Table 3.84 below provides the available data from a variety of sources obtained for each of the factors by county, organized by Mitigation Planning Region. **Table 3.85** that follows provides the ranges that were used to determine the resulting ratings. These factor ranges are calculated based on that range of data not comparing the range to another factor‘s ratings range. Ranges may be different for each hazard.

Table 3.84. Vulnerability of Kansas Counties Factor Amounts for Hail

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Hail	Annualized Crop Insurance Paid
Mitigation Planning Region A									
Cheyenne	5	54	$72,700	$10,386	$189,307	2.7	$52,458,000	$8,586,694	$858,669
Decatur	5	59	$81,000	$11,571	$232,035	3.3	$49,747,000	$3,608,558	$360,856
Gove	4	91	$160,500	$22,929	$224,662	2.5	$59,084,000	$5,914,176	$591,418
Logan	4	86	$750	$107	$223,349	2.6	$47,558,000	$10,673,516	$1,067,352
Rawlins	5	90	$333,150	$47,593	$205,462	2.4	$59,406,000	$5,461,541	$546,154
Sheridan	5	76	$787,500	$112,500	$200,661	2.9	$95,542,000	$16,696,259	$1,669,626
Sherman	4	106	$12,177,300	$1,739,614	$461,185	5.7	$108,370,000	$22,661,603	$2,266,160
Thomas	4	68	$1,000,000	$142,857	$599,973	7.4	$129,521,000	$22,831,975	$2,283,198
Wallace	3	54	$50,750	$7,250	$117,421	1.6	$47,203,000	$7,204,628	$720,463
Subtotal		**684**	**$14,663,650**	**$2,094,807**	**$2,454,055**		**$648,889,000**	**$103,638,950**	**$10,363,895**
Mitigation Planning Region B									
Ellis	2	85	$0	$0	$1,735,474	31.6	$27,729,000	$3,614,130	$361,413
Graham	4	87	$7,000	$1,000	$201,852	2.9	$42,105,000	$6,713,454	$671,345
Ness	5	73	$15,000	$2,143	$241,794	2.9	$37,636,000	$1,879,180	$187,918
Norton	5	96	$1,128,500	$161,214	$371,491	6.5	$42,614,000	$6,237,758	$623,776
Phillips	4	89	$1,020,000	$145,714	$439,444	6.4	$41,104,000	$5,315,945	$531,595
Rooks	4	80	$1,561,250	$223,036	$601,846	5.8	$46,688,000	$8,038,830	$803,883
Rush	5	99	$0	$0	$202,357	4.6	$33,863,000	$4,197,199	$419,720
Russell	4	114	$360,000	$51,429	$488,994	7.9	$23,659,000	$1,757,839	$175,784
Trego	5	90	$0	$0	$215,776	3.4	$30,057,000	$4,814,332	$481,433
Subtotal		**813**	**$4,091,750**	**$584,536**	**$4,499,028**		**$325,455,000**	**$42,568,667**	**$4,256,867**

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Hail	Annualized Crop Insurance Paid
Mitigation Planning Region C									
Grant	3	58	$0	$0	$469,849	13.6	$63,853,000	$7,327,568	$732,757
Greeley	4	39	$6,000	$857	$131,666	1.6	$64,552,000	$7,093,643	$709,364
Hamilton	4	63	$0	$0	$187,869	2.7	$51,817,000	$8,993,660	$899,366
Kearny	4	78	$0	$0	$228,723	4.6	$66,321,000	$12,751,534	$1,275,153
Lane	4	74	$0	$0	$162,362	2.4	$31,082,000	$3,198,271	$319,827
Morton	4	52	$0	$0	$230,152	4.4	$42,645,000	$6,132,679	$613,268
Scott	2	86	$0	$0	$350,514	6.9	$71,718,000	$9,950,387	$995,039
Stanton	4	66	$0	$0	$151,658	3.3	$76,592,000	$12,607,830	$1,260,783
Stevens	2	44	$500	$71	$293,762	7.9	$124,066,000	$19,078,403	$1,907,840
Wichita	5	47	$2,000	$286	$175,679	3.1	$0	$7,804,845	$780,485
Subtotal		**607**	**$8,500**	**$1,214**	**$2,382,234**		**$592,646,000**	**$94,938,820**	**$9,493,882**
Mitigation Planning Region D									
Clark	5	101	$30,000	$4,286	$182,482	2.3	$15,466,000	$1,239,994	$123,999
Finney	2	162	$8,000	$1,143	$2,042,592	28.2	$140,746,000	$18,980,491	$1,898,049
Ford	2	241	$61,250	$8,750	$1,731,663	30.8	$87,004,000	$8,506,705	$850,671
Gray	2	119	$500,000	$71,429	$360,141	6.9	$109,340,000	$4,080,894	$408,089
Haskell	3	67	$3,000	$429	$252,803	7.4	$116,154,000	$9,409,738	$940,974
Hodgeman	3	99	$0	$0	$131,155	2.2	$41,068,000	$5,099,317	$509,932
Meade	4	108	$0	$0	$295,936	4.7	$91,206,000	$1,753,005	$175,301
Seward	2	86	$0	$0	$1,021,471	35.9	$81,688,000	$6,461,231	$646,123
Subtotal		**983**	**$602,250**	**$86,036**	**$6,018,243**		**$682,672,000**	**$55,531,375**	**$5,553,138**
Mitigation Planning Region E									
Barber	4	108	$0	$0	$388,136	4.3	$15,969,000	$2,512,010	$251,201
Barton	3	117	$0	$0	$1,772,118	30.9	$65,249,000	$7,133,911	$713,391
Comanche	5	93	$0	$0	$135,138	2.4	$13,395,000	$388,451	$38,845
Edwards	4	80	$0	$0	$232,382	4.9	$73,732,000	$4,406,603	$440,660
Kiowa	4	90	$0	$0	$237,655	3.5	$34,681,000	$2,671,763	$267,176
Pawnee	5	93	$15,000	$2,143	$449,592	9.2	$67,357,000	$4,629,137	$462,914
Pratt	3	83	$0	$0	$689,239	13.1	$62,967,000	$4,380,573	$438,057
Stafford	4	96	$0	$0	$295,331	5.6	$74,613,000	$5,079,293	$507,929

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Hail	Annualized Crop Insurance Paid
Subtotal		**760**	**$15,000**	**$2,143**	**$4,199,591**		**$407,963,000**	**$31,201,741**	**$3,120,174**
Mitigation Planning Region F									
Clay	3	58	$500	$71	$599,823	13.2	$47,769,000	$1,346,188	$134,619
Cloud	5	104	$0	$0	$691,783	13.3	$55,096,000	$2,980,835	$298,084
Dickinson	4	85	$0	$0	$1,262,865	23.3	$50,121,000	$444,295	$44,430
Ellsworth	5	75	$326,400	$46,629	$459,624	9.1	$19,376,000	$4,793,404	$479,340
Jewell	5	80	$565,000	$80,714	$254,815	3.4	$61,168,000	$5,954,146	$595,415
Lincoln	4	60	$80,000	$11,429	$234,746	4.5	$32,667,000	$964,232	$96,423
Mitchell	4	57	$156,000	$22,286	$510,997	9.1	$61,762,000	$1,732,836	$173,284
Osborne	5	55	$462,000	$66,000	$343,004	4.3	$37,801,000	$2,312,074	$231,207
Ottawa	2	93	$0	$0	$418,316	8.5	$35,560,000	$448,079	$44,808
Republic	5	88	$5,000	$714	$417,216	6.9	$79,639,000	$5,339,552	$533,955
Saline	2	49	$1,100,000	$157,143	$3,591,872	77.2	$26,903,000	$311,651	$31,165
Smith	5	54	$421,000	$60,143	$278,296	4.3	$54,022,000	$9,044,787	$904,479
Subtotal		**858**	**$3,115,900**	**$445,129**	**$9,063,357**		**$561,884,000**	**$35,672,079**	**$3,567,208**
Mitigation Planning Region G									
Butler	1	201	$6,870,000	$981,429	$3,509,143	46.1	$41,249,000	$331,287	$33,129
Cowley	3	162	$110,750	$15,821	$2,180,637	32.3	$23,126,000	$1,554,302	$155,430
Harper	4	52	$300,000	$42,857	$455,272	7.5	$17,809,000	$5,011,481	$501,148
Harvey	2	57	$0	$0	$2,143,090	64.3	$49,189,000	$496,823	$49,682
Kingman	3	77	$28,000	$4,000	$606,598	9.1	$25,749,000	$1,144,967	$114,497
McPherson	4	71	$32,538,000	$4,648,286	$762,377	13.4	$43,687,000	$634,968	$63,497
Marion	2	72	$50,000	$7,143	$854,909	32.5	$57,227,000	$1,274,817	$127,482
Reno	3	163	$300,000	$42,857	$4,120,706	51.4	$69,497,000	$3,232,295	$323,230
Rice	4	43	$876,000	$125,143	$668,411	13.9	$53,225,000	$5,386,760	$538,676
Sedgwick	1	370	$224,086,500	$32,012,357	$31,528,899	499.6	$56,918,000	$2,130,128	$213,013
Sumner	2	103	$2,000	$286	$1,574,242	20.4	$50,711,000	$7,334,301	$733,430
Subtotal		**1371**	**$265,161,250**	**$37,880,179**	**$48,404,284**		**$488,387,000**	**$28,532,129**	**$2,853,213**
Mitigation Planning Region H									
Allen	3	18	$12,500	$1,786	$983,778	26.7	$15,462,000	$439,019	$43,902

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Hail	Annualized Crop Insurance Paid
Bourbon	4	51	$2,000,000	$285,714	$1,102,488	23.9	$9,918,000	$198,706	$19,871
Chautauqua	5	63	$0	$0	$285,438	5.7	$4,971,000	$12,323	$1,232
Cherokee	4	60	$20,000	$2,857	$1,293,753	36.8	$53,420,000	$436,412	$43,641
Crawford	3	54	$0	$0	$2,588,817	66.4	$34,463,000	$853,832	$85,383
Elk	5	56	$0	$0	$187,291	4.5	$0	$25,277	$2,528
Greenwood	5	59	$3,000,100	$428,586	$491,412	5.9	$8,087,000	$16,880	$1,688
Labette	4	54	$0	$0	$1,453,850	33.5	$22,765,000	$177,131	$17,713
Montgomery	4	90	$5,050,000	$721,429	$2,432,183	55.1	$16,616,000	$209,878	$20,988
Neosho	4	43	$0	$0	$1,174,150	28.9	$17,811,000	$780,420	$78,042
Wilson	4	58	$0	$0	$671,059	16.5	$26,882,000	$179,567	$17,957
Woodson	5	31	$0	$0	$207,905	6.6	$14,486,000	$103,964	$10,396
Subtotal		**637**	**$10,082,600**	**$1,440,371**	**$12,872,124**		**$224,881,000**	**$3,433,409**	**$343,341**
Mitigation Planning Region I									
Chase	3	495	$7,000	$1,000	$9,835,676	292.4	$135,033,000	$1,529,758	$152,976
Geary	3	34	$0	$0	$518,401	14	$33,029,000	$547,573	$54,757
Lyon	2	51	$0	$0	$670,953	13.7	$25,497,000	$308,570	$30,857
Morris	2	42	$0	$0	$1,598,004	45.5	$32,349,000	$477,759	$47,776
Pottawatomie	1	39	$60,000	$8,571	$659,126	16.3	$13,053,000	$406,211	$40,621
Riley	2	29	$0	$0	$2,106,266	57	$27,726,000	$134,158	$13,416
Wabaunsee	2	183	$500	$71	$977,110	23.1	$27,618,000	$133,546	$13,355
Subtotal		**97**	**$0**	**$0**	**$11,828,241**		**$32,959,000**	**$176,042**	**$17,604**
Mitigation Planning Region J									
Anderson	3	34	$0	$0	$518,401	14	$33,029,000	$547,573	$54,757
Coffey	3	51	$0	$0	$670,953	13.7	$25,497,000	$308,570	$30,857
Franklin	2	42	$0	$0	$1,598,004	45.5	$32,349,000	$477,759	$47,776
Linn	2	39	$60,000	$8,571	$659,126	16.3	$13,053,000	$406,211	$40,621
Miami	1	29	$0	$0	$2,106,266	57	$27,726,000	$134,158	$13,416
Osage	2	183	$500	$71	$977,110	23.1	$27,618,000	$133,546	$13,355
Shawnee	2	97	$0	$0	$11,828,241	327.1	$32,959,000	$176,042	$17,604
Subtotal		**475**	**$60,500**	**$8,643**	**$18,358,101**		**$192,231,000**	**$2,183,859**	**$218,386**

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Hail	Annualized Crop Insurance Paid
Mitigation Planning Region K									
Atchison	3	25	$127,000	$18,143	$1,333,363	39.3	$42,536,000	$937,293	$93,729
Brown	5	43	$0	$0	$713,225	17.5	$86,532,000	$491,825	$49,183
Doniphan	3	20	$0	$0	$557,109	20.2	$67,800,000	$280,002	$28,000
Douglas	1	87	$4,000,000	$571,429	$6,614,269	243.1	$27,973,000	$60,475	$6,048
Jackson	3	58	$24,000	$3,429	$788,323	20.5	$21,169,000	$287,596	$28,760
Jefferson	1	87	$8,000	$1,143	$1,130,852	35.9	$33,429,000	$70,437	$7,044
Marshall	4	78	$9,000	$1,286	$2,054,603	11.2	$81,815,000	$846,979	$84,698
Nemaha	4	85	$0	$0	$711,896	14.2	$67,091,000	$93,760	$9,376
Washington	4	105	$0	$0	$396,656	6.5	$65,762,000	$2,167,015	$216,702
Subtotal		**588**	**$4,168,000**	**$595,429**	**$14,300,296**		**$494,107,000**	**$5,235,382**	**$523,538**
Mitigation Planning Region L									
Johnson	1	132	$1,020,000	$145,714	$43,871,468	1,149.60	$29,472,000	$28,592	$2,859
Leavenworth	1	107	$362,000	$51,714	$4,877,783	164.7	$20,983,000	$37,737	$3,774
Wyandotte	3	29	$475,500	$67,929	$12,066,666	1,039.00	$0	$0	$0
Subtotal		**268**	**$1,857,500**	**$265,357**	**$60,815,917**		**$50,455,000**	**$66,329**	**$6,633**
Statewide Total		**8,539**	**$303,833,900**	**$43,404,843**	**$193,202,906**	**5,174.80**	**$4,804,603,000**	**$404,532,498**	**$40,453,250**

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

Table 3.85. Ranges for Hail Vulnerability Factor Ratings

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

* Population density is the number of people per square mile.
Note: The assigned 1-10 range would be based on the range of dollar losses, not comparing the range of losses to another factor‘s range.

Table 3.86 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and **Table 3.87** provides the seven rating values assigned that were considered in determining overall vulnerability to hail. **Table 3.87** that follows provides the mapped results of this analysis by county.

Table 3.86. Ranges for Overall Hail Vulnerability

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

Table 3.87. Vulnerability of Kansas Counties to Hail

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Hail Vulnerability
Mitigation Planning Region A									
Cheyenne	10	1	2	1	1	4	5	24	Medium
Decatur	10	2	2	1	1	4	3	23	Medium

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Hail Vulnerability
Gove	8	3	2	1	1	4	4	23	Medium
Logan	8	2	1	1	1	4	6	23	Medium
Rawlins	10	2	2	1	1	5	4	25	Medium
Sheridan	10	2	4	1	1	7	8	33	Medium-High
Sherman	8	3	9	1	1	8	10	40	High
Thomas	8	2	4	1	1	10	10	36	High
Wallace	6	1	1	1	1	4	5	19	Medium-Low
Mitigation Planning Region B									
Ellis	4	2	1	1	1	2	3	14	Low
Graham	8	2	1	1	1	3	4	20	Medium-Low
Ness	10	2	1	1	1	3	2	20	Medium-Low
Norton	10	3	4	1	1	3	4	26	Medium
Phillips	8	2	4	1	1	3	4	23	Medium
Rooks	8	2	4	1	1	4	5	25	Medium
Rush	10	3	1	1	1	3	3	22	Medium
Russell	8	3	3	1	1	2	2	20	Medium-Low
Trego	10	2	1	1	1	2	3	20	Medium-Low
Mitigation Planning Region C									
Grant	6	2	1	1	1	5	5	21	Medium-Low
Greeley	8	1	1	1	1	5	5	22	Medium
Hamilton	8	2	1	1	1	4	5	22	Medium
Kearny	8	2	1	1	1	5	7	25	Medium
Lane	8	2	1	1	1	2	3	18	Medium-Low
Morton	8	1	1	1	1	3	4	19	Medium-Low
Scott	4	2	1	1	1	5	6	20	Medium-Low
Stanton	8	2	1	1	1	6	7	26	Medium
Stevens	4	1	1	1	1	9	9	26	Medium
Wichita	10	1	1	1	1	1	5	20	Medium-Low
Mitigation Planning Region D									
Clark	10	3	1	1	1	1	2	19	Medium-Low
Finney	4	5	1	1	1	10	9	31	Medium-High
Ford	4	6	1	1	1	7	5	25	Medium
Gray	4	3	3	1	1	8	3	23	Medium
Haskell	6	2	1	1	1	9	6	26	Medium
Hodgeman	6	3	1	1	1	3	4	19	Medium-Low
Meade	8	3	1	1	1	7	2	23	Medium
Seward	4	2	1	1	1	6	4	19	Medium-Low
Mitigation Planning Region E									
Barber	8	3	1	1	1	1	2	17	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Hail Vulnerability
Barton	6	3	1	1	1	5	5	22	Medium
Comanche	10	3	1	1	1	1	1	18	Medium-Low
Edwards	8	2	1	1	1	6	3	22	Medium
Kiowa	8	2	1	1	1	3	2	18	Medium-Low
Pawnee	10	3	1	1	1	5	3	24	Medium
Pratt	6	2	1	1	1	5	3	19	Medium-Low
Stafford	8	3	1	1	1	6	4	24	Medium
Mitigation Planning Region F									
Clay	6	2	1	1	1	4	2	17	Medium-Low
Cloud	10	3	1	1	1	4	2	22	Medium
Dickinson	8	2	1	1	1	4	1	18	Medium-Low
Ellsworth	10	2	2	1	1	2	3	21	Medium-Low
Jewell	10	2	3	1	1	5	4	26	Medium
Lincoln	8	2	2	1	1	3	1	18	Medium-Low
Mitchell	8	2	2	1	1	5	2	21	Medium-Low
Osborne	10	1	3	1	1	3	2	21	Medium-Low
Ottawa	4	3	1	1	1	3	1	14	Low
Republic	10	2	1	1	1	6	4	25	Medium
Saline	4	1	4	1	1	2	1	14	Low
Smith	10	1	3	1	1	4	6	26	Medium
Mitigation Planning Region G									
Butler	2	6	8	1	1	3	1	22	Medium
Cowley	6	5	2	1	1	2	2	19	Medium-Low
Harper	8	1	2	1	1	1	4	18	Medium-Low
Harvey	4	2	1	1	1	4	1	14	Low
Kingman	6	2	1	1	1	2	2	15	Medium-Low
McPherson	8	2	10	1	1	3	1	26	Medium
Marion	4	2	1	1	1	4	2	15	Medium-Low
Reno	6	5	2	1	1	5	3	23	Medium
Rice	8	1	4	1	1	4	4	23	Medium
Sedgwick	2	10	10	8	5	4	2	41	High
Sumner	4	3	1	1	1	4	5	19	Medium-Low
Mitigation Planning Region H									
Allen	6	1	1	1	1	1	1	12	Low
Bourbon	8	1	4	1	1	1	1	17	Medium-Low
Chautauqua	10	2	1	1	1	1	1	17	Medium-Low
Cherokee	8	2	1	1	1	4	1	18	Medium-Low
Crawford	6	1	1	1	1	3	1	14	Low
Elk	10	2	1	1	1	1	1	17	Medium-Low
Greenwood	10	2	5	1	1	1	1	21	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Hail Vulnerability
Labette	8	1	1	1	1	2	1	15	Medium-Low
Montgomery	8	2	7	1	1	1	1	21	Medium-Low
Neosho	8	1	1	1	1	1	1	14	Low
Wilson	8	2	1	1	1	2	1	16	Medium-Low
Woodson	10	1	1	1	1	1	1	16	Medium-Low
Mitigation Planning Region I									
Chase	6	1	1	1	1	1	1	12	Low
Geary	4	1	1	1	1	1	1	10	Low
Lyon	6	3	1	1	1	2	1	15	Medium-Low
Morris	6	2	1	1	1	2	1	14	Low
Pottawatomie	2	3	1	1	1	2	1	11	Low
Riley	4	1	1	1	2	2	1	12	Low
Wabaunsee	4	2	1	1	1	1	1	11	Low
Mitigation Planning Region J									
Anderson	6	1	1	1	1	3	1	14	Low
Coffey	6	1	1	1	1	2	1	13	Low
Franklin	4	1	1	1	1	3	1	12	Low
Linn	4	1	1	1	1	1	1	10	Low
Miami	2	1	1	1	1	2	1	9	Low
Osage	4	5	1	1	1	2	1	15	Medium-Low
Shawnee	4	3	1	3	3	3	1	18	Medium-Low
Mitigation Planning Region K									
Atchison	6	1	2	1	1	3	1	15	Medium-Low
Brown	10	1	1	1	1	7	1	22	Medium
Doniphan	6	1	1	1	1	5	1	16	Medium-Low
Douglas	2	2	6	2	3	2	1	18	Medium-Low
Jackson	6	2	1	1	1	2	1	14	Low
Jefferson	2	2	1	1	1	3	1	11	Low
Marshall	8	2	1	1	1	6	1	20	Medium-Low
Nemaha	8	2	1	1	1	5	1	19	Medium-Low
Washington	8	3	1	1	1	5	2	21	Medium-Low
Mitigation Planning Region L									
Johnson	2	4	4	10	10	2	1	33	Medium-High
Leavenworth	2	3	3	2	2	2	1	15	Medium-Low
Wyandotte	6	1	3	3	10	1	1	25	Medium

