$1,312,000	15	$91,028
Nemaha	5	$751,700	1	$5,264
Washington	4	$211,700	0	$0
Subtotal	**1,066**	**$193,043,200**	**208**	**$2,258,242**

County	# of Policies in Force	Insurance in Force	# of Closed Losses	Total Payments
Mitigation Planning Region L				
Johnson	1,005	$250,485,700	773	$8,651,619
Leavenworth	264	$53,334,200	174	$2,647,895
Wyandotte	302	$83,151,500	331	$9,955,138
Subtotal	**1,571**	**$386,971,400**	**1278**	**$21,254,652**
Statewide Totals	**13,148**	**$2,116,083,200**	**5061**	**$84,783,951**

Source: FEMA, –Policy and Loss Data by Community with County and State Data

Repetitive Loss Analysis

A high priority in Kansas and nationwide is the reduction of losses to repetitive loss structures. These structures strain the National Flood Insurance Fund. They increase the NFIP's annual losses and the need for borrowing and, 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 3.74 illustrates the number and location (by county) of Kansas' repetitive loss properties. The table ranks counties by claim amounts paid. Johnson County has the most repetitive loss properties with 97, Sedgwick County, ranks second with 62 repetitive loss properties. Wyandotte County, however, has had the highest amount of repetitive flood claims paid (nearly $7 million).

Table 3.74. Table 3.36. Kansas Repetitive Loss Properties (In Order by Number of Properties)

Mitigation Planning Region	County	# Rep Loss Properties	# Mitigated	# Insured	# of Losses	Total Paid
L	Johnson	97	30	15	285	$5,129,437
G	Sedgwick	62	9	27	152	$5,439,712
L	Wyandotte	46	6	14	179	$6,697,205
G	Butler	36	22	7	112	$2,398,519
H	Montgomery	28	4	9	82	$1,799,438
L	Leavenworth	25	15	9	62	$1,119,193
F	Saline	17	1	7	43	$2,124,210
G	Sumner	14	4	5	40	$726,583
G	Cowley	12	4	3	25	$631,606
H	Crawford	12	2	2	34	$630,320
G	Harvey	12	7	4	28	$383,450
I	Pottawatomie	12	1	8	26	$1,050,325

Mitigation Planning Region	County	# Rep Loss Properties	# Mitigated	# Insured	# of Losses	Total Paid
H	Bourbon	9	2	0	25	$815,594
H	Labette	7	3	1	18	$151,083
I	Lyon	7	0	2	18	$514,872
B	Ellis	6	0	5	14	$68,009
I	Riley	6	1	3	19	$366,621
H	Cherokee	5	2	0	17	$189,902
K	Doniphan	4	1	0	8	$168,272
K	Douglas	4	1	1	15	$132,730
E	Barton	3	1	1	6	$47,898
J	Shawnee	3	0	2	8	$104,108
D	Ford	2	0	0	4	$24,190
K	Jefferson	2	0	2	4	$112,240
K	Marshall	2	2	0	4	$40,204
G	McPherson	2	0	1	4	$29,241
J	Osage	2	1	1	4	$80,288
H	Wilson	2	1	1	6	$74,753
H	Allen	1	1	0	2	$4,116
I	Chase	1	1	0	2	$23,510
F	Dickinson	1	0	1	2	$11,227
F	Ellsworth	1	1	0	2	$24,128
J	Franklin	1	0	1	2	$27,876
I	Geary	1	1	0	2	$20,146
J	Miami	1	0	1	2	$91,078
F	Mitchell	1	0	0	3	$49,833
H	Neosho	1	0	1	2	$11,725
G	Reno	1	0	0	3	$21,914
G	Rice	1	0	1	2	$36,366
D	Seward	1	0	0	2	$6,077
	Total	**451**	**124**	**135**	**1,268**	**$31,377,999**

Source: Flood Insurance Administration (Current as of October 2, 2012)

Mitigation of Repetitive Loss Properties

The State of Kansas has made mitigation of repetitive loss properties a priority use of mitigation funds. Of the 451 properties that meet the definition of repetitive loss, 124 have been mitigated, leaving just 327 unmitigated repetitive loss properties. A summary is provided below of the mitigation methods utilized for the 124 mitigated properties.

- 8 structures were elevated
- 9 structures were protected by flood control/stormwater management projects
- 3 structures were removed and replaced by elevated buildings

- 84 structures were completely removed. This includes buildings simply demolished not part of a mitigation program, those buildings acquired and demolished as part of a mitigation program, and, buildings relocated out of the floodplain.
- 20 buildings were mitigated by undesignated mitigation methods

This demonstrates that of the 121 mitigated properties, 84 have had the structure completely removed and are therefore not vulnerable to future flooding, at any level.

Severe Repetitive Loss Analysis

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 nine validated insured residential properties in Kansas that meet the qualifications of SRL and the requirements to be considered for possible mitigation activities under FEMA's SRL criteria. These nine properties are in Mitigation Planning Regions F, G, H, and L. These properties are considered a priority for use of mitigation funds by the KHMT. **Table 3.75** provides additional information on these nine properties.

Table 3.75. Verified Residential Insured Severe Repetitive Loss Properties

Name	Community Name	Total Paid	Losses	SRL Status
Mitigation Planning Region F				
Saline	Salina, City Of	$94,319	7	V
Mitigation Planning Region G				
Butler	Butler County	$96,243	4	V
Sedgwick	Wichita, City Of	$197,185	3	V
Mitigation Planning Region H				
Montgomery	Coffeyville, City Of	$96,890	4	V
Montgomery	Coffeyville, City Of	$58,585	5	V
Montgomery	Coffeyville, City Of	$82,606	3	V
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

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.

As of October 2012, Including the 9 verified, residential, insured properties on the official SRL list, there are 30 validated properties that have 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. An additional 11 properties are pending validation. With 228 combined losses, total payments to these 41 properties equaled $8,876,526. Additional details are provided in **Table 3.76**. Note, properties marked with an "*" next to the SRL status are the nine properties on the official SRL list.

Table 3.76. Kansas Severe Repetitive Loss Properties

County	Community Name	Total Paid	Losses	SRL Status
Mitigation Planning Region F				
Saline	Salina, City Of	$94,319	7	V*
Saline	Saline County	$64,858	4	VNU
Subtotal		**$159,177**	**11**	
Mitigation Planning Region G				
Butler	Butler County	$96,243	4	V*
Butler	Butler County	$127,705	3	VU
Butler	Butler County	$152,495	4	MVU
Butler	Butler County	$179,021	5	MVU
Butler	Butler County	$403,467	7	MVU
Butler	Butler County	$110,003	4	MVU
Sedgwick	Wichita, City Of	$197,185	3	V*
Sedgwick	Wichita, City Of	$170,755	8	PN
Sumner	Sumner County	$151,189	6	PU
Subtotal		**$1,588,061**	**44**	
Mitigation Planning Region H				
Bourbon	Fort Scott, City Of	$114,731	4	VNU
Bourbon	Fort Scott, City Of	$139,903	2	PN
Bourbon	Fort Scott, City Of	$54,242	4	VNU
Cherokee	Cherokee County	$69,117	5	VU
Crawford	Pittsburg, City Of	$76,738	5	VNU
Crawford	Pittsburg, City Of	$194,025	3	PU
Montgomery	Coffeyville, City Of	$96,890	4	V*
Montgomery	Coffeyville, City Of	$58,585	5	V*
Montgomery	Coffeyville, City Of	$82,606	3	V*
Montgomery	Coffeyville, City Of	$139,566	6	VU
Subtotal		**$1,026,404**	**41**	
Mitigation Planning Region I				
Lyon	Emporia, City Of	$346,926	5	VN
Riley	Riley County	$197,998	6	PNU
Subtotal		**$544,924**	**11**	
Mitigation Planning Region L				
Johnson	Fairway, City Of	$74,824	5	V*
Johnson	Johnson County	$125,677	5	VU

County	Community Name	Total Paid	Losses	SRL Status
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
Subtotal		**$5,557,959**	**121**	
Statewide Totals		**$8,876,526**	**228**	

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 41 properties with an SRL status, 5 have been mitigated (MV and MVU). Of these, one structure was elevated and 4 structures were removed; bringing the number of existing structures with an SRL status down to 36.

State Estimates of Potential Losses

The results of the HAZUS analysis were utilized to estimate potential losses for riverine flooding. The intent of this analysis was to enable the State 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. 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.

Table 3.77 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 Kansas county, organized by Mitigation Planning Region. **Table 3.78** that follows provides total direct building loss and income loss for each Kansas County, organized by Mitigation Planning Region.

Please note: HAZUS determines the displaced population based on the inundation area, not necessarily impacted buildings. As a result, there may be population vulnerable to displacement even if the structure is not vulnerable to damage. 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.

Flood sheltering needs are based on the displaced population, not the damage level of the structure. The HAZUS Flood Model determines the number of individuals likely to use government-provided short-term shelters through determining the number of displaced households as a result of the flooding. To determine how many of those households and the corresponding number of individuals will seek shelter in government-provided shelters, the number is modified by factors accounting for income and age. 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. Since the income and age factors are taken into account, the proportion of displaced population and those seeking shelter will vary from county to county.

The damaged building counts generated by HAZUS-MH are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. HAZUS-MH reports include this disclaimer: "Unlike the earthquake and hurricane models, the flood model performs its analysis at the census block level. This means that the analysis starts with a

small number of buildings within each census block and applies a series of distributions necessary for analyzing the potential damage. The application of these distributions and the small number of buildings make the flood model more sensitive to rounding errors that introduces uncertainty into the building count results." Additionally, losses are not calculated for individual buildings, but instead are based on the performances of entire classes of buildings obtained from the general building stock data. In the Flood model, the number of grid cells (pixels) at each flood depth value is divided by the total number of grid cells in the census block. The result is used to weight the flood depths applied to each specific occupancy type in the General Building Stock. First floor heights are then applied to determine the damage depths to analyze damages and losses.

Table 3.77. 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 A					
Cheyenne	47	0	0	0	0
Decatur	85	2	5	3	2
Gove	54	1	0	0	0
Logan	37	0	0	0	0
Rawlins	103	27	16	6	0
Sheridan	49	0	0	0	0
Sherman	41	0	0	0	0
Thomas	142	28	15	4	0
Wallace	37	0	1	0	0
Subtotal	**595**	**58**	**37**		**2**
Mitigation Planning Region B					
Ellis	3,805	3,068	693	170	16
Graham	96	7	14	1	0
Ness	62	2	3	0	0
Norton	426	284	9	3	1
Phillips	83	0	0	0	0
Rooks	79	1	2	1	0
Rush	292	157	49	4	0
Russell	100	16	9	0	0
Trego	38	0	0	0	0
Subtotal	**4,981**	**3,535**	**779**		**17**
Mitigation Planning Region C					
Grant	172	9	11	0	0
Greeley	56	1	6	0	0
Hamilton	276	99	58	0	0
Kearny	76	1	0	0	0
Lane	27	0	0	0	0

County	Population Vulnerable to Displacement (# of persons)	Short Term Shelter Needs * (# of persons)	Vulnerable Buildings	Damaged Buildings	Substantially Damaged Buildings
Morton	62	0	0	0	0
Scott	199	24	39	0	0
Stanton	36	0	0	0	0
Stevens	1,261	622	324	3	0
Wichita	46	2	5	0	0
Subtotal	2,211	758	443		0
Mitigation Planning Region D					
Clark	56	1	4	1	0
Finney	7,924	6,537	1,592	125	43
Ford	2,008	1,582	424	39	17
Gray	127	7	7	0	0
Haskell	201	12	17	0	0
Hodgeman	150	23	23	1	0
Meade	90	4	3	0	0
Seward	1,394	832	279	6	1
Subtotal	**11,950**	**8,998**	**2,349**		**61**
Mitigation Planning Region E					
Barber	233	48	43	3	0
Barton	7,682	5,815	2,440	521	58
Comanche	43	0	0	0	0
Edwards	453	134	120	12	0
Kiowa	26	0	0	0	0
Pawnee	430	122	58	0	0
Pratt	157	41	0	0	0
Stafford	564	90	148	3	0
Subtotal	**9,588**	**6,250**	**2,809**		**58**
Mitigation Planning Region F					
Clay	328	36	25	2	0
Cloud	385	122	77	16	6
Dickinson	2,022	1,169	493	90	3
Ellsworth	109	19	14	2	0
Jewell	217	33	45	26	10
Lincoln	207	9	45	6	0
Mitchell	219	40	32	15	11
Osborne	166	9	15	5	1
Ottawa	383	76	47	1	0
Republic	156	7	29	0	0
Saline	15,737	13,182	4,470	1,106	124
Smith	50	0	0	0	0
Subtotal	**19,979**	**14,702**	**5,292**		**155**
Mitigation Planning Region G					

County	Population Vulnerable to Displacement (# of persons)	Short Term Shelter Needs * (# of persons)	Vulnerable Buildings	Damaged Buildings	Substantially Damaged Buildings
Butler	2,544	1,186	272	61	19
Cowley	1,712	609	375	73	24
Harper	125	1	5	1	0
Harvey	2,124	1,119	310	91	20
Kingman	297	36	49	8	0
Marion	761	208	99	18	8
McPherson	1,412	659	218	49	5
Reno	15,516	12,742	4736	595	37
Rice	672	288	162	2	0
Sedgwick	81,987	73,064	23,266	10,393	1,386
Sumner	884	252	103	19	10
Subtotal	**108,034**	**90,164**	**29,595**		**1,509**
Mitigation Planning Region H					
Allen	546	97	45	20	6
Bourbon	362	59	3	2	2
Chautauqua	192	24	9	5	1
Cherokee	901	263	67	41	25
Crawford	750	271	70	27	11
Elk	101	0	1	0	0
Greenwood	291	16	28	7	0
Labette	1,096	464	200	45	4
Montgomery	895	160	86	10	5
Neosho	285	49	21	1	0
Wilson	292	22	8	2	1
Woodson	117	16	1	0	0
Subtotal	**5,828**	**1,441**	**539**		**55**
Mitigation Planning Region I					
Chase	219	27	27	3	2
Geary	469	270	98	79	79
Lyon	725	187	28	9	6
Morris	614	273	163	81	7
Pottawatomie	462	68	29	3	2
Riley	740	432	128	51	44
Wabaunsee	149	6	3	0	0
Subtotal	**3,378**	**1,263**	**476**		**140**
Mitigation Planning Region J					
Anderson	276	5	7	0	0
Coffey	315	17	23	4	3
Franklin	1,090	319	101	45	19
Linn	342	53	3	2	0
Miami	886	318	103	55	10
Osage	479	65	0	0	0