Figure 3.74. Vulnerability Summary for Hail

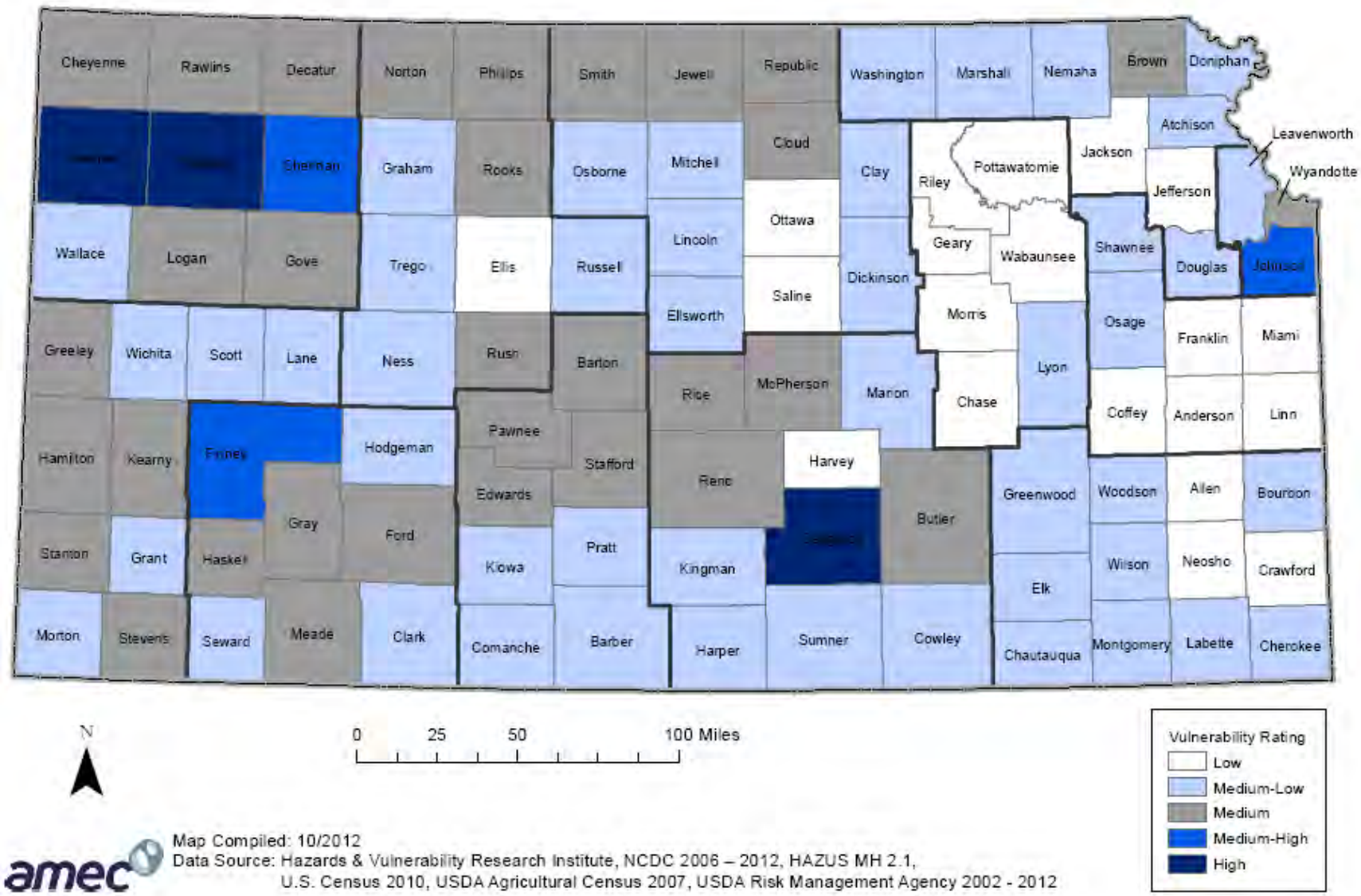


Table 3.88 below lists the top counties vulnerable to hail in Kansas according to this methodology.

Table 3.88. Top Counties: Vulnerable to Hail

Mitigation Planning Region	County	Overall Vulnerability Rating	Hail Vulnerability
G	Sedgwick	41	High
A	Sherman	40	High
A	Thomas	36	High
A	Sheridan	33	Medium-High
L	Johnson	33	Medium-High
D	Finney	31	Medium-High
C	Stevens	26	Medium
C	Stanton	26	Medium
D	Haskell	26	Medium
F	Smith	26	Medium
B	Norton	26	Medium
F	Jewell	26	Medium
G	Marion	26	Medium

State Estimates of Potential Losses

Severe thunderstorms and the associated hail events will continue to cause damage to anything and everything exposed to the weather elements. Historically NCDC has reported 21 injuries in Kansas from 2006 through 2012 which calculates to an annualized occurrence of three injuries.

To determine potential financial loss estimates to hail in Kansas, the available historical loss data was annualized. In the case of frequently occurring weather-related hazards such as hail, annualized historical loss data is considered to be the best resource for determining future potential losses. As discussed above in the vulnerability overview for hail, the planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (2006 – 2012) and the USDA Risk Management Agency insured crop loss payments (2002 – 2011) since agriculture plays such as important role in the Kansas economy. According to this data, the combined annualized property loss for the State of Kansas from hail is $83,858,093 ($43,404,843 property and $40,453,250 crop damages) and can be viewed in **Table 3.84** (vulnerability overview section).

Figure 3.75 provides the potential annualized insured crop loss estimates for hail and **Figure 3.76** provides the potential annualized property loss estimates per county. For the annualized insured crop loss, the highest counties also have the highest value of crop exposure. There is no distinct pattern of loss that can be inferred for property loss other than that the highest county, Sedgwick, also has high building exposure. Thus, this analysis demonstrates the random distribution of this hazard and its impacts statewide.

Figure 3.75. Annualized Insured Crop Losses from Hail

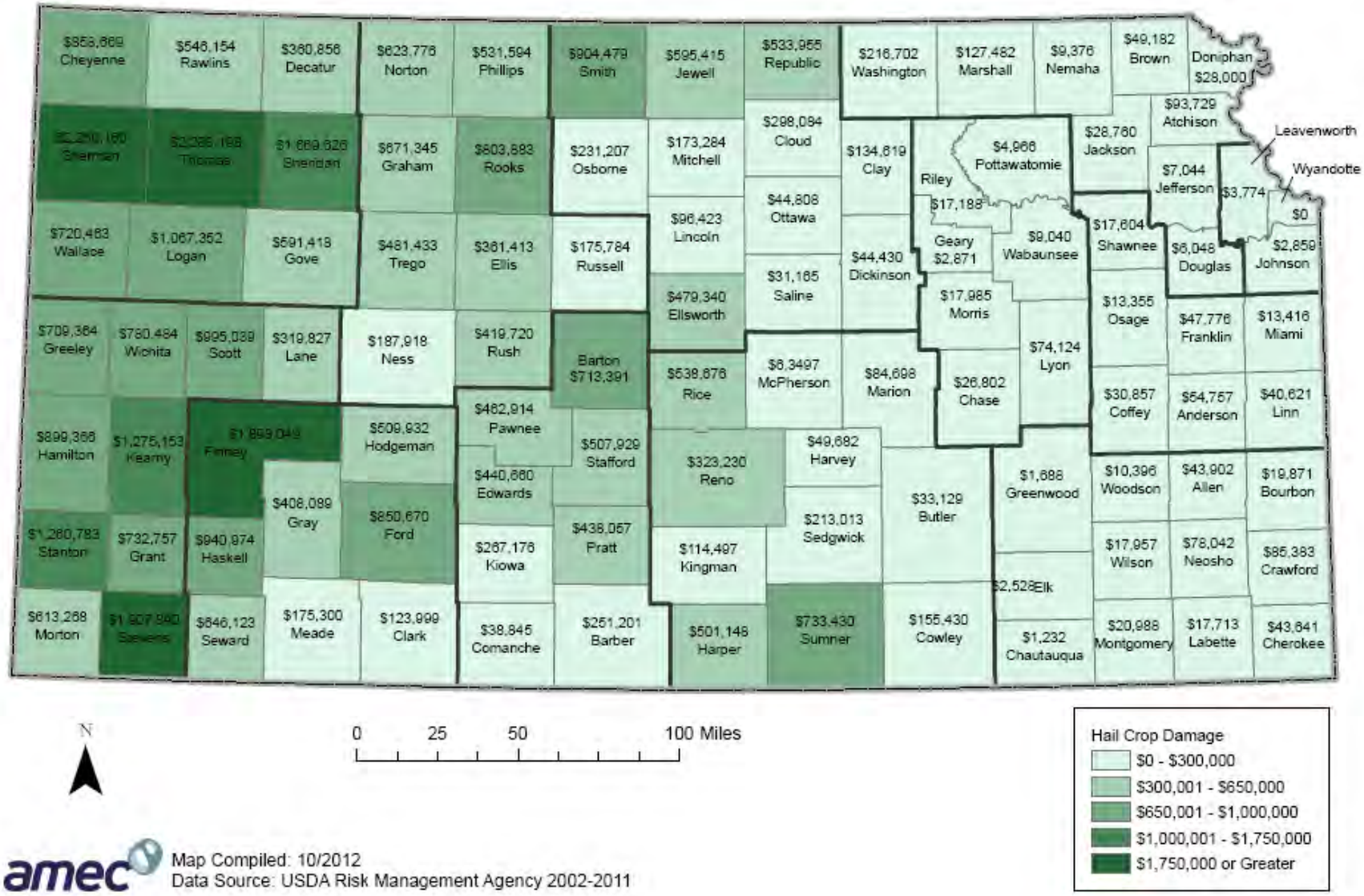
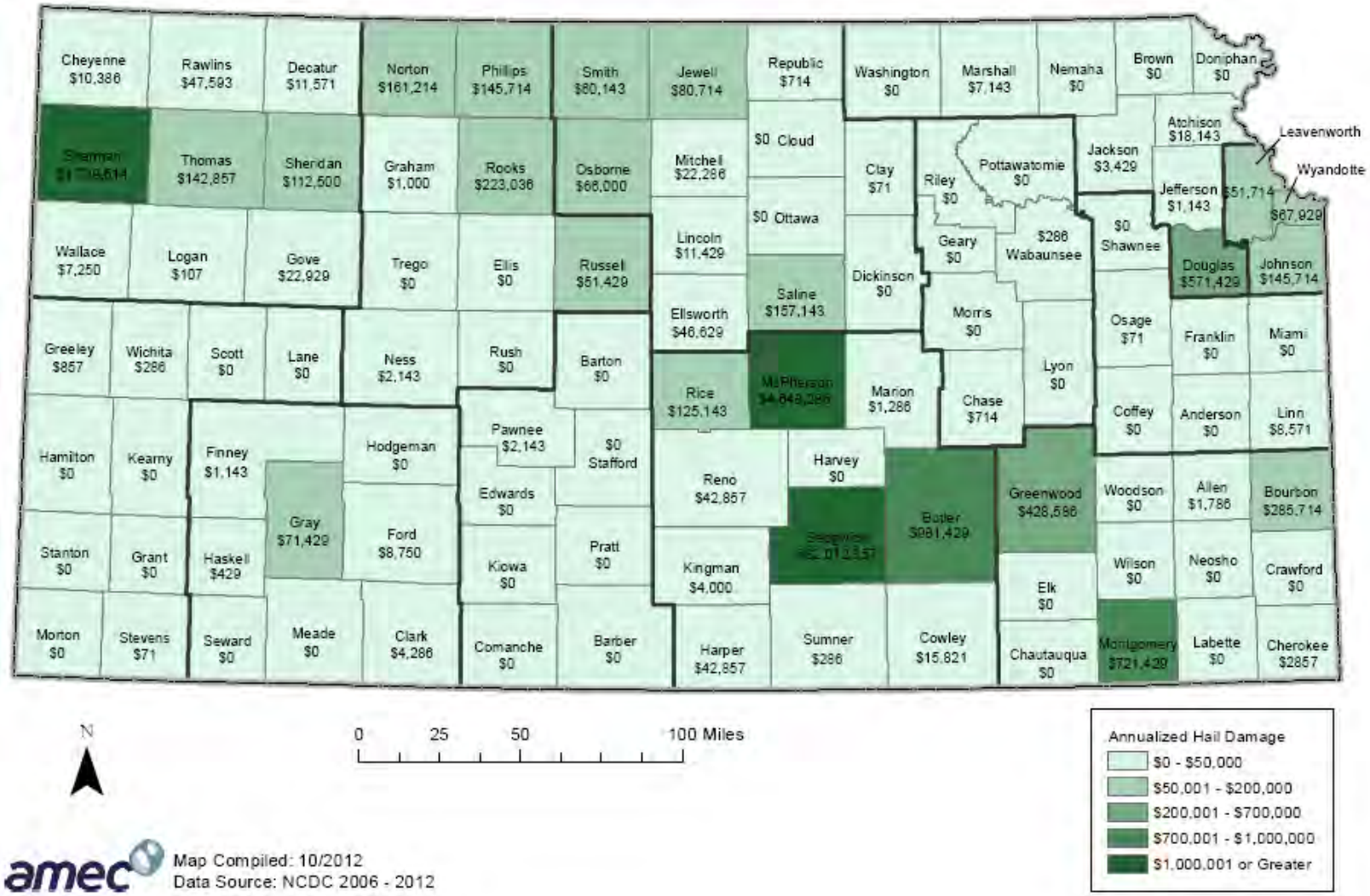


Figure 3.76. Annualized Property Losses from Hail



Development in Hazard Prone Areas

In Kansas, the increased number of people and new development is not as significant to hail damage as agricultural losses. Agriculture has a more significant role and the bigger potential economic impact. Thus the counties with the most farmland acreage such as Butler, Reno, Finney, Sumner, Sherman, Thomas, Ford, Ness, Barber and Hamilton are more susceptible to hail damage. If agricultural development is expanded, vulnerability to crop damage due to hail will also increase.

Consequence Analysis

The information in **Table 3.89** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.89. EMAP Consequence Analysis: Hailstorm

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

3.3.10. Hazardous Materials

Calculated Priority Risk Index	Planning Significance
2.9	Moderate

Description/Location

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

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

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

Also of concern in Kansas are caverns in the salt beds, which are used for underground hydrocarbon storage specifically storing natural gas, liquid petroleum gas and crude oil. Some caverns were originally created during salt mining; others were created by solutions specifically for the storage of hydrocarbons. Salt caverns are used for storage because salt is highly impermeable, and salt beds in Kansas are thick and fairly predictable. Nevertheless, there are problems associated with such storage, such as the potential for natural leakage, cavern failure, and equipment failure, which can result in fires and explosions.

Kansas has more subsurface hydrocarbon storage caverns than any other State (see **Figure 3.82,** Total Subsurface Void Space by County). Subsurface hydrocarbon storage occurs in Rice, Reno, McPherson, Kingman, Grant and Ellsworth Counties and the specific amounts per county are in **Table 3.105**, Subsurface Void Space Vulnerability Analysis. For more information on underground hydrocarbon storage sites in Kansas, please reference Kansas Department of Health and Environment, Underground Hydrocarbon Storage Unit.