County	Population Vulnerable to Displacement (# of persons)	Short Term Shelter Needs * (# of persons)	Vulnerable Buildings	Damaged Buildings	Substantially Damaged Buildings
Shawnee	13,283	10,349	3,237	1,669	399
Subtotal	**16,671**	**11,126**	**3,474**		**431**
Mitigation Planning Region K					
Atchison	357	87	52	11	1
Brown	157	9	4	0	0
Doniphan	1,425	758	222	177	152
Douglas	897	235	67	19	5
Jackson	425	67	7	3	1
Jefferson	540	52	28	5	5
Marshall	411	75	55	16	3
Nemaha	211	3	0	0	0
Washington	187	5	8	1	0
Subtotal	**4,610**	**1,291**	**443**		**167**
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
Subtotal	**15,972**	**13,144**	**3,523**		**1,344**
Statewide Totals	**203,797**	**152,730**	**49,759**		**3,939**

Source: HAZUS MH 2.1

*Note: HAZUS takes into account Population that may be vulnerable to displacement as a result of precautionary evacuation or flooded access even if no buildings are reported as vulnerable. Additionally, income and age factors are taken into consideration in determining short-term shelter needs.

Table 3.78. 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 & Contents Loss Ratio
Mitigation Planning Region A							
Cheyenne	$285,000	$236,000	$5,000	$526,000	$0	$526,000	0.07%
Decatur	$1,969,000	$2,551,000	$188,000	$4,708,000	$7,000	$4,715,000	0.67%
Gove	$823,000	$643,000	$31,000	$1,497,000	$0	$1,497,000	0.17%
Logan	$509,000	$559,000	$11,000	$1,079,000	$4,000	$1,083,000	0.15%
Rawlins	$1,732,000	$3,629,000	$279,000	$5,640,000	$46,000	$5,686,000	1.04%
Sheridan	$654,000	$642,000	$47,000	$1,343,000	$0	$1,343,000	0.19%
Sherman	$1,062,000	$1,687,000	$80,000	$2,829,000	$11,000	$2,840,000	0.22%
Thomas	$1,738,000	$1,432,000	$66,000	$3,236,000	$2,000	$3,238,000	0.14%
Wallace	$247,000	$266,000	$1,000	$514,000	$1,000	$515,000	0.14%
Subtotal	**$9,019,000**	**$11,645,000**	**$708,000**	**$21,372,000**	**$71,000**	**$21,443,000**	
Mitigation Planning Region B							
Ellis	$26,189,000	$54,726,000	$1,198,000	$82,113,000	$625,000	$82,738,000	1.85%
Graham	$1,301,000	$1,329,000	$118,000	$2,748,000	$2,000	$2,750,000	0.39%
Ness	$938,000	$764,000	$39,000	$1,741,000	$1,000	$1,742,000	0.18%
Norton	$2,838,000	$2,308,000	$7,000	$5,153,000	$1,000	$5,154,000	0.37%
Phillips	$1,792,000	$1,622,000	$83,000	$3,497,000	$6,000	$3,503,000	0.22%
Rooks	$873,000	$793,000	$67,000	$1,733,000	$2,000	$1,735,000	0.07%
Rush	$2,700,000	$4,964,000	$112,000	$7,776,000	$78,000	$7,854,000	1.43%
Russell	$1,426,000	$1,180,000	$74,000	$2,680,000	$2,000	$2,682,000	0.14%
Trego	$436,000	$323,000	$6,000	$765,000	$0	$765,000	0.09%
Subtotal	**$38,493,000**	**$68,009,000**	**$1,704,000**	**$108,206,000**	**$717,000**	**$108,923,000**	
Mitigation Planning Region C							
Grant	$1,119,000	$2,105,000	$248,000	$3,472,000	$6,000	$3,478,000	0.26%
Greeley	$266,000	$161,000	$1,000	$428,000	$0	$428,000	0.07%
Hamilton	$452,000	$653,000	$35,000	$1,140,000	$14,000	$1,154,000	0.21%
Kearny	$108,000	$88,000	$0	$196,000	$0	$196,000	0.02%
Lane	$253,000	$231,000	$12,000	$496,000	$0	$496,000	0.08%

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Loss	Structure & Contents Loss Ratio
Morton	$308,000	$381,000	$25,000	$714,000	$0	$714,000	0.10%
Scott	$968,000	$1,811,000	$98,000	$2,877,000	$11,000	$2,888,000	0.31%
Stanton	$262,000	$621,000	$39,000	$922,000	$20,000	$942,000	0.24%
Stevens	$2,080,000	$3,524,000	$198,000	$5,802,000	$34,000	$5,836,000	0.74%
Wichita	$269,000	$126,000	$0	$395,000	$0	$395,000	0.04%
Subtotal	**$6,085,000**	**$9,701,000**	**$656,000**	**$16,442,000**	**$85,000**	**$16,527,000**	
Mitigation Planning Region D							
Clark	$571,000	$406,000	$2,000	$979,000	$2,000	$981,000	0.13%
Finney	$26,497,000	$44,746,000	$1,913,000	$73,156,000	$676,000	$73,832,000	1.31%
Ford	$9,386,000	$17,349,000	$1,630,000	$28,365,000	$128,000	$28,493,000	0.60%
Gray	$563,000	$808,000	$84,000	$1,455,000	$0	$1,455,000	0.13%
Haskell	$360,000	$805,000	$11,000	$1,176,000	$18,000	$1,194,000	0.19%
Hodgeman	$1,620,000	$879,000	$23,000	$2,522,000	$0	$2,522,000	0.42%
Meade	$1,025,000	$1,556,000	$165,000	$2,746,000	$2,000	$2,748,000	0.32%
Seward	$2,720,000	$5,444,000	$200,000	$8,364,000	$105,000	$8,469,000	0.32%
Subtotal	**$42,742,000**	**$71,993,000**	**$4,028,000**	**$118,763,000**	**$931,000**	**$119,694,000**	
Mitigation Planning Region E							
Barber	$2,725,000	$4,270,000	$330,000	$7,325,000	$17,000	$7,342,000	0.65%
Barton	$55,180,000	$116,315,000	$15,362,000	$186,857,000	$818,000	$187,675,000	3.78%
Comanche	$387,000	$203,000	$1,000	$591,000	$0	$591,000	0.09%
Edwards	$1,856,000	$3,451,000	$58,000	$5,365,000	$60,000	$5,425,000	0.88%
Kiowa	$227,000	$115,000	$0	$342,000	$0	$342,000	0.03%
Pawnee	$1,286,000	$894,000	$16,000	$2,196,000	$8,000	$2,204,000	0.12%
Pratt	$1,369,000	$1,189,000	$71,000	$2,629,000	$1,000	$2,630,000	0.10%
Stafford	$2,060,000	$5,145,000	$333,000	$7,538,000	$79,000	$7,617,000	1.04%
Subtotal	**$65,090,000**	**$131,582,000**	**$16,171,000**	**$212,843,000**	**$983,000**	**$213,826,000**	
Mitigation Planning Region F							
Clay	$3,660,000	$4,670,000	$378,000	$8,708,000	$24,000	$8,732,000	0.47%
Cloud	$2,947,000	$3,014,000	$129,000	$6,090,000	$20,000	$6,110,000	0.26%