The primary agency responsible for hazardous materials within the State of Kansas is the Kansas Department of Health and Environment, Division of Environment http://www.kdheks.gov/environment/index.html . The Kansas Response Plan, Emergency Support Function #10 – Oil and Hazardous Materials is another resource for response

information. (The Kansas Response Plan has not added as an appendix to this mitigation plan for security reasons.)

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

The KHMT considers the risk level from hazardous materials accidents to be relatively low in the northwestern region of the State because that region of the State has the least amount of development and industrialization. The risk is more elevated, but still relatively low, in the north central, southeastern and southwestern regions of Kansas. A more moderate risk is considered to be present in the northeast region of the State, reflecting the development and industrialization of the Kansas City metropolitan area, as well as in the south central region of the State, again reflecting the development and industrialization in the Wichita metropolitan area. Generally, it is the developed areas or environmental resources in the immediate vicinity of facilities or transportation routes that would be at risk.

Fixed Facility Locations

In 2011, there were 13,679 facilities housing hazardous chemicals in Kansas identified by the Community Right to Know Act. The number of facilities is illustrated by county in **Figure 3.77**.

Figure 3.77. Number of Kansas Facilities Housing Hazardous Chemicals Per County, 2011

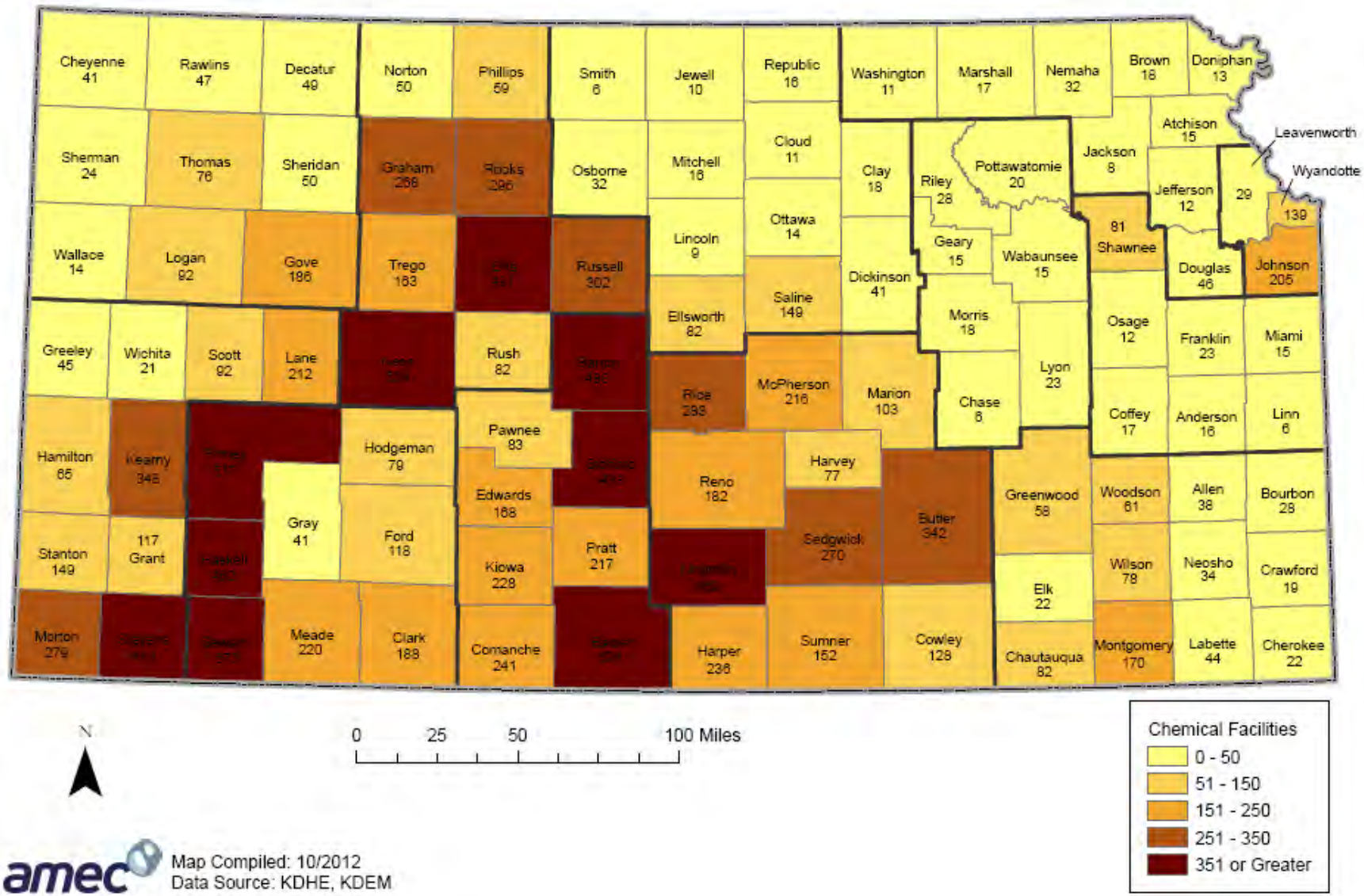


Table 3.90 shows U.S. Environmental Protection Agency Superfund sites in Kansas. A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, which may affect local ecosystems and/or people. Eleven Kansas sites are currently on the Superfund National Priority list listed below by Mitigation Planning Region. The proposed date and final date are the National Priority Listing history information. An additional proposed superfund site is at the Tri-county Public Airport facility, Morris County, as of July 27, 2000.

Table 3.90. Superfund National Priorities List Sites in Kansas

Mitigation Planning Region	National Priority List Sites	City	County	Proposed Date	Final Date
A	Ace Services	Colby	Thomas	2/13/1995	9/29/1995
D	Wright Ground Water Contamination	Wright	Ford	10/2/1995	6/17/1996
E	Planting, Inc. site	Great Bend	Barton	9/19/2007	3/19/2008
G	Pester Refinery Company site	near El Dorado	Butler	6/24/1988	3/31/1989
G	Strother Field Industrial Park	near Winfield & Arkansas City	Cowley	10/15/1984	6/10/1986
G	Obee Road (Hutchinson City Dump)	Obeeville	Reno	1/22/1987	7/22/1987
G	57th & North Broadway Street site	Wichita Heights	Sedgwick	2/7/1992	10/14/1992
H	Cherokee County (Tri-state Mining District, Tar Creek Area)	Galena, Baxter Springs, Treece, Badger, Lawton, Waco, Crestline	Cherokee	12/30/1982	9/8/1983
I	Fort Riley	near Junction City	Geary and Riley	7/14/1989	8/30/1990
L	Chemical Commodities Inc.	Olathe	Johnson	1/18/1994	5/31/1994
L	Doepke Disposal (Holliday)		Johnson	12/30/1982	9/8/1983

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

Pipelines

According to the U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration‘s Pipeline Safety Stakeholder Communications, Kansas‘ pipeline system is seen in **Table 3.91.**

Table 3.91. Kansas Pipeline Mileage

Pipeline System	Mileage
Hazardous Liquid Lines	10,632
Gas Transmission Lines	14,286
Gas Gathering Lines	115
Gas Distribution (945,445 total services)*	21,770
Total Pipelines	46,803

Source: U.S. Department of Transportation, Pipeline Safety Stakeholder Communications, http://primis.phmsa.dot.gov/comm/reports/safety/KS_detail1.html?nocache=3112,

* Gas distribution service lines (the connection between the distribution line and the end user) are not included in the gas distribution mileage. The total number of miles for that service is 945,445.

All mileages are for 2010 and are approximate as some data sources may not have contained a complete record of state pipeline mileage.

Table 3.92 shows the breakdown of gas transmission line and hazardous liquid line mileage by Mitigation Planning Region and county.

Table 3.92. Gas Transmission Line and Hazardous Liquid Line Mileage by Mitigation Planning Region and County.

County	Gas Miles	Liquid Miles	Percent of Total
Mitigation Planning Region A			
Cheyenne	129	37	0.60%
Decatur	59	0	0.20%
Gove	88	36	0.50%
Logan	76	35	0.40%
Rawlins	97	19	0.40%
Sheridan	59	34	0.30%
Sherman	55	35	0.30%
Thomas	106	34	0.50%
Wallace	34	37	0.20%
Subtotal	703	267	
Mitigation Planning Region B			
Ellis	123	116	0.90%
Graham	60	14	0.30%
Ness	20	92	0.40%
Norton	59	0	0.20%
Phillips	140	68	0.80%
Rooks	147	82	0.90%
Rush	131	29	0.60%
Russell	48	88	0.50%
Trego	122	79	0.80%
Subtotal	850	568	
Mitigation Planning Region C			
Grant	191	65	1.00%
Greeley	76	0	0.30%
Hamilton	41	0	0.10%
Kearny	160	0	0.60%
Lane	58	48	0.40%
Morton	98	16	0.40%
Scott	167	59	0.90%
Stanton	6	0	0.00%
Stevens	52	26	0.30%
Wichita	49	4	0.20%
Subtotal	898	218	
Mitigation Planning Region D			
Clark	367	211	2.30%
Finney	163	40	0.80%
Ford	457	34	1.90%

County	Gas Miles	Liquid Miles	Percent of Total
Gray	101	23	0.50%
Haskell	136	68	0.80%
Hodgeman	68	24	0.30%
Meade	393	126	2.00%
Seward	292	167	1.80%
Subtotal	1977	693	
Mitigation Planning Region E			
Barber	88	90	0.70%
Barton	275	121	1.50%
Comanche	80	91	0.60%
Edwards	211	16	0.90%
Kiowa	434	165	2.40%
Pawnee	132	73	0.80%
Pratt	262	190	1.80%
Stafford	251	150	1.60%
Subtotal	1733	896	
Mitigation Planning Region F			
Clay	93	138	0.90%
Cloud	161	81	0.90%
Dickinson	195	91	1.10%
Ellsworth	215	110	1.30%
Jewell	67	0	0.20%
Lincoln	252	14	1.00%
Mitchell	55	0	0.20%
Osborne	44	14	0.20%
Ottawa	212	137	1.40%
Republic	88	51	0.50%
Saline	51	162	0.80%
Smith	33	15	0.10%
Subtotal	1466	813	
Mitigation Planning Region G			
Butler	225	544	3.00%
Cowley	168	285	1.80%
Harper	57	170	0.90%
Harvey	198	247	1.70%
Kingman	203	255	1.80%
Marion	218	93	1.20%
McPherson	290	794	4.30%
Reno	480	786	5.00%
Rice	386	312	2.80%
Sedgwick	339	341	2.70%
Sumner	118	151	1.00%
Subtotal	2682	3978	
Mitigation Planning Region H			
Allen	81	202	1.10%
Bourbon	27	3	0.10%
Chautauqua	67	115	0.70%
Cherokee	94	31	0.50%

County	Gas Miles	Liquid Miles	Percent of Total
Crawford	22	36	0.20%
Elk	63	0	0.20%
Greenwood	194	106	1.20%
Labette	75	2	0.30%
Montgomery	126	304	1.70%
Neosho	18	90	0.40%
Wilson	61	89	0.60%
Woodson	1	23	0.10%
Subtotal	829	1001	
Mitigation Planning Region I			
Chase	185	37	0.80%
Geary	91	25	0.40%
Lyon	180	84	1.00%
Morris	24	123	0.50%
Pottawatomie	128	2	0.50%
Riley	45	24	0.20%
Wabaunsee	23	132	0.60%
Subtotal	676	427	
Mitigation Planning Region J			
Anderson	134	64	0.80%
Coffey	230	54	1.10%
Franklin	374	31	1.60%
Linn	0	106	0.40%
Miami	242	192	1.70%
Osage	84	42	0.50%
Shawnee	46	132	0.70%
Subtotal	1110	621	
Mitigation Planning Region K			
Atchison	39	81	0.40%
Brown	132	83	0.80%
Doniphan	22	81	0.40%
Douglas	89	59	0.60%
Jackson	36	22	0.20%
Jefferson	76	95	0.60%
Marshall	93	90	0.70%
Nemaha	78	47	0.50%
Washington	346	182	2.10%
Subtotal	911	740	
Mitigation Planning Region L			
Johnson	232	120	1.40%
Leavenworth	106	134	0.90%
Wyandotte	66	155	0.80%
Subtotal	404	409	
Statewide Total	**14,239**	**10,631**	

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

Figure 3.78 and **Figure 3.79** show the locations of the State's gas and petroleum lines.

Figure 3.78. Kansas Gas Transmission Lines

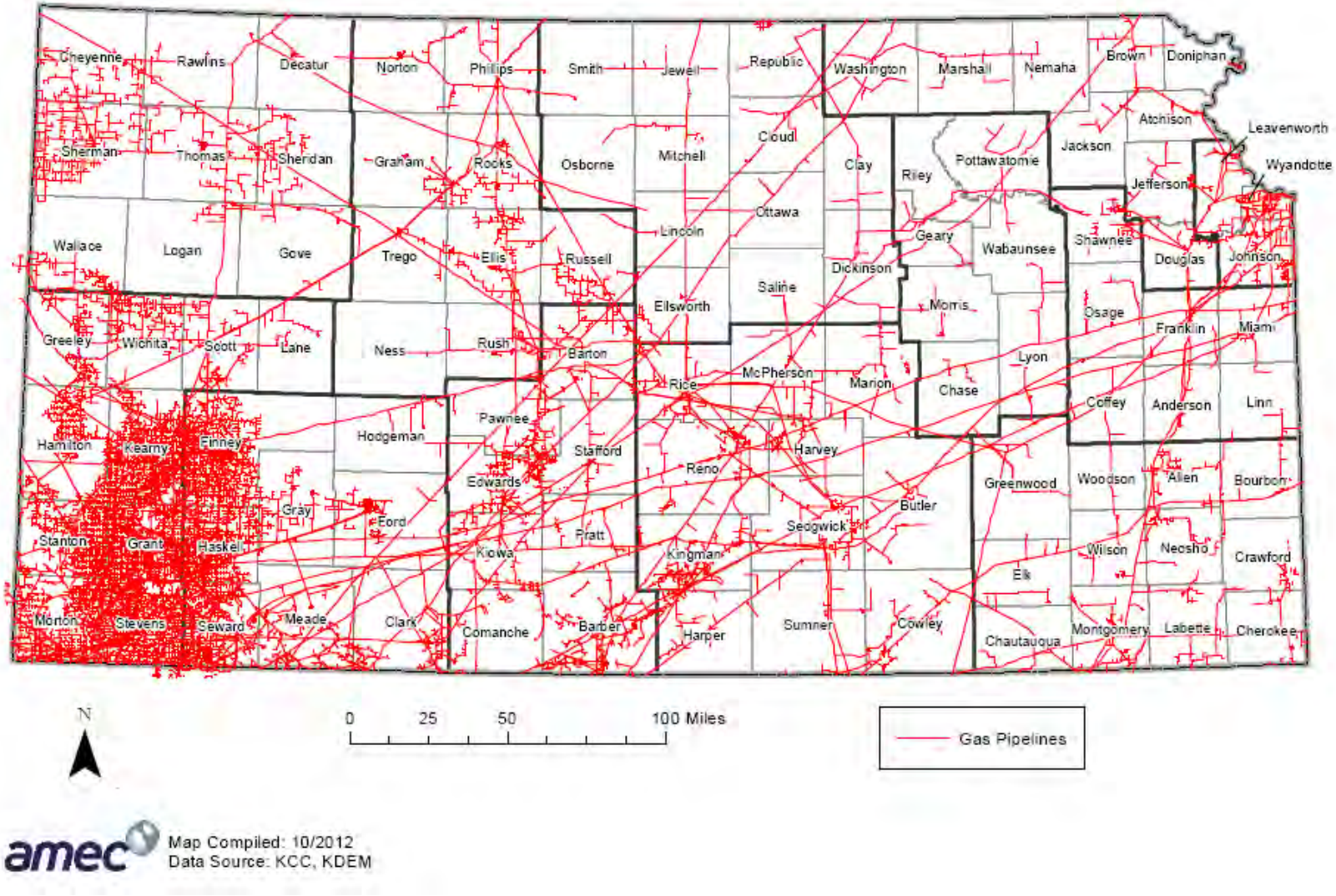
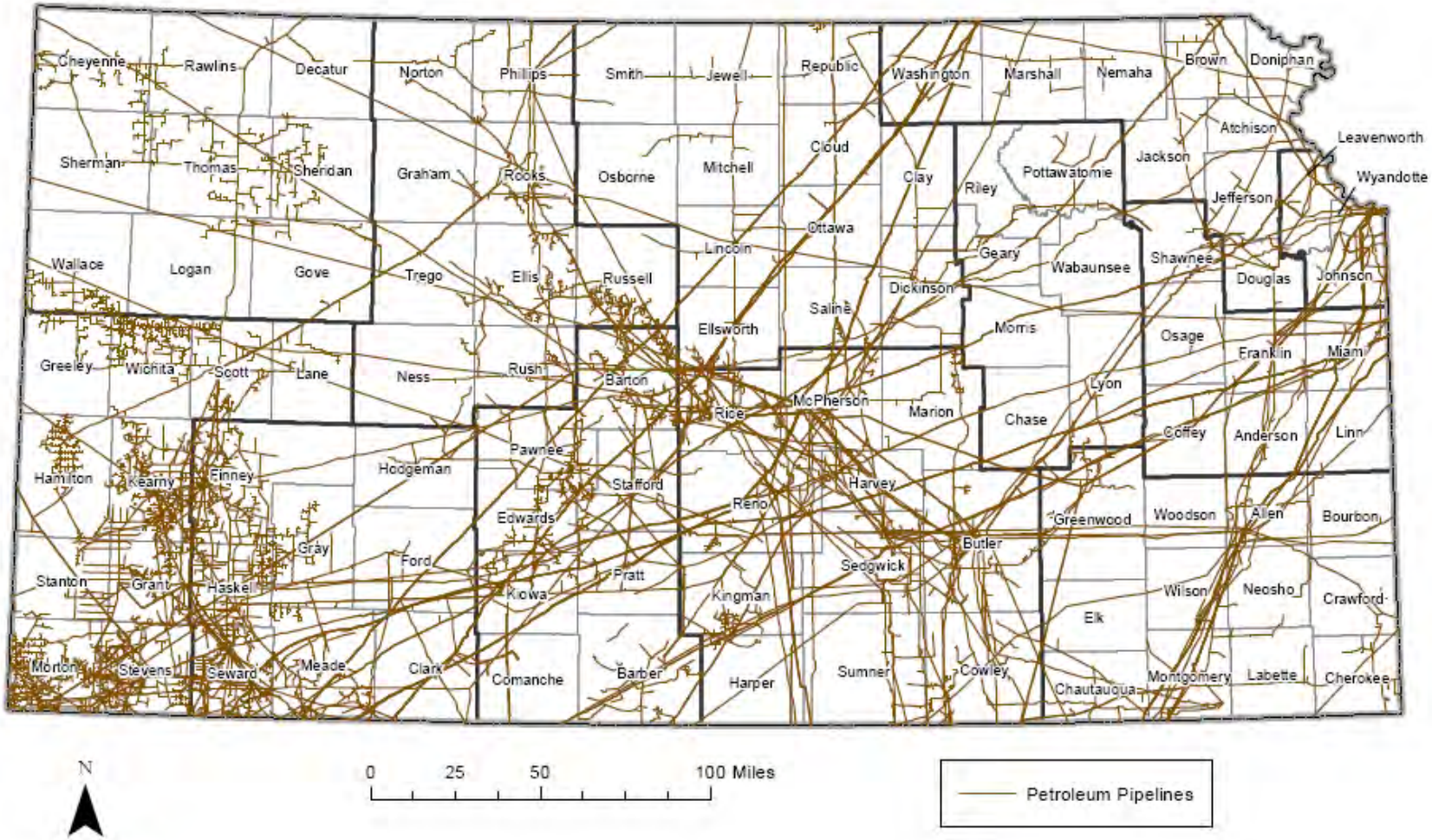