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Loss	Structure & Contents Loss Ratio
Dickinson	$15,584,000	$23,209,000	$1,383,000	$40,176,000	$275,000	$40,451,000	1.10%
Ellsworth	$2,125,000	$2,392,000	$153,000	$4,670,000	$12,000	$4,682,000	0.31%
Jewell	$3,453,000	$3,027,000	$49,000	$6,529,000	$22,000	$6,551,000	0.71%
Lincoln	$1,395,000	$1,269,000	$21,000	$2,685,000	$8,000	$2,693,000	0.33%
Mitchell	$3,828,000	$3,443,000	$124,000	$7,395,000	$26,000	$7,421,000	0.40%
Osborne	$2,771,000	$2,875,000	$261,000	$5,907,000	$0	$5,907,000	0.47%
Ottawa	$3,477,000	$3,980,000	$195,000	$7,652,000	$20,000	$7,672,000	0.58%
Republic	$1,003,000	$733,000	$14,000	$1,750,000	$0	$1,750,000	0.11%
Saline	$127,928,000	$218,673,000	$10,346,000	$356,947,000	$3,270,000	$360,217,000	3.59%
Smith	$763,000	$616,000	$39,000	$1,418,000	$1,000	$1,419,000	0.13%
Subtotal	**$168,934,000**	**$267,901,000**	**$13,092,000**	**$449,927,000**	**$3,678,000**	**$453,605,000**	
Mitigation Planning Region G							
Butler	$34,473,000	$35,147,000	$1,562,000	$71,182,000	$208,000	$71,390,000	0.62%
Cowley	$17,829,000	$20,793,000	$1,366,000	$39,988,000	$182,000	$40,170,000	0.58%
Harper	$1,558,000	$1,207,000	$74,000	$2,839,000	$0	$2,839,000	0.15%
Harvey	$24,922,000	$30,093,000	$1,267,000	$56,282,000	$229,000	$56,511,000	0.83%
Kingman	$4,911,000	$10,361,000	$1,884,000	$17,156,000	$119,000	$17,275,000	1.02%
Marion	$7,642,000	$9,019,000	$424,000	$17,085,000	$235,000	$17,320,000	0.63%
McPherson	$15,536,000	$21,202,000	$1,278,000	$38,016,000	$124,000	$38,140,000	0.60%
Reno	$85,384,000	$214,341,000	$12,690,000	$312,415,000	$3,888,000	$316,303,000	3.10%
Rice	$2,729,000	$4,051,000	$381,000	$7,161,000	$60,000	$7,221,000	0.36%
Sedgwick	$1,152,689,000	$1,666,048,000	$68,023,000	$2,886,760,000	$23,702,000	$2,910,462,000	3.11%
Sumner	$9,267,000	$6,986,000	$208,000	$16,461,000	$10,000	$16,471,000	0.27%
Subtotal	**$1,356,940,000**	**$2,019,248,000**	**$89,157,000**	**$3,465,345,000**	**$28,757,000**	**$3,494,102,000**	
Mitigation Planning Region H							
Allen	$11,529,000	$15,621,000	$2,200,000	$29,350,000	$39,000	$29,389,000	0.94%
Bourbon	$7,047,000	$5,644,000	$160,000	$12,851,000	$11,000	$12,862,000	0.30%
Chautauqua	$2,927,000	$2,249,000	$116,000	$5,292,000	$1,000	$5,293,000	0.47%
Cherokee	$16,772,000	$14,426,000	$866,000	$32,064,000	$49,000	$32,113,000	0.67%
Crawford	$10,915,000	$11,761,000	$644,000	$23,320,000	$45,000	$23,365,000	0.27%

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Loss	Structure & Contents Loss Ratio
Elk	$1,143,000	$637,000	$1,000	$1,781,000	$1,000	$1,782,000	0.21%
Greenwood	$4,936,000	$3,685,000	$67,000	$8,688,000	$12,000	$8,700,000	0.46%
Labette	$17,041,000	$28,121,000	$2,316,000	$47,478,000	$187,000	$47,665,000	1.16%
Montgomery	$12,339,000	$11,195,000	$939,000	$24,473,000	$25,000	$24,498,000	0.27%
Neosho	$4,171,000	$3,630,000	$184,000	$7,985,000	$8,000	$7,993,000	0.18%
Wilson	$3,557,000	$3,189,000	$87,000	$6,833,000	$67,000	$6,900,000	0.27%
Woodson	$1,181,000	$858,000	$52,000	$2,091,000	$0	$2,091,000	0.25%
Subtotal	**$93,558,000**	**$101,016,000**	**$7,632,000**	**$202,206,000**	**$445,000**	**$202,651,000**	
Mitigation Planning Region I							
Chase	$3,449,000	$3,567,000	$96,000	$7,112,000	$25,000	$7,137,000	1.21%
Geary	$8,033,000	$8,146,000	$135,000	$16,314,000	$112,000	$16,426,000	0.34%
Lyon	$9,705,000	$11,925,000	$368,000	$21,998,000	$202,000	$22,200,000	0.28%
Morris	$13,300,000	$27,078,000	$857,000	$41,235,000	$329,000	$41,564,000	3.80%
Pottawatomie	$9,165,000	$14,143,000	$759,000	$24,067,000	$221,000	$24,288,000	0.72%
Riley	$11,720,000	$13,769,000	$615,000	$26,104,000	$85,000	$26,189,000	0.22%
Wabaunsee	$2,768,000	$3,047,000	$163,000	$5,978,000	$24,000	$6,002,000	0.43%
Subtotal	**$58,140,000**	**$81,675,000**	**$2,993,000**	**$142,808,000**	**$998,000**	**$143,806,000**	
Mitigation Planning Region J							
Anderson	$3,926,000	$3,441,000	$173,000	$7,540,000	$3,000	$7,543,000	0.40%
Coffey	$6,250,000	$7,909,000	$380,000	$14,539,000	$105,000	$14,644,000	0.71%
Franklin	$18,487,000	$20,542,000	$783,000	$39,812,000	$120,000	$39,932,000	0.77%
Linn	$7,361,000	$7,156,000	$269,000	$14,786,000	$33,000	$14,819,000	0.67%
Miami	$16,796,000	$12,989,000	$479,000	$30,264,000	$15,000	$30,279,000	0.38%
Osage	$6,079,000	$5,934,000	$192,000	$12,205,000	$17,000	$12,222,000	0.38%
Shawnee	$212,028,000	$255,669,000	$9,650,000	$477,347,000	$2,150,000	$479,497,000	1.30%
Subtotal	**$270,927,000**	**$313,640,000**	**$11,926,000**	**$596,493,000**	**$2,443,000**	**$598,936,000**	
Mitigation Planning Region L							
Atchison	$7,777,000	$14,048,000	$524,000	$22,349,000	$132,000	$22,481,000	0.62%
Brown	$2,639,000	$2,851,000	$130,000	$5,620,000	$9,000	$5,629,000	0.24%