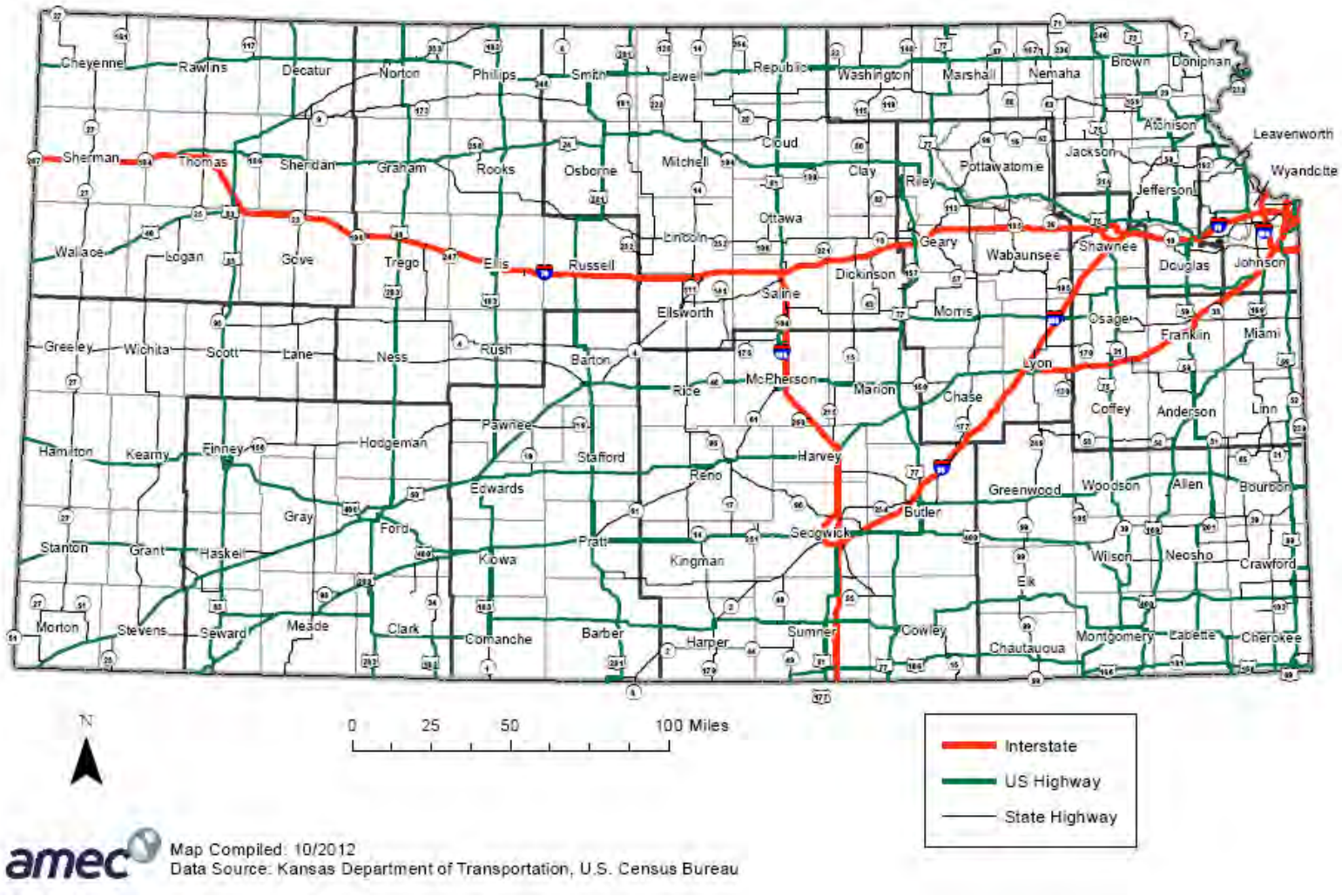
Figure 3.79. Kansas Petroleum Pipelines



Transportation

Figure 3.80 illustrates the size, location and complexity of Kansas transportation infrastructure.

Figure 3.80. Kansas Transportation Routes



Previous Occurrences

When viewed statewide, hazardous materials accidents are frequent events. Annualized statistics from the Kansas Division of Emergency Management, Technological Hazards Section in **Table 3.93** indicate the number of statewide incidents at the primary locations of fixed facility, motor carrier, pipeline and rail during the 10-year period of 2003-2012. The largest number of incidents occurred at fixed facilities during this timeframe. **Table 3.98** in the State Estimate of Potential Losses Section shows the number of all incidents by Kansas county during the 2003-2012 timeframe.

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

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

Table 3.93. Primary Locations of Hazardous Materials Incidents, 2003-2012

Year	Fixed Facility	Motor Carrier	Pipeline	Rail
2003	323	69	61	2
2004	597	35	47	6
2005	399	29	26	10
2006	248	31	24	11
2007	267	21	26	6
2008	200	47	21	5
2009	242	56	22	19
2010	217	64	20	18
2011	173	31	29	12
2012	165	38	20	19
Total	**2,831**	**421**	**296**	**108**
10-year average	**283.1**	**42.1**	**29.6**	**10.8**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Table 3.94 shows that the major cause of hazardous material incidents in Kansas was equipment failure for incidents from 2003-2012.

Table 3.94. Causes of Hazardous Materials Incidents in Kansas, 2003-2012

Year	Explosion	Fire	Spill	Equipment Failure	Operator Error	Natural	Dumping	Other
2003	6	14	194	191	29	6	2	51
2004	5	10	58	355	31	2	1	315
2005	1	5	49	181	21	2	6	0
2006	0	3	46	214	18	1	3	89
2007	1	6	41	238	13	3	0	94
2008	3	7	59	168	27	9	1	110
2009	1	7	142	207	25	14	4	112
2010	2	7	234	120	20	2	2	105
2011	1	6	154	91	10	3	2	21
2012	1	8	153	69	23	1	3	94
Total	**21**	**73**	**1130**	**1834**	**217**	**43**	**24**	**991**
10-year Average	**2.1**	**7.3**	**113**	**183.4**	**21.7**	**4.3**	**2.4**	**99.1**

Source: Kansas Division of Emergency Management, Technological Hazards Section

Managing the Risk: 2011 Kansas Commission on Emergency Planning and Response Annual Report, shows the number of hazardous material releases reported to all three Kansas agencies of Kansas Division of Emergency Management (KDEM), the Kansas Department of Health and Environment (KDHE) and the Kansas Corporation Commission (KCC). The 2011 Annual Report can be viewed at http://www.kansastag.gov/advhtml_doc_upload/2011%20managing%20the%20risk.pdf

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

Reports from the U.S. Department of Transportation's Pipeline & Hazardous Materials Safety Administration's provides detail and incident history for the pipeline systems in the State of Kansas between 2001 and 2012. Significant incidents are those incidents reported by pipeline operators with any of the following conditions met: 1) fatality or injury requiring in-patient hospitalization; 2) $50,000 or more in total costs, measured in 1984 dollars; 3) highly volatile liquid releases of five barrels or more or other liquid releases of 50 barrels or more; 4) liquid releases resulting in an unintentional fire or explosion. According to these reports, there were 147 pipeline incidents that caused four fatalities, 24 injuries and $69.5 million in damages over the 12 year period (2001-2012). **Table 3.95** gives the incident details by Mitigation Planning Region and only the specific counties that incidents occurred in. On average, Kansas experienced 12 incidents, less than one fatality, two injuries and $5.7 million in damages each year.

Table 3.95. Details of Kansas Pipeline Incidents by Mitigation Planning Region and County, 2001-2012

County	Total Natural Gas Transmission Incidents	Total Natural Gas Distribution Incidents	Total Hazardous Liquid Incidents	Total Fatalities	Total Injuries	Total Damage	Gross Barrels Lost	Total Barrels Recovered
Mitigation Planning Region A								
Cheyenne	0	1	0	0	0	$136,332	0	0
Decatur	0	0	0	0	0	0	0	0
Gove	0	0	0	0	0	0	0	0
Logan	0	0	0	0	0	0	0	0
Rawlins	0	0	0	0	0	0	0	0
Sheridan	0	0	0	0	0	0	0	0
Sherman	0	0	0	0	0	0	0	0
Thomas	0	0	0	0	0	0	0	0
Wallace	0	0	0	0	0	0	0	0
Decatur	0	0	0	0	0	0	0	0
Gove	0	0	0	0	0	0	0	0
Subtotal	0	1	0	0	0	$136,332	0	0
Mitigation Planning Region B								
Ellis	0	0	0	0	0	0	0	0
Graham	0	0	0	0	0	0	0	0
Ness	0	0	0	0	0	0	0	0
Norton	0	0	0	0	0	0	0	0
Phillips	0	0	0	0	0	0	0	0
Rooks	0	0	4	0	0	$246,747	1,700	241
Rush	0	0	0	0	0	0	0	0
Russell	0	0	0	0	0	0	0	0
Trego	0	0	0	0	0	0	0	0
Subtotal	0	0	4	0	0	$246,747	1,700	241
Mitigation Planning Region C								
Grant	0	1	0	0	0	$71,563	0	0
Greeley	0	0	0	0	0	0	0	0
Hamilton	0	0	0	0	0	0	0	0
Kearny	0	0	0	0	0	0	0	0
Lane	0	0	0	0	0	0	0	0
Morton	0	0	1	0	0	$1,578	58	25
Scott	0	0	0	0	0	0	0	0
Stanton	0	0	0	0	0	0	0	0
Stevens	0	0	1	0	0	$19,349	70	70
Wichita	0	0	0	0	0	0	0	0
Subtotal	0	1	2	0	0	$92,490	128	95
Mitigation Planning Region D								
Clark	0	0	1	0	0	$1,591,000	6,000	6,000
Finney	0	0	0	0	0	0	0	0

County	Total Natural Gas Transmission Incidents	Total Natural Gas Distribution Incidents	Total Hazardous Liquid Incidents	Total Fatalities	Total Injuries	Total Damage	Gross Barrels Lost	Total Barrels Recovered
Ford	0	0	0	0	0	0	0	0
Gray	0	0	0	0	0	0	0	0
Haskell	1	0	0	0	4	$182,500	0	0
Hodgeman	0	0	0	0	0	0	0	0
Meade	0	1	0	0	0	$148,431	0	0
Seward	0	0	0	0	0	0	0	0
Subtotal	1	1	1	0	4	$1,921,931	6,000	6,000
Mitigation Planning Region E								
Barber	0	0	0	0	0	0	0	0
Barton	0	0	0	0	0	0	0	0
Comanche	0	0	2	0	0	$483,046	11	11
Edwards								
Kiowa	0	1	1	0	0	$327,274	3,415	3,415
Pawnee	0	0	0	0	0	0	0	0
Pratt	0	0	0	0	0	0	0	0
Stafford	0	0	3	0	0	$26,116	473	351
Subtotal	0	1	6	0	0	$836,436	3,899	3,777
Mitigation Planning Region F								
Clay	0	0	1	0	2	$821,125	4,513	4,513
Cloud	0	2	2	0	0	$1,029,847	270	270
Dickinson	0	0	2	0	0	$616,534	1,684	1,674
Ellsworth	0	1	0	0	1	$1,859,151	0	0
Jewell	0	0	0	0	0	0	0	0
Lincoln	0	0	0	0	0	0	0	0
Mitchell	0	0	0	0	0	0	0	0
Osborne	0	0	0	0	0	0	0	0
Ottawa	0	0	0	0	0	0	0	0
Republic	0	0	0	0	0	0	0	0
Saline	1	0	0	1	0	$916,922	0	0
Smith	0	0	0	0	0	0	0	0
Subtotal	1	3	5	1	3	$5,243,579	6,467	6,457
Mitigation Planning Region G								
Butler	0	2	16	0	0	$3,504,167	5,949	1,912
Cowley	0	0	1	0	0	$1,145,067	1,174	94
Harper	1	0	0	0	3	$615,777	0	0
Harvey	0	1	1	0	0	$140,211	12	12
Kingman	0	2	1	0	0	$1,367,174	4,858	4,858
Marion	0	1	0	0	0	$135,297	0	0
McPherson	0	0	7	0	0	$469,940	59	57
Reno	0	4	6	0	0	$6,440,922	201	71
Rice	0	2	3	0	2	$146,948	790	450
Sedgwick	5	1	2	0	5	$1,173,760	261	16
Sumner	0	0	0	0	0	0	0	0

County	Total Natural Gas Transmission Incidents	Total Natural Gas Distribution Incidents	Total Hazardous Liquid Incidents	Total Fatalities	Total Injuries	Total Damage	Gross Barrels Lost	Total Barrels Recovered
Subtotal	6	13	37	0	10	$15,139,263	13,304	7,470
Mitigation Planning Region H								
Allen	0	1	2	0	0	$1,430,431	845	628
Bourbon	0	0	0	0	0	0	0	0
Chautauqua	0	1	0	0	0	$276,360	0	0
Cherokee	0	0	0	0	0	0	0	0
Crawford	1	0	0	0	0	$99,064	0	0
Elk	0	0	0	0	0	0	0	0
Greenwood	0	0	1	0	0	$6,900	142	2
Labette	0	1	0	1	0	$396,797	0	0
Montgomery	0	0	45	0	0	$7,335,410	3,501	2,329
Neosho	0	1	0	0	1	$113,319	0	0
Wilson	1	0	0	0	1	$1,493	0	0
Woodson	0	0	0	0	0	0	0	0
Subtotal	2	4	8	1	2	$9,659,774	4,488	2,959
Mitigation Planning Region I								
Chase	0	0	0	0	0	0	0	0
Geary	0	0	0	0	0	0	0	0
Lyon	0	0	0	0	0	0	0	0
Morris	0	0	1	0	0	$121,472	5	5
Pottawatomie	0	0	0	0	0	0	0	0
Riley	0	0	0	0	0	0	0	0
Wabaunsee	0	0	0	0	0	0	0	0
Subtotal	0	0	1	0	0	$121,472	5	5
Mitigation Planning Region J								
Anderson	0	2	0	0	0	$391,390	0	0
Coffey	0	1	0	0	0	$995,348	0	0
Franklin	0	0	1	0	0	$693,181	1,901	1,660
Linn	0	0	1	0	0	$329,750	10	10
Miami	0	0	2	0	0	$228,850	1,719	1,718
Osage	0	0	0	0	0	0	0	0
Shawnee	2	0	0	1	0	$536,284	0	0
Subtotal	2	3	4	1	0	$3,174,803	3,630	3,388
Mitigation Planning Region K								
Atchison	0	0	0	0	0	0	0	0
Brown	0	0	0	0	0	0	0	0
Doniphan	0	0	1	0	0	$333,500	8	0
Douglas	0	1	2	0	0	$964,011	706	406
Jackson	0	0	0	0	0	0	0	0
Jefferson	0	1	0	0	0	$1,148,554	0	0
Marshall	0	0	0	0	0	0	0	0

County	Total Natural Gas Transmission Incidents	Total Natural Gas Distribution Incidents	Total Hazardous Liquid Incidents	Total Fatalities	Total Injuries	Total Damage	Gross Barrels Lost	Total Barrels Recovered
Nemaha	0	0	1	0	0	$339,300	15	0
Washington	0	2	2	0	0	$1,140,200	611	575
Subtotal	0	4	6	0	0	$3,925,565	1,340	981
Mitigation Planning Region L								
Johnson	3	1	1	0	0	$1,897,704	258	196
Leavenworth	1	0	0	0	1	$80,160	0	0
Wyandotte	2	0	7	1	3	$14,724,798	6,800	5,089
Subtotal	6	1	8	1	4	$16,702,662	7,058	5,285
Undisclosed Location	1	1	13	0	1	$12,397,468	9,541	8,734
State-wide Total	19	33	95	4	24	$69,598,522	57,560	45,392

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

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

Notable Hazardous Materials Incidents

- **August 2, 2011:** Multiple explosions occurred at Global Propane Energy in Rose Hill, Butler County. The blast injured 3 workers, one of which later died of his injuries and destroyed 4 houses and a commercial building. The explosion started when a worker was filling a propane cylinder and a coupling broke. Flames shot the 33-pound cylinders up 400 feet in the air. It is unknown what ignited the propane.
- **August 1, 2011:** In Cedar Vale, Chautauqua County officials noticed an unknown film layer on one of the city‘s sewer lagoons, accompanied by an odd odor. While trenching a sewer line to identify the problem it filled with liquid gasoline. It was determined that a leaking above ground storage tank containing gasoline caused fumes and vapors to enter the sewer system. These vapors reached explosive levels which prompted the evacuation of approximately 150 residents. One resident was hospitalized from fume exposure.
- **July 17, 2007:** Hundreds of people were evacuated from Valley Center near Wichita, Kansas after an explosion and subsequent fire at a Barton Solvent plant. Authorities determined that 36 storage tanks containing approximately 660,000 pounds of chemicals, including hydrocarbons, ketones and alcohol, went up in smoke. The fire was so intense that firefighters could do little to extinguish the flames; instead they mainly kept the blaze from spreading to nearby buildings. The Fire Marshal for the Wichita Fire Department said, "The plume looks like it's going up into the air and dissipating." Miraculously, no one at the plant or its surroundings was injured in the explosion, although 10 people were admitted to a Wichita hospital as a precautionary measure.
- **June 26-30, 2007:** In Montgomery County, heavy rains caused the Verdigris River to overflow its banks, top protective levees, and flood the town of Coffeyville. As floodwaters

rose, officials at the Coffeyville Resources refinery and nitrogen fertilizer plant ordered the facilities shut down and 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 on the refinery to overflow. 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.