County	Structural Damage	Contents Damage	Inventory Loss	Total Direct Loss	Total Income Loss	Total Direct and Income Loss	Structure & Contents Loss Ratio
Doniphan	$28,066,000	$34,050,000	$2,607,000	$64,723,000	$124,000	$64,847,000	3.59%
Douglas	$21,716,000	$33,090,000	$1,798,000	$56,604,000	$428,000	$57,032,000	0.30%
Jackson	$6,880,000	$8,553,000	$527,000	$15,960,000	$60,000	$16,020,000	0.66%
Jefferson	$8,854,000	$8,104,000	$201,000	$17,159,000	$134,000	$17,293,000	0.44%
Marshall	$5,443,000	$8,795,000	$843,000	$15,081,000	$38,000	$15,119,000	0.67%
Nemaha	$2,446,000	$2,190,000	$127,000	$4,763,000	$5,000	$4,768,000	0.18%
Washington	$2,676,000	$3,154,000	$340,000	$6,170,000	$9,000	$6,179,000	0.47%
Subtotal	**$86,497,000**	**$114,835,000**	**$7,097,000**	**$208,429,000**	**$939,000**	**$209,368,000**	
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%
Subtotal	**$618,118,000**	**$814,039,000**	**$47,370,000**	**$1,479,527,000**	**$5,408,000**	**$1,484,935,000**	
Statewide Totals	**$2,814,543,000**	**$4,005,284,000**	**$202,534,000**	**$7,022,361,000**	**$45,455,000**	**$7,067,816,000**	

Source: HAZUS MH 2.1

Note: HAZUS calculates losses based on the performances of entire classes of buildings obtained from the general building stock data, not for individual buildings. Additionally, counts of vulnerable/damaged buildings are based on distributions at the census block level and are subject to rounding errors. Therefore, caution should be used in comparing damaged building counts and building damages.

The maps in **Figure 3.71** and **Figure 3.72** depict the Population Vulnerable to Displacement and Total Direct Building and Income Loss according to the HAZUS-MH results.

Figure 3.71. HAZUS MH 2.1 Flood Scenario Population Vulnerable to Displacement

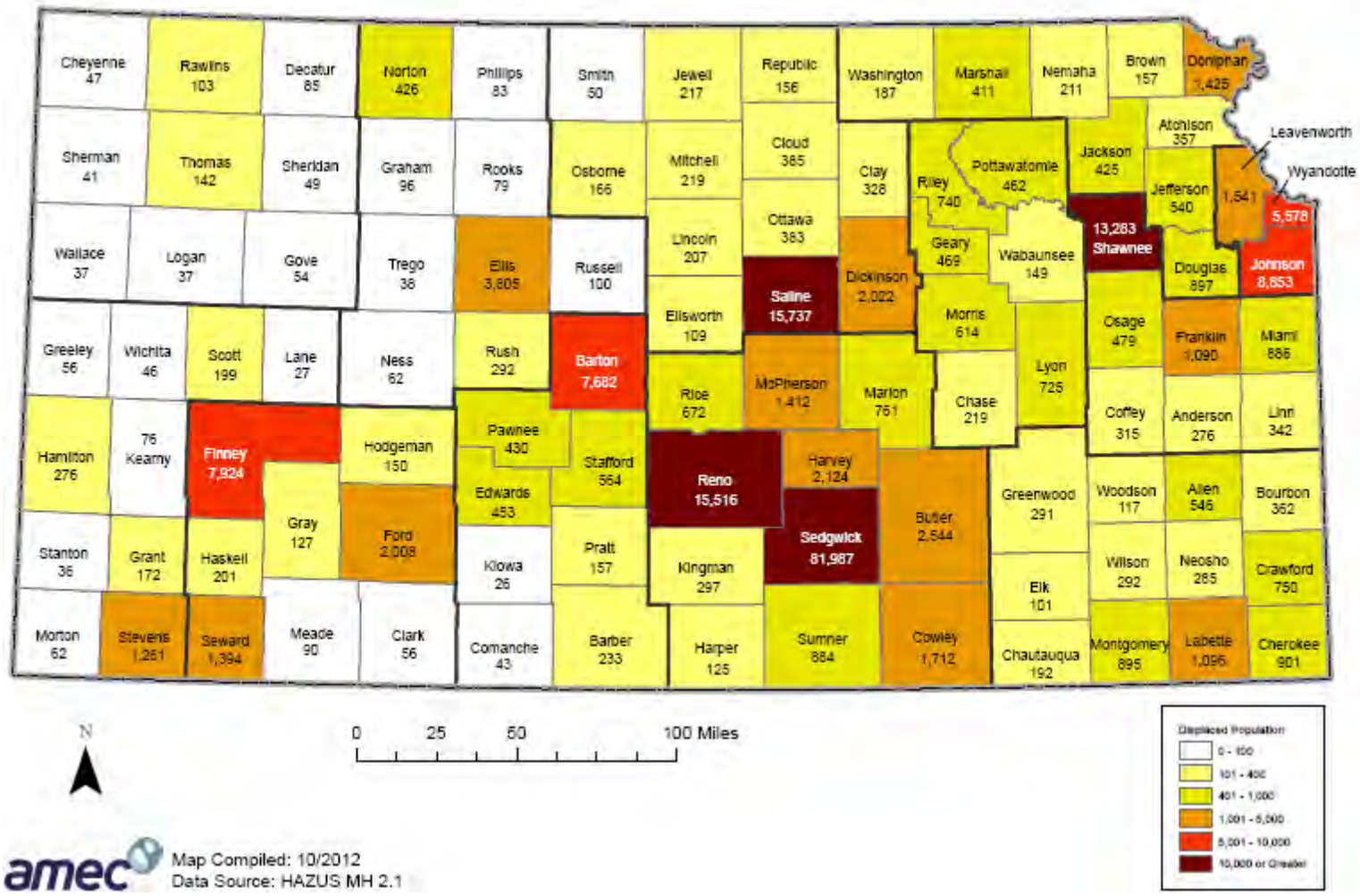


Figure 3.72. HAZUS MH 2.1 Flood Scenario Total Direct Building and Income Losses

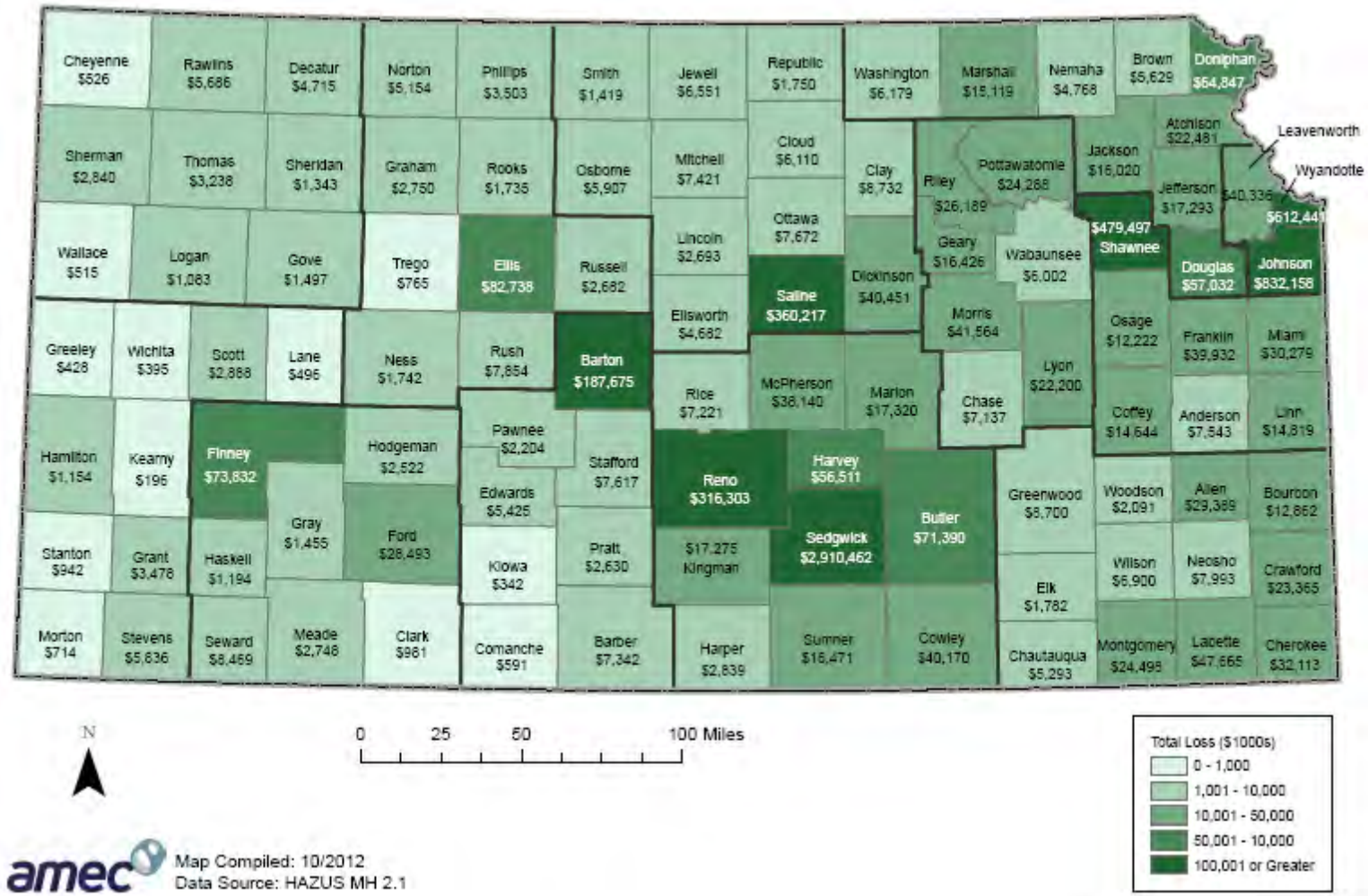


Table 3.79 lists the top ten most severely impacted counties based on building loss, loss ratio, and displaced population indicators. Sedgwick, Saline, Reno, Finney, Barton, Wyandotte, and Ellis Counties are in the top 10 for all three indicators. Shawnee and Butler Counties are in the top ten for two of the three indicators.

Table 3.79. Top Ten Counties: Population Vulnerable to Displacement, Structure and Contents Loss Ratio, and Total Direct Building and Income Loss.

Population Vulnerable to Displacement		
Mitigation Planning Region	**County**	**Population Vulnerable to Displacement**
G	Sedgwick	81,987
F	Saline	15,737
G	Reno	15,516
J	Shawnee	13,283
L	Johnson	8,853
D	Finney	7,924
E	Barton	7,682
L	Wyandotte	5,578
B	Ellis	3,805
G	Butler	2,544

Structure and Contents Loss Ratio		
Mitigation Planning Region	**County**	**Structure & Contents Loss Ratio**
I	Morris	3.80%
E	Barton	3.78%
K	Doniphan	3.59%
F	Saline	3.59%
G	Sedgwick	3.11%
G	Reno	3.10%
B	Ellis	1.85%
L	Wyandotte	1.79%
B	Rush	1.43%
D	Finney	1.31%

Total Direct Building and Income Loss		
Mitigation Planning Region	**County**	**Total Direct and Income Loss**
G	Sedgwick	$2,910,462,000
L	Johnson	$832,158,000
L	Wyandotte	$612,441,000
J	Shawnee	$479,497,000
F	Saline	$360,217,000
G	Reno	$316,303,000
E	Barton	$187,675,000
B	Ellis	$82,738,000
D	Finney	$73,832,000
G	Butler	$71,390,000

FEMA HAZUS Average Annualized Loss Study

Another study consulted to determine potential loss estimates is FEMA's HAZUS Average Annualized (AAL) Loss Study that was completed in 2009 and updated in 2010. According to this study, the Total AAL for riverine flood damages in Kansas is $547,377,000.

Development in Hazard Prone Areas

Continuing land development in certain areas of Kansas could place more people and property in flood-prone areas, unless floodplain management is implemented. Some of the highest risk flood counties are also experiencing the greatest development pressures. Of the counties that that were in the top ten for at least one of the building loss, loss ratio, and displaced population indicators, the following are also in the top ten for population gains (number of indicators is in parentheses): Sedgwick (3), Shawnee (2), Butler (2). Several of the counties in the top ten indicator categories also experienced significant gains in housing units between 2000 and 2010. These counties include Butler and Sedgwick.

It is not known how much development is occurring in flood hazard areas, but for communities in these counties 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 3.80** 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 3.80. 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
B	Ellis, City of	Ellis	10/1/2007	9	5	5
G	Harvey County	Harvey	5/1/2012	9	5	5
L	Lansing, City of	Leavenworth	5/1/2011	8	10	5
K	Lawrence, City of	Douglas	10/1/2004	7	15	5
L	Lenexa, City of	Johnson	10/1/2011	8	10	5
G	Lindsborg, City of	McPherson	10/1/1992	8	10	5
I	Lyon County	Lyon	10/1/2007	9	5	5
J	Lyons, City of	Rice	5/1/2012	9	5	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
J	Shawnee County	Shawnee	5/1/2011	9	5	5
I	Wamego, City of	Pottawatomie	10/1/2012	9	5	5

Source: NFIP Flood Insurance Manual, October 1, 2011

Consequence Analysis

The vulnerability of Kansas to flooding is significant. While health and safety impacts of flooding can be devastating, loss of life to floods during the last 50 years has declined while economic losses (e.g., property, crop, and infrastructure) have continued to rise (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. Kansas' 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, and saturate the ground for months.

Floods are often accompanied by other types of severe weather, including tornadoes, lightning, and severe thunderstorm activity. These storms also present a danger to life and property, often resulting in many injuries, and in some cases, fatalities. Floodwaters often interact with hazardous materials. This secondary hazard associated with floodwaters can make response and clean-up more difficult and time-consuming.

Public health concerns that may result from flooding include the need for disease and injury surveillance, community sanitation, evaluation of flood-affected food supplies, private water and sewage sanitation, and vector control (for mosquitoes and other pests that thrive in water or moist areas)

The information in **Table 3.81** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.81. 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).

3.3.9. Hailstorm

Calculated Priority Risk Index	Planning Significance
2.95	Moderate

Description/Location

According to the National Oceanic and Atmospheric Administration (NOAA), 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.