- **September 8, 2003:** A train derailment in Barber County required the precautionary evacuation of people within a one-mile area. The train carried a hazardous material which was not identified and 6,000 gallons of diesel fuel spilled from the locomotive, but was contained.
- **February 2002:** In downtown Sterling, Rice County, a fire broke out in a business producing chemicals mostly used in oil fields.
- **August 30, 2001:** A train carrying hazardous materials derailed near Mulvane, Sumner County requiring the evacuation of more than 100 people.
- **January 2001:** An apparent leak in the baggy gas storage field resulted in explosions that killed two people and destroyed several buildings in Hutchinson, Reno County. This event continued for weeks.
- **July 7 and July 14, 2000:** The Farmland Industries facility in Lawrence, Douglas County, produced ammonia and urea ammonium nitrate had a minor fire on July 7th and a second fire and explosion on July 14th. The plant closed down after the fires.
- **May 13, 2000:** There was a 49 traincar derailment near Arlington, Reno County, carrying hazardous materials and the wreck punctured the neighboring Co-Op's fuel tanks causing a fire.
- **June 8, 1998:** A massive explosion took place at the DeBruce Grain Company in Haysville. Seven people died and eleven were injured. Harvey and Sedgwick Counties received federal emergency declarations (FEMA-3126-EM) related to the event.

Probability of Future Hazard Events

The KHMT determined that there is a "Highly Likely" probability that a hazardous materials incident will occur in any given year. People, livestock and vegetation in close proximity to facilities fabricating, processing and storing as well as those where hazardous waste is treated, stored and disposed of are most at risk for hazardous materials incidents. Additionally, localities along transportation corridors that carry these materials to their final destinations are at risk. Populations downstream, downwind and downhill of a released substance are particularly vulnerable. Depending on the characteristics of the substance released, a larger area may be in damage from explosion, absorption, injection or inhalation. Occupants of areas previously contaminated by a persistent material may also be harmed either directly or through consumption of contaminated food and water.

According to incidents reported to Kansas Division of Emergency Management, Technological Hazards Section data in **Table 3.93**, it shows the hazardous materials incidents in Kansas from

2003-2012. There is an average of 283 incidents from a fixed facility, 42 incidents from a motor carrier, 30 incidents from pipelines and 11 incidents on railways per year.

State Vulnerability Analysis

According to the Kansas Division of Emergency Management, Technological Hazards Section there are over 660 facilities subject to the Risk Management Plan requirements in Kansas as of December 2012. The top ranked facilities are listed in **Table 3.96** and are ranked based on population affected according to the Risk Management Plan's Worst Case Scenario. Sedgwick County has the most worst case scenario facilities (7) followed by Wyandotte County (4). Information concerning these facilities is limited in this plan because of security and liability issues.

Table 3.96. Top Ranked Worst Case Scenario Facilities in Kansas, 2012

Mitigation Planning Region	County	Type of Facility
J	Coffey	Energy Plant
G	Sedgwick	Chemical Plant
L	Wyandotte	Chemical Production and Processing
G	Sedgwick	Water Treatment
L	Wyandotte	Specialty Gas
J	Shawnee	Water Treatment
K	Doniphan	Chemical Production
H	Cherokee	Chemical Production and Processing
H	Montgomery	Refinery
L	Wyandotte	Water Treatment
F	Saline	Water Treatment
L	Wyandotte	Refrigerated Warehouse
G	Butler	Refinery
G	Sedgwick	Ethanol Plant
D	Ford	Fertilizer Manufacturing
D	Finney	Ethanol Plant
D	Ford	Beef Packing
I	Lyon	Beef Packing
D	Ford	Meat Processing, Storage & Distribution
F	Saline	Fertilizer Storage and Blending
L	Johnson	Refrigerated Warehouse & Distribution
G	McPherson	Refinery
D	Seward	Water Treatment
G	Sedgwick	Chemical Distribution
G	Reno	Food Processing
G	Sedgwick	Refrigerated Warehouse
G	McPherson	Fertilizer Manufacturing
I	Lyon	Water Treatment
H	Montgomery	Fertilizer Manufacturing
I	Lyon	Fertilizer Storage & Distribution
J	Shawnee	Food Manufacturing
G	McPherson	Storage Terminal
G	Cowley	Beef Packing
H	Crawford	Water Treatment
D	Finney	Fertilizer Manufacturing
L	Johnson	Food Manufacturing

Mitigation Planning Region	County	Type of Facility
L	Leavenworth	Water Treatment
G	Sedgwick	Production of Dairy Products
K	Atchison	Fertilizer Storage & Distribution
H	Montgomery	Fertilizer Manufacturing
G	Sedgwick	Meat Processing

Source: Kansas Division of Emergency Management, Technological Hazards Section

State Estimates of Potential Losses

In estimating potential losses, the most significant loss potential with hazardous materials incidents concerns people. Special populations are particularly vulnerable to the impacts of a hazardous materials incident because of the inherent potential difficulties involved in the evacuation. **Table 3.97** shows the number of special population facilities in each county that is located within ½ mile of a chemical facility. The locations of colleges, educational and correctional institution facilities is from the Kansas Data Access & Support Center (DASC), health facilities is from FEMA's HAZUS, aging facilities is from KDEM and child care facilities is from KDHE. A comparison was completed with the latitude and longitude of the facilities with the hazardous chemical facilities in Kansas.

Table 3.97. Number of Special Population Facilities Within ½ Mile of a Chemical Facility

County	Health Facilities	Colleges	Educational Facilities	Aging Facilities	Child Care	Correctional Institutions
Mitigation Planning Region A						
Cheyenne	0	0	4	1	6	1
Decatur	1	0	2	2	11	1
Gove	0	0	6	1	9	0
Logan	0	0	5	0	8	0
Rawlins	1	0	2	1	7	1
Sheridan	1	0	2	1	7	1
Sherman	0	0	4	0	10	1
Thomas	2	0	5	2	28	1
Wallace	0	0	4	0	3	1
Total	5	0	34	8	89	7
Mitigation Planning Region B						
Ellis	0	2	9	2	50	1
Graham	0	0	0	0	0	0
Ness	1	0	6	1	10	0
Norton	1	0	5	1	18	1
Phillips	1	0	9	4	30	0
Rooks	1	0	7	2	24	2
Rush	1	0	6	2	8	0
Russell	1	0	6	5	19	2
Trego	0	0	1	1	5	1
Total	6	2	49	18	164	7
Mitigation Planning Region C						
Grant	2	0	6	3	24	1
Greeley	0	0	2	2	4	1
Hamilton	1	0	2	2	6	1
Kearny	0	0	3	1	6	0
Lane	1	0	4	2	4	1

County	Health Facilities	Colleges	Educational Facilities	Aging Facilities	Child Care	Correctional Institutions
Morton	1	0	4	1	5	1
Scott	1	0	3	1	14	1
Stanton	1	0	3	2	9	1
Stevens	1	0	5	1	13	1
Wichita	1	0	3	2	6	0
Total	9	0	35	17	91	8
Mitigation Planning Region D						
Clark	2	0	6	3	4	1
Finney	1	1	24	6	121	2
Ford	2	0	14	6	61	1
Gray	0	0	9	1	6	0
Haskell	0	0	3	0	6	1
Hodgeman	0	0	3	0	6	1
Meade	1	0	6	2	12	1
Seward	0	0	12	0	27	1
Total	6	1	77	18	243	8
Mitigation Planning Region E						
Barber	1	0	4	1	14	1
Barton	1	0	14	6	72	1
Comanche	1	0	3	1	8	0
Edwards	1	0	2	1	3	1
Kiowa	1	1	8	2	5	1
Pawnee	0	0	8	2	18	1
Pratt	0	0	5	2	25	1
Stafford	1	0	2	1	3	0
Total	6	1	46	16	148	6
Mitigation Planning Region F						
Clay	0	0	3	1	27	1
Cloud	2	1	3	3	39	1
Dickinson	2	0	8	5	43	2
Ellsworth	0	0	5	2	15	1
Jewell	1	0	6	1	7	1
Lincoln	1	0	2	1	18	1
Mitchell	1	0	7	0	19	1
Osborne	1	0	6	3	9	1
Ottawa	1	0	4	2	19	1
Republic	1	0	7	4	15	1
Saline	2	2	5	13	109	2
Smith	0	0	5	4	26	1
Total	12	3	61	39	346	14
Mitigation Planning Region G						
Butler	1	1	29	3	61	2
Cowley	0	1	11	2	42	2
Harper	4	0	5	2	23	1
Harvey	1	1	10	4	38	1
Kingman	0	0	7	1	18	1
Marion	1	0	8	3	39	1
McPherson	2	2	17	8	53	2
Reno	2	0	20	7	58	2
Rice	1	0	13	2	28	1
Sedgwick	7	12	68	25	342	6
Sumner	1	0	16	11	55	1
Total	20	17	204	68	757	20

County	Health Facilities	Colleges	Educational Facilities	Aging Facilities	Child Care	Correctional Institutions
Mitigation Planning Region H						
Allen	1	0	11	2	48	1
Bourbon	0	1	4	3	27	1
Chautauqua	1	0	4	2	4	1
Cherokee	1	0	7	3	33	2
Crawford	1	0	14	5	35	1
Elk	0	0	1	2	2	1
Greenwood	1	0	5	3	14	1
Labette	2	1	10	4	53	3
Montgomery	0	2	15	7	71	3
Neosho	0	1	10	3	66	1
Wilson	0	0	5	2	14	0
Woodson	0	0	2	1	3	1
Total	7	5	88	37	370	16
Mitigation Planning Region I						
Chase	0	0	2	0	4	1
Geary	0	0	5	0	26	2
Lyon	0	1	8	3	43	1
Morris	0	0	2	0	6	0
Pottawatomie	0	1	3	2	17	1
Riley	0	1	8	0	32	1
Wabaunsee	0	0	5	0	15	1
Total	0	3	33	5	143	7
Mitigation Planning Region J						
Anderson	1	1	6	3	6	0
Coffey	1	0	7	0	18	1
Franklin	0	0	2	1	16	1
Linn	0	0	3	1	5	0
Miami	2	0	3	2	29	1
Osage	0	0	4	2	20	0
Shawnee	4	6	21	19	130	2
Total	8	7	46	28	224	5
Mitigation Planning Region K						
Atchison	0	0	4	1	20	1
Brown	1	0	5	4	19	2
Doniphan	0	1	7	0	12	1
Douglas	1	1	8	9	81	1
Jackson	0	0	3	4	9	0
Jefferson	1	0	6	4	13	0
Marshall	1	0	8	3	18	1
Nemaha	2	0	8	6	20	1
Washington	2	0	4	0	13	0
Total	8	2	53	31	205	7
Mitigation Planning Region L						
Johnson	4	14	53	37	340	5
Leavenworth	1	1	12	2	31	2
Wyandotte	2	2	33	3	102	5
Total	7	17	98	42	473	12
Statewide Total	**94**	**58**	**824**	**327**	**3,253**	**117**

Source: DASC, HAZUS, KDHE, and KDEM

Table 3.98 lists the number of hazardous materials incidents, injuries, fatalities and people evacuated from the public and facilities by county in Kansas over the 10-year period of 2003-2012. There were a total of 4,034 incidents reported to KDEM with the Mitigation Planning Regions H and G reporting the highest number of incidents. It also shows that 57 percent of Kansas counties have experienced hazardous materials incidents with injuries or fatalities and 46 percent of Kansas counties have experienced evacuation.

Table 3.98. Reported Number of Hazardous Materials incidents, Injuries, Fatalities and People Evacuated by County, 2003-2012

Incident County	Incidents	Injuries	Fatalities	People Evacuated
Mitigation Planning Region A				
Cheyenne	9	1	2	0
Decatur	2	1	0	30
Gove	15	4	0	0
Logan	10	1	0	0
Rawlins	5	0	1	0
Sheridan	4	2	0	0
Sherman	12	0	0	0
Thomas	7	0	0	0
Wallace	1	0	0	0
Subtotal	**65**	**9**	**3**	**30**
Mitigation Planning Region B				
Ellis	23	5	0	0
Graham	3	0	0	0
Ness	1	0	0	0
Phillips	10	0	0	91
Rooks	3	0	0	0
Rush	2	0	0	0
Russell	18	1	0	10
Trego	6	1	0	0
Subtotal	**66**	**7**	**0**	**101**
Mitigation Planning Region C				
Grant	10	4	0	16
Greeley	3	0	0	20
Hamilton	1	0	0	0
Kearny	5	1	1	50
Lane	2	0	0	0
Morton	1	0	0	0
Scott	3	0	0	0
Stanton	2	2	0	0
Stevens	5	0	0	1
Subtotal	**32**	**7**	**1**	**87**
Mitigation Planning Region D				
Clark	3	0	0	0
Finney	53	2	2	164
Ford	73	1	0	180
Gray	6	0	0	0
Haskell	20	2	1	0
Hodgeman	1	0	0	0
Meade	7	0	0	0
Seward	32	1	0	0
Subtotal	**195**	**6**	**3**	**344**

Incident County	Incidents	Injuries	Fatalities	People Evacuated
Mitigation Planning Region E				
Barber	5	0	0	2
Barton	14	0	0	0
Comanche	4	0	0	0
Edwards	1	0	0	0
Kiowa	33	0	0	0
Pawnee	3	10	5	20
Pratt	30	7	3	260
Stafford	14	3	0	20
Subtotal	**104**	**20**	**8**	**302**
Mitigation Planning Region F				
Clay	12	0	0	0
Cloud	4	0	0	0
Dickinson	33	3	0	0
Ellsworth	15	1	0	251
Jewell	2	0	0	0
Lincoln	10	1	0	4
Mitchell	4	1	0	4
Osborne	3	0	0	3
Ottawa	14	5	0	13
Republic	2	0	0	0
Saline	38	6	0	1,205
Smith	3	0	0	0
Subtotal	**140**	**17**	**0**	**1,480**
Mitigation Planning Region G				
Butler	605	10	4	32
Cowley	40	5	0	104
Harper	24	7	0	85
Harvey	15	1	1	0
Kingman	10	0	0	0
Marion	15	0	0	2
McPherson	206	0	0	0
Reno	64	1	0	58
Rice	8	1	0	0
Sedgwick	108	7	2	460
Sumner	23	3	0	325
Subtotal	**1,118**	**35**	**7**	**1,066**
Mitigation Planning Region H				
Allen	22	2	1	1
Bourbon	19	4	3	0
Chautauqua	8	0	0	0
Cherokee	11	0	0	76
Crawford	8	0	0	16
Elk	2	0	0	0
Greenwood	4	1	0	0
Labette	10	0	0	25
Montgomery	1,461	12	0	161
Neosho	14	1	0	20
Wilson	18	9	0	100
Woodson	4	1	0	1
Subtotal	**1,581**	**30**	**4**	**400**

Incident County	Incidents	Injuries	Fatalities	People Evacuated
Mitigation Planning Region I				
Chase	13	3	0	65
Geary	7	0	0	990
Lyon	26	3	0	0
Morris	2	1	0	0
Pottawatomie	7	0	0	0
Riley	5	4	0	0
Wabaunsee	9	1	0	0
Subtotal	**69**	**14**	**0**	**1,055**
Mitigation Planning Region J				
Anderson	11	3	0	2
Coffey	11	2	0	0
Franklin	18	5	0	2
Linn	7	0	0	9
Miami	10	0	0	0
Osage	16	0	0	2
Shawnee	103	4	0	147
Subtotal	**176**	**14**	**0**	**162**
Mitigation Planning Region K				
Atchison	16	2	0	0
Brown	21	2	1	0
Doniphan	5	2	1	0
Douglas	27	1	1	4
Jackson	9	0	0	28
Jefferson	13	0	0	12
Marshall	10	1	2	10
Nemaha	8	1	0	0
Washington	18	2	0	0
Subtotal	**127**	**11**	**5**	**54**
Mitigation Planning Region L				
Johnson	96	4	0	81
Leavenworth	50	49	3	152
Wyandotte	215	6	0	87
Subtotal	**361**	**59**	**3**	**320**
Statewide Total	**4,034**	**229**	**34**	**5,401**

Source: Kansas Division of Emergency Management, Technological Hazards Section

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

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

As mentioned, it is difficult to determine the potential losses to existing development because of the variable nature of a hazardous materials spill. For example, a spill of a toxic airborne chemical in a populated area could have great potential for loss of life and by contrast, the spill

of a very small amount of a chemical in a rural agricultural area would be much less costly and possible limited to remediation of soil.

For discussion purposes, the materials needed for a spill at a fixed facility at an easily remediated area are listed below in **Table 3.99**. The costs for the cleanup are estimated from the current State of Kansas Unified HazMat Response Program statewide contract # 35167.

Table 3.99. Potential Cost Estimate for HAZ-MAT Spill Remediation

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

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

Development in Hazard Prone Areas

As the infrastructure and population of Kansas increases in certain areas of the State, along with the number and type of hazardous chemicals stored and transported through the State, the amount of potential losses will increase.

Hazard Impact Overview

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

The threat of hazardous chemical release is analyzed in KDEM‘s THIRA. 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.

Table 3.100 provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.100. EMAP Consequences Analysis: Hazardous Materials

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

3.3.11. Land Subsidence

Calculated Priority Risk Index	Planning Significance
2.65	Moderate

Description/Location

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

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

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

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

Some isolated incidents of subsidence have been associated with high volume pumping of water wells. This type of subsidence is not widespread in Kansas and can usually be addressed on a case-by-case basis.

Solution Mining/Shaft Mining Subsidence

The subsidence risk is highest in the southeast corner of the State, where subsidence events are primarily due to coal, lead, and zinc mining. The risk is considered to be somewhat less in the large central area of the State, where subsidence is often due to dissolution in subsurface salt layers. The lowest relative risk of subsidence is in the western part of the State and in areas along the Nebraska border.

Overall, over 100,000 acres in 41 counties have been affected by coal mining in Kansas, including 1,142 acres of mining-related subsidence under towns and roads. The most important coal mining in the State was in southeast Kansas where coal beds were extensively mined in portions of Cherokee, Crawford, Osage, Franklin, Linn, and Bourbon Counties. In many locations in southeastern Kansas, the location and extent of abandoned mine passages are not known.

Subsidence from abandoned lead-zinc mines is also a problem in Cherokee County, **Figure 3.81** (in Galena in particular).