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

Hailstorms in Kansas cause damage to property, crops and the environment and kill and injure livestock. Because of Kansas' large agricultural industry, crop damage and livestock losses due to hail are of concern to the State. The risk in the western part of the State is elevated due to more frequent hailstorms and the presence of significant crop lands. In the United States, hail causes more than $1 billion in damage to property and crops each year. Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are the other things most commonly damaged by hail. Hail has been known to cause injury to humans, occasionally fatal injury.

Based on information provided by the Tornado and Storm Research Organization, **Table 3.82** below describes typical damage impacts of the various sizes of hail.

Table 3.82. 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

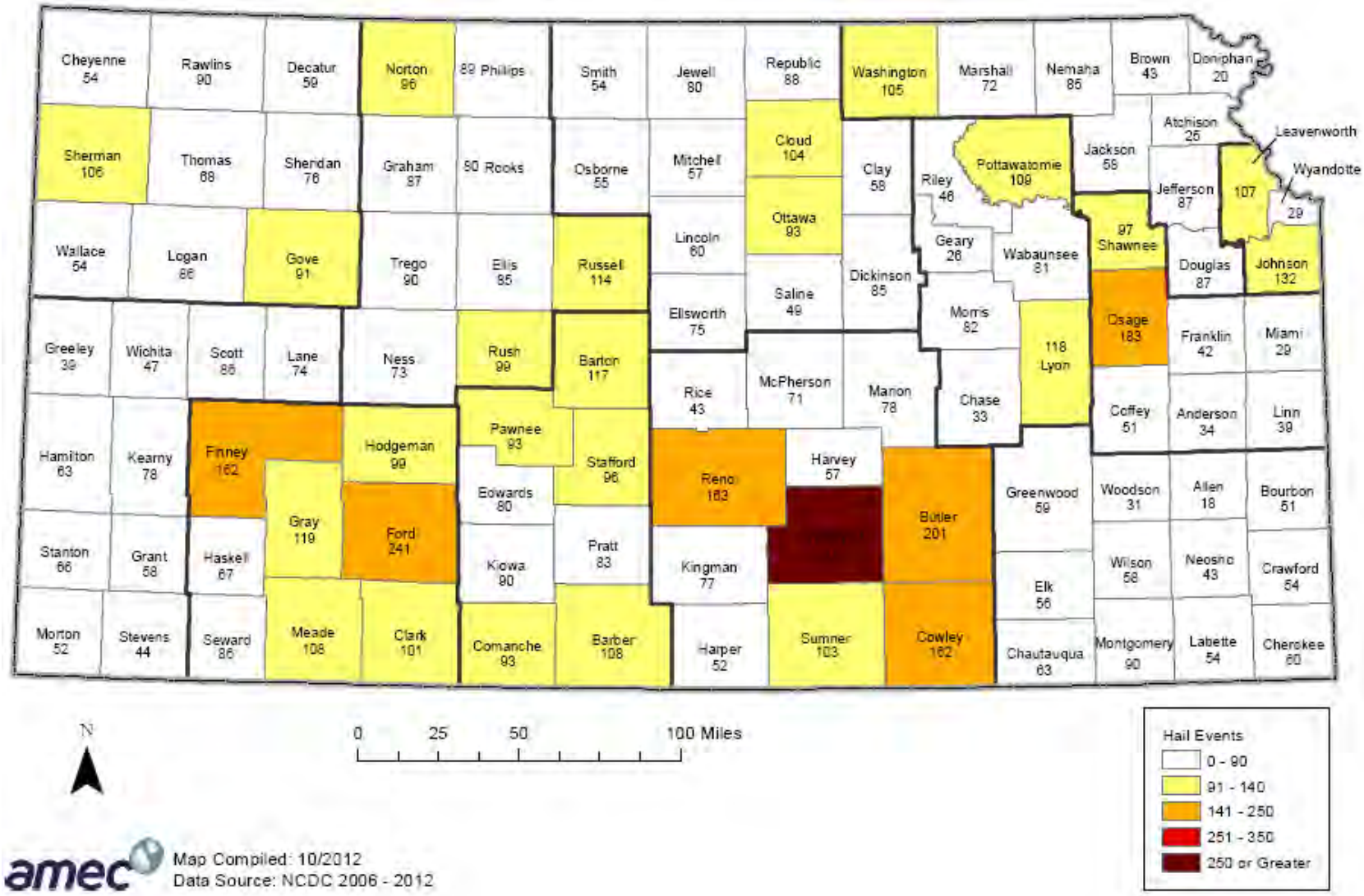
Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick 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

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity.

Previous Occurrences

According to the National Climatic Data Center's (NCDC) Storm Events database, there were 8,539 hail events and 21 hail-related injuries, when hail was at least one inch in diameter, between 2006 and 2012 (see **Table 3.84**). The events between 2006 and 2012 caused approximately $303,833,800 in property damages. This information suggests that Kansas could experience 1,220 one-inch-size hail events, $43 million in hail-related property damage, and three hail-related injuries each year. (Data limitation: NCDC receives storm data from the National Weather Service (NWS), which receives information from a variety of sources, which include but are not limited to county, state, and federal emergency management officials, local law enforcement officials, Skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry, and the general public. The hail events represent multiple hail reports, not necessarily individual storms, and thus likely over count the actual number of hailstorms.)

Figure 3.73. Kansas Hail Events by County, 2006 - 2010



Notable Hail Events:

- **June 10, 2012:** An isolated supercell thunderstorm developed over southwest Reno County and western Harvey County. The storm remained nearly stationary for almost 2 hours producing hail up to the size of golf balls.
- **April 14, 2012:** A large portion of Kansas was under a High Risk convective outlook from the Storm Prediction Center this day. Severe thunderstorm reports included ping pong ball size hail in numerous Kansas counties throughout the night.
- **August 9, 2011:** This was the most noteworthy hail event of 2011 of north central Kansas. The storm tracked southeast through portions of western Phillips, Rooks and Osborne County producing hail up to softball size. Large hail between the size of ping pong balls and baseballs pounded several communities including Logan, Stockton, Plainville, Zurich, Damar and Palco. In Zurich, some stones were reported to be softball size. Damage reports included broken windows on homes and vehicles, along with battered siding.

Source: Photo of hail damaged vehicle in Damar, Kansas. Courtesy of Becky Wells.
http://www.crh.noaa.gov/gid/?n=august9thsevere

- **June 1, 2011:** Numerous strong to severe thunderstorms affected portions of central and east central Kansas during the evening hours. The hardest hit areas were Lincoln and Russell Counties with hail up to baseball size along with winds up to 80 mph. Several roofs and vehicles were damaged by the hail.
- **May 24, 2011:** A vigorous upper level disturbance, jet streak dynamics and a strong dry line combined to produce numerous rotating thunderstorms. Large hail, flooding rains and tornadoes were observed. The city of Laird in Ness County experienced 4.25 inch diameter hail.
- **April 8, 2011:** Severe storms created a large swath of golf ball to baseball size hail across portions of south central Kansas. The city of Rose Hill in Butler County was pounded with the hail causing damage to roofs, siding, cars and homes. Nearly every home in town had 50 to 100 percent roof damage. Nine out of 10 city police cars were damaged and extensive damage to city buildings occurred.