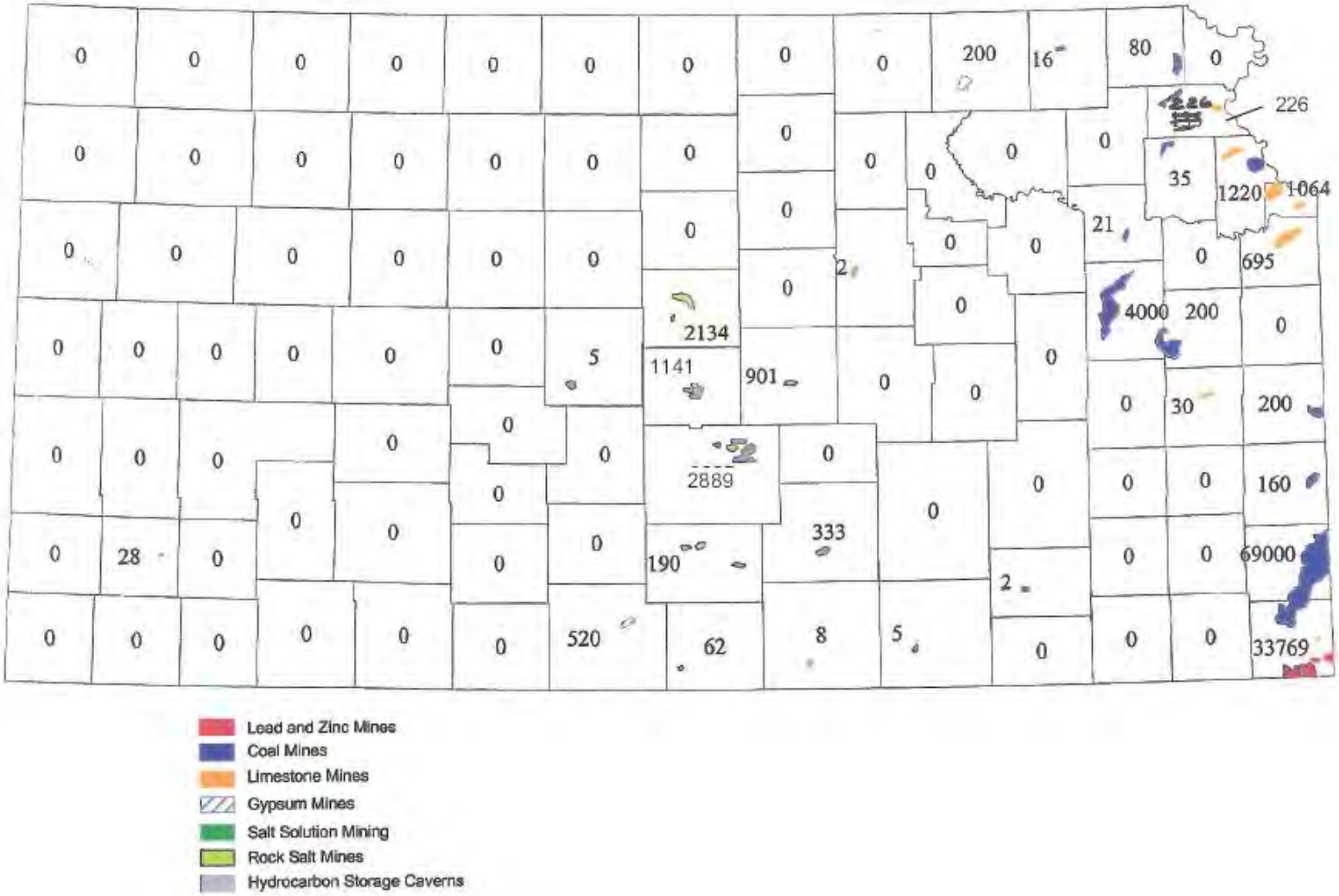
Figure 3.81. Road Subsidence in Cherokee County

Source: Kansas Department of Health and Environment Abandoned Mine Land (AML) Program, http://www.kdheks.gov/mining/emergency.html

Underground limestone mines have contributed to a subsidence problem in the Kansas City metropolitan area. Natural land subsidence from dissolution of salt occurs in Sumner, Sedgwick, Reno, Harvey, Saline and McPherson Counties. Subsidence has also been associated with water withdrawal, predominantly in the western and central parts of the State that overlie the High Plains Aquifer.

The Kansas Department of Health and Environment in 2006 prepared a report on —Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas." The report inventoried subsurface void space from oil and gas exploration and production, natural sources, shaft mining, and solution mining. Since publication of the report, the acres of subsurface void space for Reno, Rice, and Atchison Counties have been corrected as there were errors in the original report. The revised total void space inventory for all sources in the State is 119,136 acres. The distribution of total acres and major cause of void spaces are shown for each county in **Figure 3.82.** Additional information from this report is discussed in the State Vulnerability Analysis Section below.

Figure 3.82. Total Subsurface Void Space by County (in acres) from Mining/Exploration/Storage



Source http://www.engg.ksu.edu/CHSR/outreach/tosnac/sites/docs/04.pdf; corrections made by AMEC.

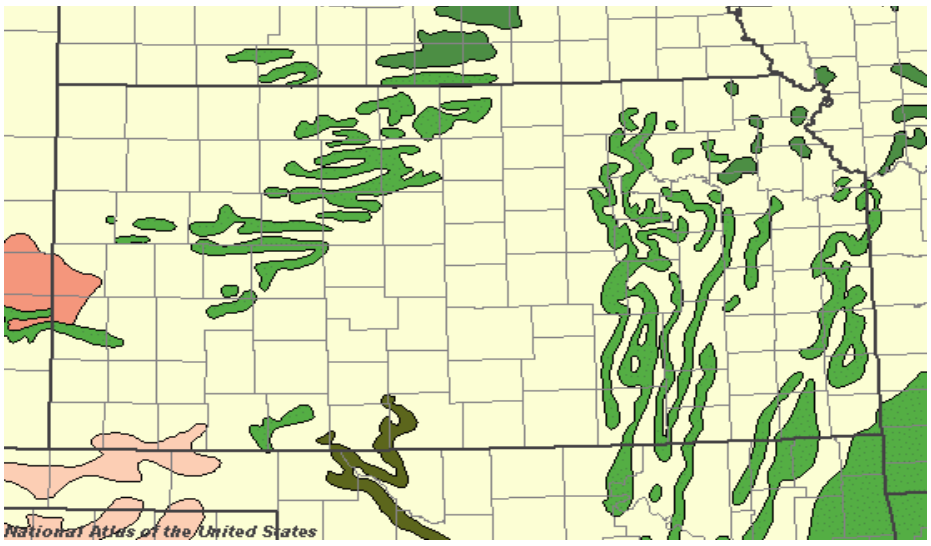
Dissolution of Minerals—"Lost Circulation Zone" and Karst Topography

In addition to the inventory of known subsurface void spaces, there is a large area of the State that has the potential for sinkholes and subsidence that is commonly referred to as the "Lost Circulation Zone". This applies to a large area impacted by dissolution of salt and gypsum. The dissolution of salt and gypsum created a large area of discontinuous solution zones and subsurface subsidence areas that extend along the entire eastern edge of what is called the "Hutchinson Salt Member of the Wellington Formation". This dissolution area extends from north of Salina to the Oklahoma border. The total acres potentially affected are estimated to be approximately 965,000 acres in the following counties: Harvey, Reno, McPherson, Saline, Sumner, and Sedgwick.

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

Figure 3.83 illustrates the location of karst features and features analogous to karst in Kansas. The green areas shown in the map show fissures, tubes, and caves generally less than 1,000 feet long with 50 feet or less vertical extent in gently dipping to flat-lying carbonate rock. Brown areas have similar features in gently dipping to flat lying gypsum beds. Light pink colored areas are features analogous to karst with fissures and voids present to a depth of 250 feet or more in areas of subsidence from piping in thick unconsolidated material. Darker pink areas contain fissures and voids (analogous to karst) to a depth of 50 feet. There are limited documented problems associated with natural limestone subsidence and sinkholes in Kansas. However, eastern Kansas has anthropogenic risk associated with limestone mines.

Figure 3.83. Karst Features in Kansas



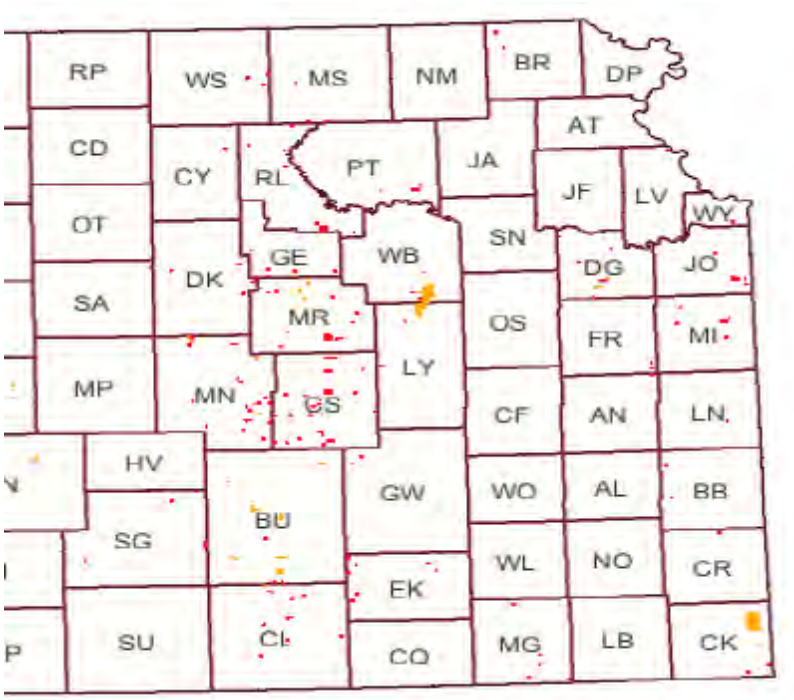
Source: U.S. Geological Survey, mapped by the National Atlas of the United States, www.nationalatlas.gov

With the exception of Grant County, the potential for subsidence as a result of mining is mostly in eastern and southeast Kansas. While the potential for subsidence as a result of dissolution of minerals occurs in central Kansas (–Lost Circulation Zone") and into parts of western Kansas (karst topography).

Previous Occurrences

Figure 3.84 shows one-mile square sections of land in the eastern half of Kansas where sinkhole locations have been documented in literature. Sections in red indicate sinkhole occurrences (yellow indicates springs). Notice that documented previous occurrences of sinkholes are in areas with void space from mines, karst features, and the –ost circulation zone".

Figure 3.84. Sinkholes in Eastern Kansas



Numerous land subsidence events are recorded in Kansas every year. The Kansas Department of Health and Environment's Surface Mining Section is the agency responsible for the reclamation of abandoned coal mines in Kansas under the Surface Mining and Control Reclamation Act of 1977 (P.L. 95-87). Federal funds are available through the office of Surface Mining Reclamation and Enforcement for the reclamation of past mining problems which are hazardous to the health, safety, and general welfare of the public. The Abandoned Mine Land (AML) Program receives about 100 reports a year on coal mine subsidence alone.

Data was obtained from KDHE for the following:

- Lead and Zinc Mines that required filling,
- Coal Subsidence Projects,
- Coal Emergency Program Projects. This Emergency Program provides for the remediation of sites which are an immediate threat to the health and safety of the general public.

From 2004 to October 2012, 129 lead and zinc mine holes were filed for a total of $881,862. All of the lead and zinc mine filling projects occurred in Cherokee County. **Table 3.101** provides the yearly summary:

Table 3.101. Lead and Zinc Mines, Annual Number of Holes and Cost to Fill

Year	Number of Holes	Amount Paid to Fill Holes
2004	20	$110,265
2005	14	$157,376
2006	20	$164,493
2007	16	$108,359
2008	13	$90,581
2009	7	$63,969
2010	22	$89,841
2011	16	$96,897
2012	1	$82
Total	**129**	**$881,862**

Source: KDHE Surface Mining Section

From 1996 to October 2012, $1,806,790 was spent to fill vertical openings in Cherokee and Crawford Counties related to coal subsidence. Of this amount, $1,444,413 was spent in Cherokee County and $362,367 was spent in Crawford County. **Table 3.102** provides the yearly summary.

Table 3.102. Coal Mines-Vertical Openings, Annual Number of Holes and Cost to Fill

Year	Holes Filled	Cost
1996	18	$5,341
1997	59	$89,298
1998	45	$86,652
1999	100	$144,109
2000	35	$56,797
2001	65	$125,197
2002	100	$137,758
2003	36	$78,878
2004	22	$74,410
2005	105	$156,881
2006	64	$123,141
2007	58	$100,020
2008	68	$108,109
2009	106	$178,569
2010	18	$35,186
2011	82	$156,468
2012	51	$149,977
Total	**1,032**	**$1,806,790**

Source: KDHE Surface Mining Section

From 1980 to October 2012, $7,609,662 was spent on 2,609 projects in the Coal Emergency Program. **Table 3.103** provides the yearly summary. **Table 3.104** that follows provides the amounts paid per county during this nearly 33 year period.

Table 3.103. Coal Emergency Program, Annual Cost

Year	Number of Projects	Cost
1980	11	$423,383
1981	23	$232,513
1982	32	$97,546
1983	53	$403,653
1984	49	$73,688
1985	79	$280,404
1986	98	$414,102
1987	70	$326,930
1988	89	$595,254
1989	92	$184,570
1990	97	$122,583
1991	79	$161,883
1992	103	$98,476
1993	123	$281,113
1994	135	$260,349
1995	98	$19,245
1996	69	$51,896
1997	96	$167,492
1998	103	$117,312
1999	102	$132,550
2000	61	$45,705
2001	82	$61,647
2002	78	$288,021
2003	69	$120,184
2004	88	$411,124
2005	69	$148,981
2006	75	$204,694
2007	124	$245,201
2008	82	$455,201
2009	96	$829,315
2010	63	$119,613
2011	69	$133,882
2012	52	$101,153
Total	**2,609**	**$7,609,662**

Source: KDHE Surface Mining Section

Table 3.104. Coal Emergency Fund Expenditures by County, 1980 to Oct. 2012

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

Source: KDHE Surface Mining Section

Other notable Land Subsidence Events

- **2006**: A mine collapse occurred in an alley behind the Green Parrot Bar in downtown Galena, Cherokee County. Subsidence from an abandoned lead and zinc mine took the alley and the 114-year old building with it.
- **2005:** A sinkhole near railroad tracks in the City of Hutchinson, Riley County is about 200 feet across and about 20 feet deep. The sinkhole is on land that was once part of a salt company's evaporation plant. Stabilization efforts have included pouring a cement-sand mixture into its north bank.
- **1998–1999:** Two medical buildings were damaged in Wyandotte County.
- **1965–1966:** Subsidence over abandoned limestone mines in Wyandotte County damaged roads and destroyed houses.
- Two active sinkholes along a short stretch of I-70 in Russell County (Gorham Oil Field) have been pulling down the driving lanes since the highway's construction in the mid-1960s. They are the result of dissolution of a salt bed below the surface. An improperly capped abandoned oil well allowed fresh water to pass through and dissolve the salt. The areas have been regraded at significant cost, and efforts were made to stop the subsidence at one of the sinkholes, but the lanes continue to drop. A nearby overpass (one end of which dropped over six feet since it was built in 1965) was torn down because of the subsidence. To date, this bridge has not been replaced.
- **1959:** A circular pit 300 feet in diameter and 85 feet deep developed in a few hours around a plugged and abandoned salt water disposal well (related to oil drilling) southeast of Hutchinson and required the relocating of railroad tracks.
- Other subsidence events related to salt mining were recorded in 1914 southwest of Hutchinson, in 1952 southeast of Hutchinson, and there again in 1974 and 2005. Another collapse occurred near Ellsworth in 1972.
- **1879**: Natural sinkhole related to the Crooked Creek Fault in March 1879 in Meade County

Probability of Future Hazard Events

Based on historical records, land subsidence events occur in Kansas on an annual basis. This hazard's CPRI probability is "**Highly Likely**" within the calendar year.

State Vulnerability Analysis

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

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

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

The categories are based on the following characteristics:

High Risk:

- Source material very soluble,
- Source material thickness may leave large voids,
- Depth of source material less than 100 feet in depth,
- Mining operations either solution or shaft mine has left a large vertical void space (4-300 feet),
- Mining operations has large vertical shafts or bore holes associated with the mining techniques,
- Mined area has a large void space to pillar ratio,
- Void space in the mine has filled with water,
- Mine floor susceptible to collapse or loading failure,
- Cap rock not competent for long term support,
- Mine pillars susceptible to deterioration and future collapse,
- Mine roof less than 60 feet in thickness,
- Bedrock material comprising the mine roof is not competent material for long-term stability,
- Horizontal or inclined mine shafts with shallow or thin overburden, and
- Areas in the subsurface where support pillars in columns have been mined or removed.

Medium Risk

- Depth of mine floor greater than 125 feet,
- Void space to pillar ration (80 to 90 percent),
- Vertical opening 4 feet or greater,
- Water filled void increases subsidence risk,
- Overlying bedrock material very competent,

- Numerous mine shafts or boreholes associated with mining technique, and
- Support columns or pillars susceptible to serious deterioration when void space is filled with water.

Low Risk

- Small vertical void space,
- Void space to pillar ratio good (75 to 80 percent),
- Vertical shafts and bore holes are in good condition,
- Depth of mined material relatively deep, +/- 150 feet,
- Competent cap rock over void space,
- Long wall mining method allows slow subsidence with minimal vertical opening; surface subsidence is minimal to undetected,
- Mine opening is dry, no pillar deterioration, and
- Mine area has little risk of sudden subsidence.

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

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

With the known number of acres in each risk category for each county with documented subsurface void spaces, a weighted vulnerability calculation was completed. Acreage in risk Category I (High Risk) received a multiplier of three, acreage in risk Category II (Moderate Risk) received a multiplier of two and acreage in risk Category III (Low Risk) received a multiplier of one. **Table 3.105** provides the results of this vulnerability analysis for counties with known subsurface void spaces, organized by Mitigation Planning Region**.** **Table 3.106** is the Top 10 Counties Vulnerable to Land Subsidence According to Weighted Calculation.

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Table 3.105. Subsurface Void Space Vulnerability Analysis

County	Lead/ Zinc Cat. I Acres	Coal Category I	Coal Category II	Coal Category III	Limestone Category I	Limestone Category II	Limestone Category III	Gypsum Category II	Salt Solution Category I	Salt Solution Category II	Salt Solution Category III	Rock Salt Category III	Hydrocarbon Storage Category III	Total Sub-surface Void Space	Weighted Calculation
Mitigation Planning Region A															
Lyon	0	Void Space Unknown			0	0	0	0	0	0	0	0	0	0	0
Subtotal	**0**	**Void Space Unknown**			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mitigation Planning Region C															
Grant	0	0	0	0	0	0	0	0	0	0	0	0	28	28	28
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**28**	**28**	**28**
Mitigation Planning Region E															
Barber	0	0	0	0	0	0	0	520	0	0	0	0	0	520	1,040
Barton	0	0	0	0	0	0	0	0	0	5	0	0	0	5	10
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**520**	**0**	**5**	**0**	**0**	**0**	**525**	**1,050**
Mitigation Planning Region F															
Cloud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dickinson	0	0	0	0	0	0	0	0	0	2	0	0	0	2	4
Ellsworth	0	0	0	0	0	0	0	0	0	24	0	1,825	285	2,134	2,158
Jewell	0	Void Space Unknown			0	0	0	0	0	0	0	0	0	0	0
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**26**	**0**	**1,825**	**285**	**2,136**	**2,162**
Mitigation Planning Region G															
Cowley	0	0	5	0	0	0	0	0	0	0	0	0	0	5	10
Harper	0	0	0	0	0	0	0	0	0	12	0	50	0	62	74
Kingman	0	0	0	0	0	0	0	0	0	12		150	28	190	202
McPherson	0	0	0	0	0	0	0	0	0	0	0	0	901	901	901
Reno	0	0	0	0	0	0	0	0	200	660	400	925	704	2,889	3,949
Rice	0	0	0	0	0	0	0	0	30	149	136	750	76	1,141	1,350
Sedgwick	0	0	0	0	0	0	0	0	136	34	163			333	639

County	Lead/ Zinc Cat. I Acres	Coal Category I	Coal Category II	Coal Category III	Limestone Category I	Limestone Category II	Limestone Category III	Gypsum Category II	Salt Solution Category I	Salt Solution Category II	Salt Solution Category III	Rock Salt Category III	Hydrocarbon Storage Category III	Total Sub-surface Void Space	Weighted Calculation
Sumner	0	0	0	0	0	0	0	0	0	8	0	0	0	8	16
Subtotal	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**366**	**875**	**699**	**1,875**	**1,709**	**5529**	**7,141**
Mitigation Planning Region H															
Bourbon	0	0	160	0	0	0	0	0	0	0	0	0	0	160	320
Chautauqua	0	Void Space Unknown			0	0	0	0	0	0	0	0	0	0	0
Cherokee	2,700	15,517	15,550	0	0	0	2	0	0	0	0	0	0	33,769	85,753
Crawford	0	12,100	56,900	0	0	0	0	0	0	0	0	0	0	69,000	150,100
Elk	0	0	2	0	0	0	0	0	0	0	0	0	0	2	4
Neosho	0	Void Space Unknown			0	0	0			0	0	0	0	0	0
Subtotal	**2,700**	**27,617**	**72,612**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**10,2931**	**236,177**
Mitigation Planning Region J															
Anderson	0	0	0	0	30	0	0	0	0	0	0	0	0	30	90
Coffey	0	Void Space Unknown			0	0		0	0	0	0	0	0	0	0
Franklin	0	0	200	0	0	0	0	0	0	0	0	0	0	200	400
Linn	0	0	200	0	0	0	0	0	0	0	0	0	0	200	400
Osage	0	0	4,000	0	0	0	0	0	0	0	0	0	0	4,000	8,000
Shawnee	0	0	21	0	0	0	0	0	0	0		0	0	21	42
Subtotal	**0**	**0**	**4,421**	**0**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4,451**	**8,932**
Mitigation Planning Region K															
Atchison	0	0	0	27	66	66	67	0	0	0	0	0	0	226	424
Brown	0	0	0	80	0	0	0	0	0	0	0	0	0	80	80
Jackson	0	Void Space Unknown0			0	0	0	0	0	0	0	0	0	0	0
Jefferson	0	0	30	0	0	5	0	0	0	0	0	0	0	35	70
Marshall	0	0	0	0	0	0	0	200	0	0	0	0	0	200	400
Nemaha	0	0	16	0	0	0	0	0	0	0	0	0	0	16	32
Subtotal	**0**	**0**	**46**	**107**	**66**	**71**	**67**	**200**	**0**	**0**	**0**	**0**	**0**	**557**	**1,006**

County	Lead/ Zinc Cat. I Acres	Coal Category I	Coal Category II	Coal Category III	Limestone Category I	Limestone Category II	Limestone Category III	Gypsum Category II	Salt Solution Category I	Salt Solution Category II	Salt Solution Category III	Rock Salt Category III	Hydrocarbon Storage Category III	Total Sub-surface Void Space	Weighted Calculation
Mitigation Planning Region L															
Johnson	0	0	0	0	209	209	277	0	0	0	0	0	0	695	1,322
Leavenworth	0	0	0	1100	40	40	40	0	0	0	0	0	0	1,220	1,340
Wyandotte	0	0	0	0	394	323	347	0	0	0	0	0	0	1,064	2,175
Subtotal	**0**	**0**	**0**	**1100**	**643**	**572**	**664**	**0**	**0**	**0**	**0**	**0**	**0**	**2,979**	**4,837**
Statewide															
Totals	**2,700**	**27,617**	**77,084**	**1,207**	**739**	**643**	**733**	**720**	**366**	**906**	**699**	**3,700**	**2,022**	**119,136**	**261,333**

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

Table 3.106. Top 10 Counties Vulnerable to Land Subsidence According to Weighted Calculation

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

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

In addition to the inventory of known subsurface void spaces, due to various forms of mining, the —Lost Circulation Zone" (defined in the Description/Location Section) exists in central Kansas. Due to the slow development of the subsidence area, the safety danger from sudden collapse of the surface is not a serious concern. However, structures built over these areas are likely to be damaged over time.

Table 3.107 shows the counties and affected acreage that are part of the —Lost Circulation Zone".

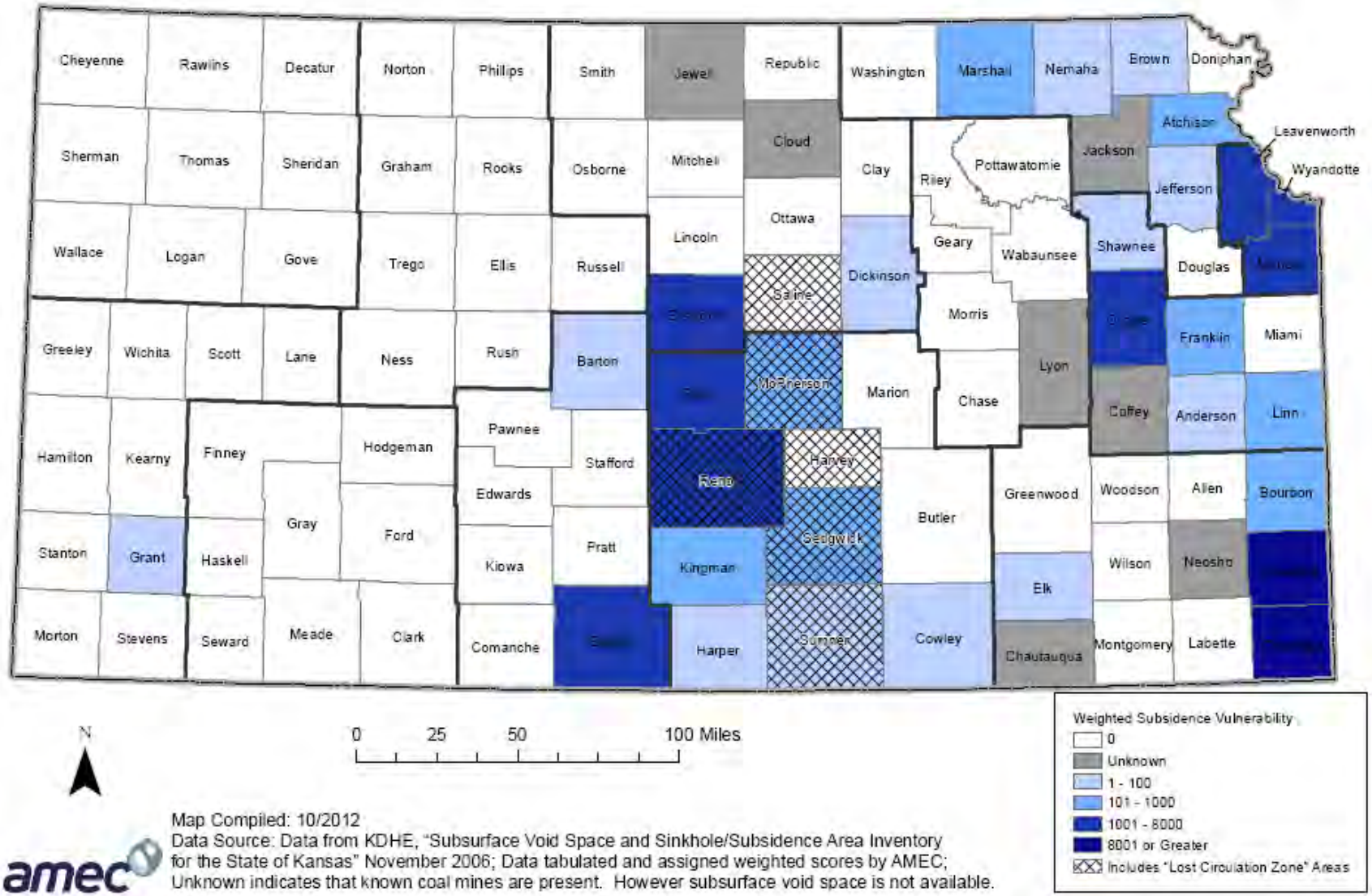
Table 3.107. Counties/Acreage Impacted by "Lost Circulation Zone"

Mitigation Planning Region	County	Lost Circulation Zone
G	Harvey	37,760
G	Reno	94,720
G	McPherson	115,200
F	Saline	160,000
G	Sumner	268,800
G	Sedgwick	288,000

Source: KDHE, —Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas" November 2006

Figure 3.85 that follows shows the results of the weighted vulnerability analysis as well as the counties impacted by the —Lost Circulation Zone"

Figure 3.85. Subsurface Void Space Weighted Vulnerability Analysis



State Estimates of Potential Losses

The KDHE Abandoned Mine Land Program estimates there are over 350 abandoned coal mine sites alone identified with health and safety problems. The cost to reclaim all problems is estimated to be over $225 million. While not all abandoned mines include subsidence issues it is a great concern.

Records maintained by KDHE, indicate that over $10,000,000 has been spent during the years that records were available for the Abandoned Mine Land Program. The combined annualized cost for the three programs for which data was obtained is $434,861. **Table 3.108** breaks it down as follows for the impacted counties:

Table 3.108. Annualized Cost for Abandoned Mine Land Programs by County

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

Source: KDHE Surface Mining Section

The above annualized amounts of historical costs capture only the remediation costs eligible for KDHE's programs. The potential for other structural damage and economic impacts exists for all counties that have subsurface void spaces (See **Figure 3.85)**. Damages will be more isolated in general compared to other hazards, but future disruptions to transportation and other infrastructure as well as structural damage are possible.

Development in Hazard Prone Areas

Comparison of the weighted vulnerability calculation considering known subsurface void spaces with the top 10 counties for housing unit gains and populations gains reveals that Leavenworth and Johnson Counties are in the top 10 for both housing and population gains and scored within the top 10 counties in the weighted vulnerability calculation for land subsidence. Other counties that have known land subsidence that are in the top 10 for housing and/or population gains include: Sedgwick and Shawnee Counties.

Of the counties impacted by the lost circulation zone, the following are in the top 10 for housing unit and population gains: Sedgwick and Saline Counties.

Consequence Analysis

The information in **Table 3.109** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.109. EMAP Consequence Analysis: Land Subsidence

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

3.3.12. Landslide

Calculated Priority Risk Index	Planning Significance
2.2	Moderate

Description/Location

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

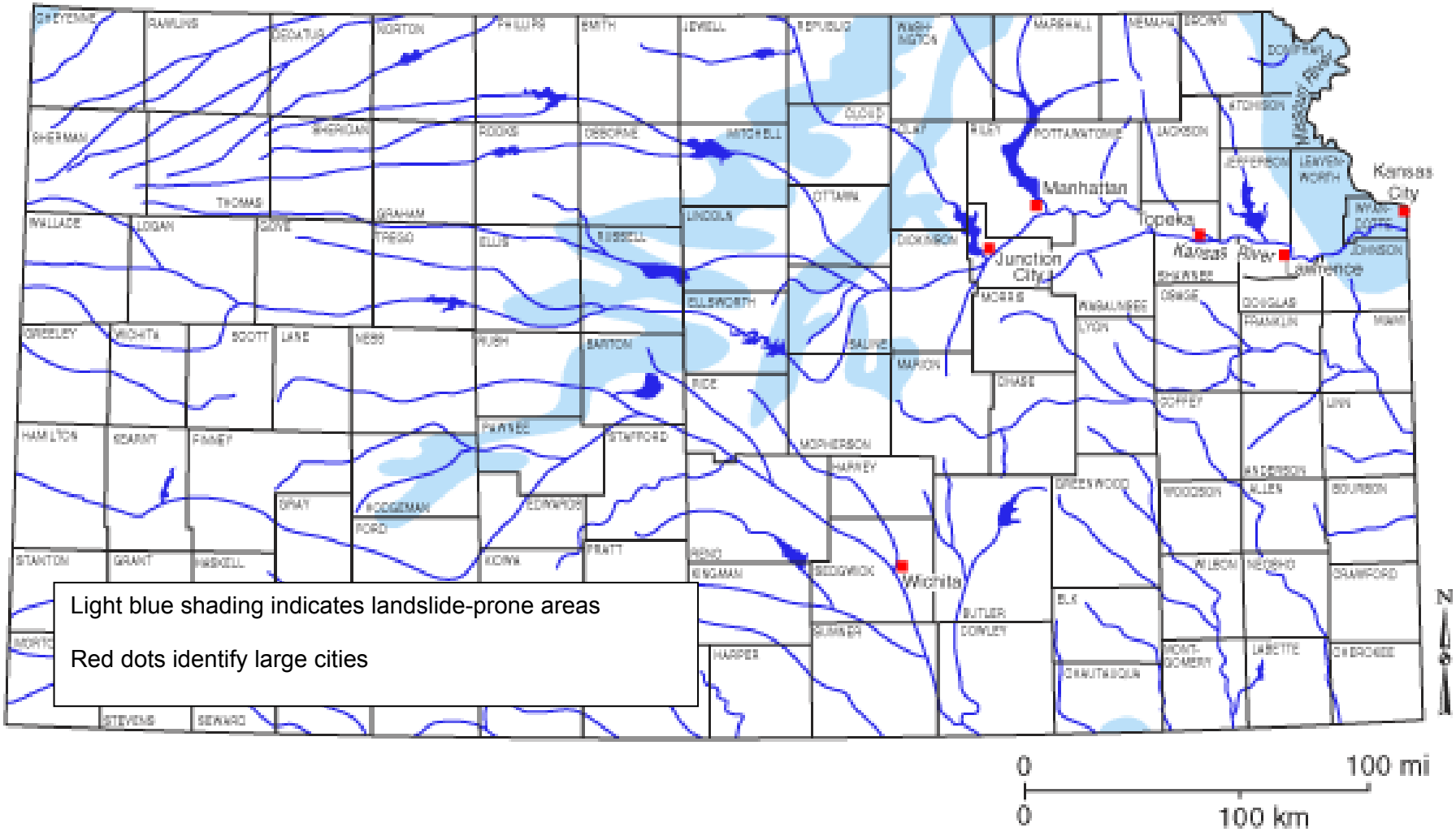
Landslides require hilly terrain. Typically, as the slope angle increases, so does the potential for landslides. Anything that increases the slope angle can trigger a landslide (e.g., a stream actively eroding a hill, construction practices). Slope steepness is the primary factor determining slope stability,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

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

Landslides occur occasionally in Kansas and are a localized problem, but growth of cities provides potential for more property losses. In parts of the State where topographic relief is greatest, especially in central and eastern Kansas, landslides can occur when underlying shales become saturated with water in wet years. Rocks and overlying soils then slip down slope and are a particular problem in areas of housing or where road construction has occurred.

According to the U.S. Geological Survey, the areas of Kansas that are most prone to landslides are the Missouri River Corridor in northeastern Kansas, including the Kansas City metropolitan area (Johnson, Leavenworth, and Wyandotte counties); the Smoky Hills in northern and central Kansas; and northwestern Hamilton County (see light blue shaded areas in **Figure 3.86**). Though not shown on the map, the region along the Kansas River and its tributaries from Kansas City to Junction City are also landslide prone. This includes the cities of Lawrence (Douglas County), Manhattan (Riley County), and Topeka (Shawnee County). Although landslides are more likely in the regions discussed here, they can occur anywhere in the State.

Figure 3.86. Landslide-Prone Areas of Kansas



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

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

Previous Occurrences

Kansas landslides cause structural damage and disrupt transportation on a regular basis. The most costly landslide in Kansas occurred in 1995 in Overland Park. Two houses were destroyed and four lots were damaged. Damage was estimated at $1.15 million. Other Kansas landslides include the following:

- **2007:** Flooding caused landslides in southeast Kansas.
- **July 2001**: In the City of Mission, Johnson County, a 180 foot wide landslide accord along the north side of Foxridge Drive. The earthen mass moved laterally and downward approximately 2 feet.
- **2001:** Landslide in the City of Shawnee, Johnson County, began about 10 feet behind a house and extended about 90 feet north to the stream 50 feet below. A $275,000 retaining wall was built to mitigate damages.
- **October 4, 1998:** An intense rainfall event caused excessive pressure on retaining walls at the Woodlanw Cemetery in Kansas City, KS (see **Figure 3.87**) and several roads throughout Wyandotte County experienced landslide damage from the event.

Figure 3.87. Landslide Damage at Woodlanw Cemetary in Kansas City, Kansas

Source: Wyandotte County EOC files, dated 10/5/1998

- **1998:** $360,000 in damage to a house in the Stanley, $170,000 in damage to a road and beach in Douglas County.
- **1997:** A landslide in Atchison County along Riverview Drive damaged the street at the top of the hill and broke a sewer line along the base of the slope.
- **1995:** A landslide closed a road about 5 miles southwest of Manhattan in Riley County. It cost $880,000 to stabilize the slope and repair the road.
- **1995:** A landslide destroyed two homes in Overland Park, Kansas in Johnson County. Total damage was estimated at $1.15 million. (see **Figure 3.88)**

Figure 3.88. 1995 Overland Park Landslide

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

- **1990:** $120,000 in structural damages to two houses in the City of Leawood, Johnson County.

Probability of Future Hazard Events

Based on the past events between 1990 and 2007, a damaging landslide occurred every 2 years; however, there have not been any reported events from 2007 to 2012. The potential for damaging landslides is more during wet years. This hazard's CPRI probability is **—likely**" within the next three years.