Source: Photo of 2.75 inch hail that fell in Butler County. Picture taken by Kevin Leis courtesy of Butler County Emergency Management. http://www.crh.noaa.gov/ict/scripts/viewstory.php?STORY_NUMBER=2011040912

- **April 3, 2011:** A strong cold front surged into central Kansas during the evening hours that collided with a higher level of moisture. The severe storms brought hail up to two inch size and 70 mph winds to portions of northeast and central Kansas. The hail caused windows to be knocked out in the City of Lincolnville Marion County and roof damage was reported from Leavenworth County to Linn County.
- **June 18, 2010:** A warm front moved north into south western Kansas and created thunderstorms close to the Oklahoma border. The city of Kismet in Seward County experienced four inch diameter hail.
- **June 1, 2010:** A strong shortwave moved through the central plains bringing severe weather and produced hail over 2 inches in diameter. The largest hail fell in the city of Beattie in Marshall County. The streets were covered with hail and several windows were broken.
- **May 12, 2010:** Severe thunderstorms developed over portions of south central Kansas during the afternoon producing severe weather from 1.75 diameter hail, damaging winds and a few tornadoes in open fields. The golf ball sized hail caused 50 roofs to be damaged in the city of Kingman with 15 percent of those needing total replacement.
- **July 20, 2009:** A supercell moved southeast across northern and eastern portions of Harper County, producing a swath of golf ball to baseball size hail and 60 to 70 mph winds from just east of Runnymede, southeast through the Danville and Freeport areas. A narrow swath of intense damage occurred, including uprooted trees, shattered car and building windows. At least three damaged irrigation systems, a damaged stock show trailer, structural and roof damage to several barns and homes, damage to various sheds and outbuildings, and devastating crop damage to soybeans, milo and corn occurred. Additionally, a camper trailer was thrown into a field near Danville, and a railroad crossing traffic barrier was blown down just east of Danville.
- **June 12, 2009:** Hail was accompanied by 70 to 90 mph winds and did extensive damage to vehicles, buildings, crops and wildlife. The largest stones were a bit bigger than a baseball with the majority golf ball sized. At one location two miles southeast of Cimarron the siding was stripped off a house. Many fields of alfalfa and wheat were completely mowed down by the wind and hail. Numerous rabbits and birds were lying dead where cover had once stood. Also, there were five pivot irrigation sprinklers overturned and several trees uprooted. Trees

that were not uprooted were completely stripped of leaves and even pine trees were stripped of their needles in some cases.

- **April 24, 2008:** Severe thunderstorms developed over northwest Kansas during the early evening hours. One long-lived supercell moved slowly east across Sheridan and Graham Counties, producing baseball size hail and winds of 70-80 mph. Several grain bins were damaged or destroyed, hundreds of homes suffered broken windows on the north side of the dwellings and minor power outages occurred.
- **July 15, 2007:** Scattered thunderstorms rumbled across north central Kansas during the evening hours. Some of the storms produced some hail up to the size of golf balls and winds around 60 mph.
- **May 31, 2007:** Severe thunderstorms blasted through north central Kansas. These storms produced hail, strong winds, and a brief tornado. Hail up to golf ball and baseball size was driven by winds of 60 to 70 mph. The worst damage was reported around the Smith Center area. A couple of outbuildings were destroyed in Smith Center and siding was damaged by the wind-driven hail. North of town, crops were stripped or mowed down by the hail.
- **July 13, 2006:** Baseball size hail and wind gusts to 65 mph damaged vehicles and crops in Jewell County around Burr Oak and Esbon.
- **June 29, 2006:** Severe crop damage was reported around Lebanon and Burr Oak as a result of quarter to golf ball size hail driven by 50+ mph winds. The worst damage occurred in a swath from four miles north of Lebanon to five miles north of Burr Oak, where fields of wheat, corn, and soybeans were totally destroyed.
- **May 8-9, 2006:** Numerous locations in southwest Kansas received golf ball size hail. Hail drifts up to 18 inches deep were reported a few miles northeast of Hanston in Hodgeman County.
- **April 24, 2006:** An early morning severe thunderstorm pounded western and central portions of Sedgwick County with destructive hail as large as three inches in diameter. Widespread property damage to automobiles, homes, and businesses was reported across the Wichita area. Damage was estimated at $70 million.
- **April 23, 2006:** Large hail and straight-line winds were reported in northeast Kansas. Hail up to the size of tennis balls caused $4 million in damage to homes and vehicles in Lawrence.
- **March 12, 2006:** Hail up to the size of tennis balls in Burlingame caused considerable damage to homes and vehicles. Golf ball to tennis ball size hail was also reported in Morris, Shawnee, Geary, Douglas, Jefferson, Pottawatomie and Wabaunsee Counties.
- **June 30, 2005:** Severe thunderstorms in Woodson County dropped baseball size hail on farmland, causing estimated $415,000 damage to crops.
- **August 2002:** Hail was reported as large as golf balls.
- **May 2002:** Hailstorm was severe enough for farmers in 33 counties to be eligible for emergency loans.
- **May 16, 1999:** A major storm hit Greeley, Wichita, Scott and Lane Counties.
- **1991:** A hailstorm hit Lawrence with walnut sized to golf ball size hail.
- **May 1977:** A major storm hit Greeley, Wichita, Scott, and Lane Counties.

- **September 3, 1970:** The largest hailstone ever measured in Kansas (and, until recently, the United States) fell on Coffeyville, Kansas: 1.67 pounds and 17.5 inches in circumference.

Insured Crop Loss Data

According to the USDA Risk Management Agency, insured crop losses through the State of Kansas as a result of hail for the ten year period of 2002-2011 totaled $404,532,501 as shown in **Table 3.83**. It shows the highest year of crop losses as 2008 in this 10-year period. State-wide in Kansas, 82 percent of the row crops were insured in 2011 according to the *2011 Kansas Crop Insurance Profile Report* issued by the USDA Risk Management Agency. This information is also reported and annualized by county in **Table 3.84** in the State Vulnerability Analysis Section.

Table 3.83. Crop Insurance Paid for Hail Damages by Year, 2002-2011

Year	Crop Insurance Paid
2011	$67,439,403
2010	$28,128,706
2009	$83,783,766
2008	$84,626,548
2007	$32,966,631
2006	$22,461,486
2005	$17,162,484
2004	$29,475,984
2003	$14,701,821
2002	$23,785,672
Total	**$404,532,501**

Source: USDA Risk Management Agency

Probability of Future Hazard Events

Severe thunderstorms that create hail events are a common occurrence throughout Kansas.

According to the National Climatic Data Center Storm Events database, there were 8,539 hail events in Kansas between 2006 and 2012 (7 years). Based on this information, the probability that at least one hail event could occur in Kansas in any given year is 100 percent. Kansas can expect approximately $43 million in hail-related losses each year. This hazard‘s CPRI probability is ―**Highly Likely**” within the calendar year.

State Vulnerability Analysis

All 105 counties in Kansas are vulnerable to hailstorms. The statistical analysis method was used to refine and assess the relative vulnerability of each of Kansas‘ counties to hail. The State 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, 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 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). 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 Kansas, that using historical events and property damages from 2006 forward provides adequate events to describe the hail hazard in Kansas.