State Vulnerability Analysis

Vulnerability to landslide hazards is a function of location, type of human activity, use, and frequency of landslide events. Overall, the relative risk posed by landslide to Kansas is low. But, the level of risk is somewhat higher in the northeast corner of the State in the vicinity of the Kansas City Metropolitan Area. According to the Kansas Geological Survey, there are also landslide-prone areas in central and north central Kansas. **Table 3.110** lists all counties

(organized by Mitigation Planning Region) that are indicated to have landslide-prone areas according to the Kansas Geological Survey map in **Figure 3.86** as well as additional commentary indicating areas along the Missouri River and Kansas River Corridors.

Table 3.110. Kansas Counties with Landslide-Prone Areas

Mitigation Planning Region	County	Mitigation Planning Region	County
A	Cheyenne	G	Marion
B	Ellis	G	Rice
B	Rush	I	Riley
B	Russell	J	Shawnee
C	Stanton	K	Atchison
D	Ford	K	Brown
D	Hodgeman	K	Doniphan
E	Pawnee	K	Jefferson
F	Clay	K	Washington
F	Cloud	K	Douglas
F	Ellsworth	L	Johnson
F	Lincoln	L	Leavenworth
F	Mitchell	L	Wyandotte
F	Osborne		
F	Republic		
F	Saline		

Source: Kansas Geological Survey

State Estimates of Potential Losses

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

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

Development in Hazard Prone Areas

Of the landslide-prone areas, listed in **Table 3.110**, the following are also in the top 10 Kansas Counties for Housing Unit Gains: Johnson, Douglas, Shawnee, Leavenworth, Riley and Saline. Additionally, the following are also in the top 10 Kansas Counties for Population Gains: Johnson, Riley, Leavenworth, and Douglas. If construction is occurring in or near landslide hazard areas, more structures/population will be at risk to damage/injury from landslides.

The effects of landslides on people and structures can be lessened by total avoidance of landslide hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. The hazard from landslides can be reduced by avoiding construction on steep slopes and existing landslides, or by stabilizing the slopes. Stability increases when ground water is prevented from rising in the landslide mass by (1) covering the landslide with an impermeable membrane, (2) directing surface water away from the landslide, (3) draining ground water away from the landslide, and (4) minimizing surface irrigation. Slope stability is also increased when a retaining structure and/ or the weight of a soil/rock berm are placed at the toe of the landslide or when mass is removed from the top of the slope.

Consequence Analysis

The information in **Table 3.111** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.111. EMAP Consequence Analysis: Landslide

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

3.3.13. Lightning

Calculated Priority Risk Index	Planning Significance
2.5	Moderate

Description/Location

According to the National Weather Service, lightning is one of the most underrated severe weather hazards. The second deadliest weather killer in the United States, it ranks above hurricanes or tornadoes. Of the estimated 1,000 people who are struck by lightning each year on the U.S., only 10 percent are killed, but survivors may suffer life-long disabilities.

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

Most of Kansas has an average of 30 to 50 thunderstorm days each year; however, most of the eastern counties have annual averages of 50-70 thunderstorm days (see **Figure 3.89**).

Figure 3.89. Distribution and Frequency of Thunderstorms

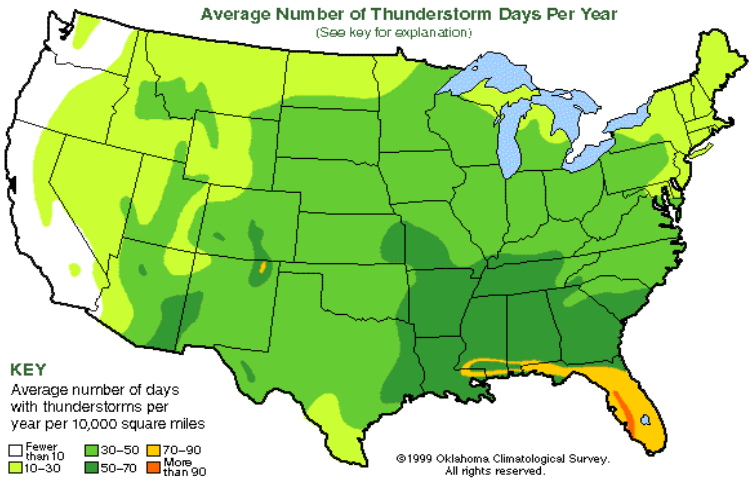
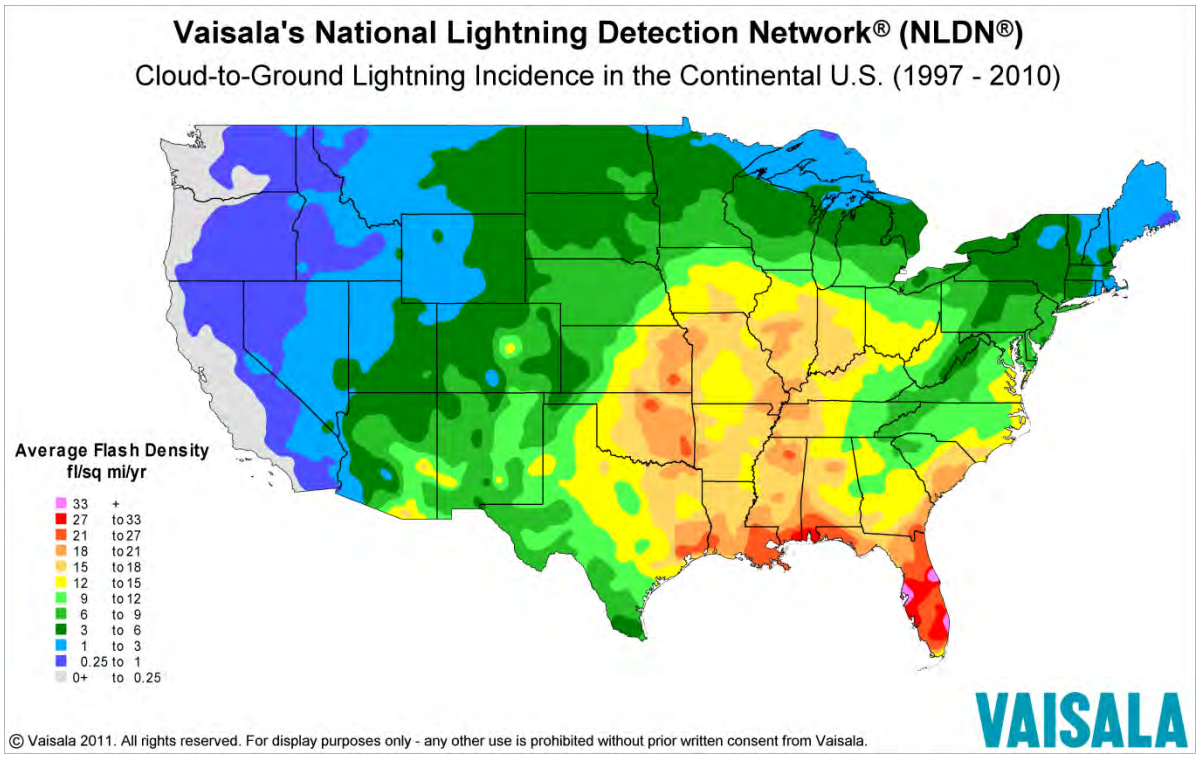


Figure 3.90, which is based on data from 1997 to 2010, shows that the distribution of lightning throughout the U.S. In particular, the lightning frequency is similar to the pattern of thunderstorm frequency. There are three to six strikes per square mile per year in the western Kansas counties, while recognizing the eastern and southeastern Kansas counties experience at least

18 to 21 strikes per square mile per year. Showing these differences, the KHMT considers the threat posed by lightning to be generally higher is the eastern portion of the State.

Figure 3.90. Location and Frequency of Lightning in U.S., 1997-2010



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

Previous Occurrences

Information measured by the National Lightning Detection Network between 1997 and 2011 ranks Kansas 16th among the continental states in terms of cloud-to-ground flash densities with 934,368 flashes per year (11.4 flashes per square mile). According to the National Climatic Data Center Storm Events database, there were 72 lightning events in Kansas between 2006 and 2012 that resulted in fatality, injury, and/or property damage see **Figure 3.91.** Total property damage for these events is estimated at $3,538,000. There were 10 deaths and 32 injuries in this time period. This suggests that Kansas experiences an average of 10 damaging lightning events over this 7–year period, $505,429 in lightning-related losses and four lightning-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. Reporting of events and the historic events detailed here are likely not a true reflection of all the damaging lightning strikes.)

Longer-term data exists for lightning-related deaths and injuries only. **Figure 3.92** and **Figure 3.93** show historical Kansas lightning deaths and injuries in Kansas. Based on this data, there is roughly one death and four injuries as a result of lightning in Kansas per year, on average (based on 65 deaths and 198 injuries in a 53-year time period).

Figure 3.91. Kansas Lightning Events by County, 2006 - 2010

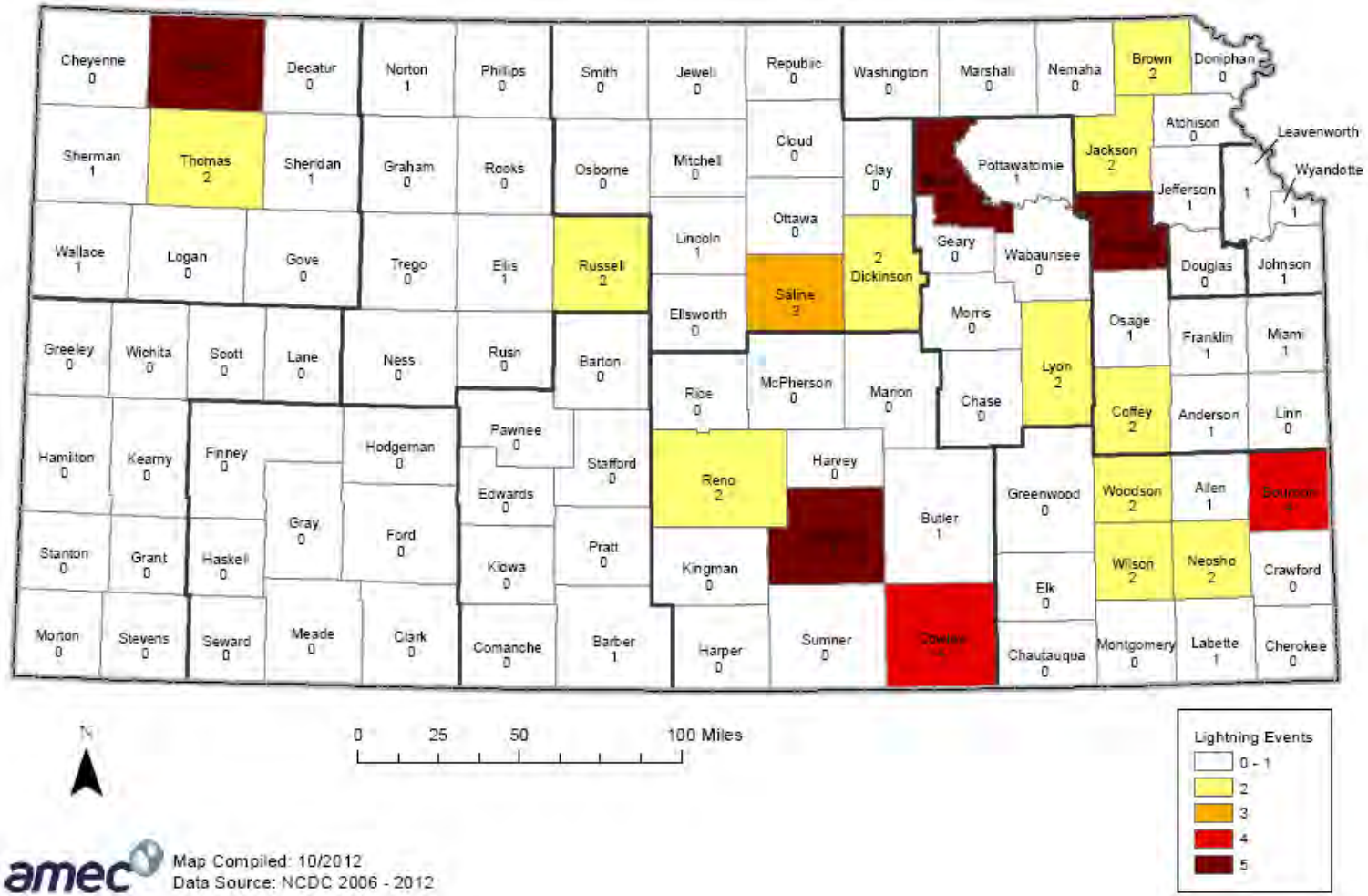
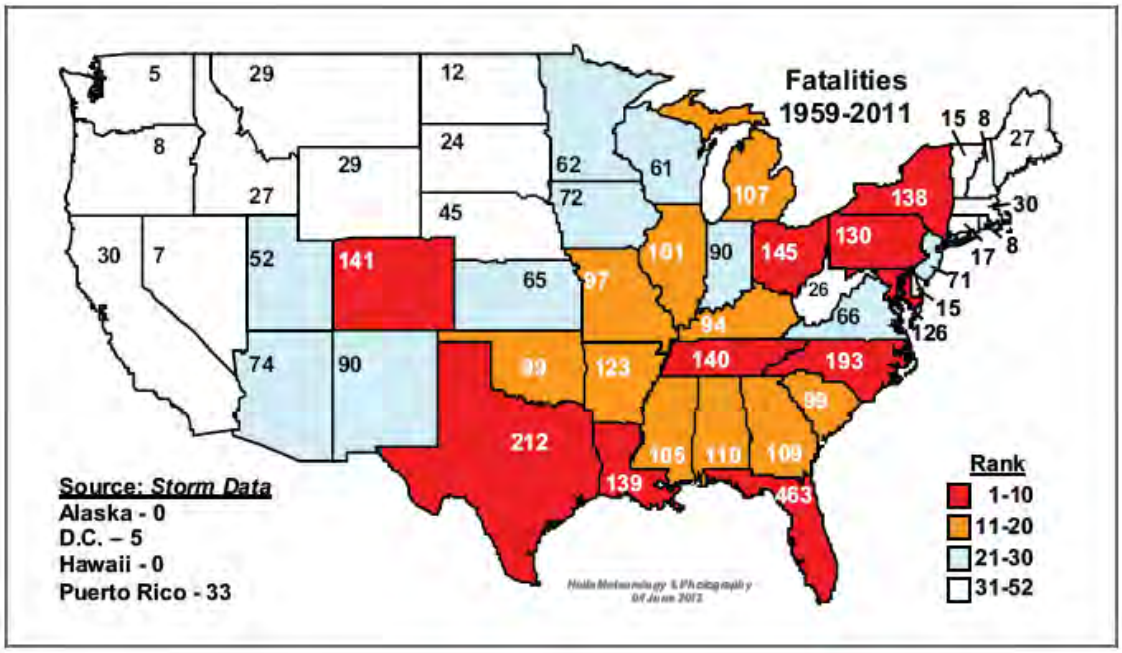
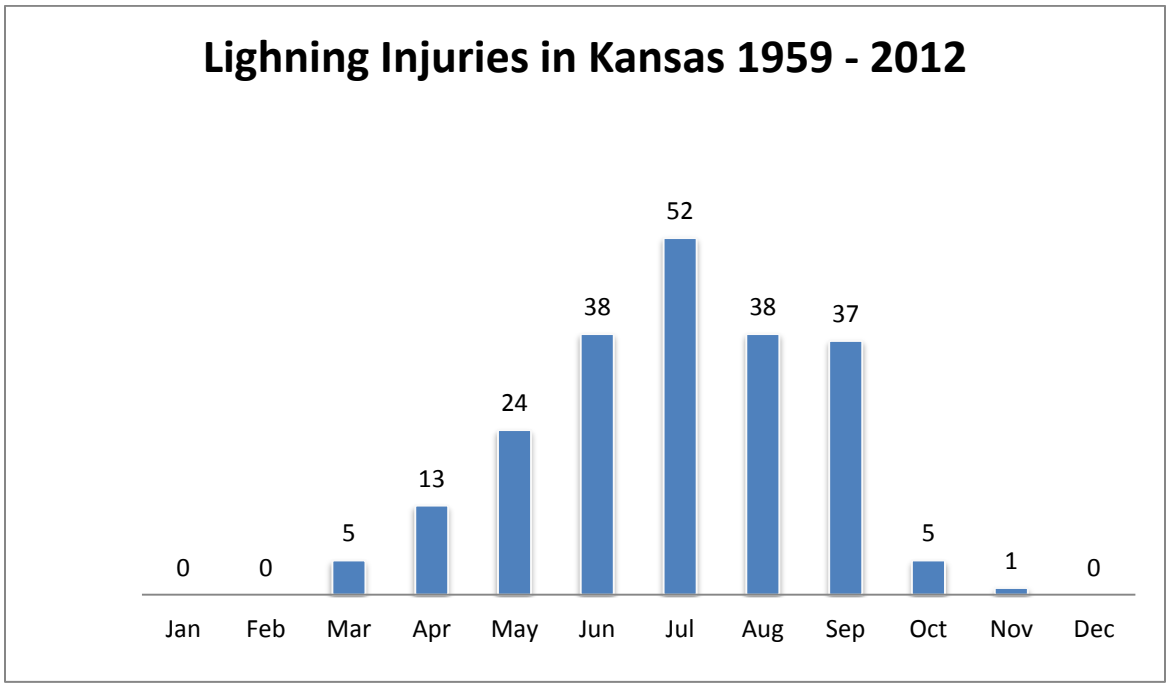


Figure 3.92. U.S. Lightning Fatalities by State, 1959–2011



Source: NOAA, http://www.lightningsafety.noaa.gov/stats/59-11_fatalities_rates.pdf

Figure 3.93. Kansas Lightning Injuries 1959–2012



Source: National Weather Service, NCDC, graph prepared by AMEC

Notable Lightning Events:

- **July 7, 2012:** A Kansas man died after being struck by a bolt of lightning outside his home near Waverly in Coffey County. He was killed by a stray bolt of lightning from a nearby storm.
- **May 30, 2012:** Lightning strike caused a grass fire in Saline County.
- **September 10, 2011:** A woman was riding her bike across John Redmond Dam in Coffey County when she was struck by lightning from a passing thunderstorm. She passed away the next day.
- **August 5, 2011:** Lightning struck an automobile and a radio station in Salina. The strike burned the vehicle and the radio station suffered damages to the transmitter, satellites and other equipment.
- **April 4, 2011:** Lightning struck an oil tank battery on a farm in northeast Rawlins County causing an explosion that blew the lid of the crude oil storage tank and damaged a second tank.
- **September 15, 2010:** Lightning struck the Bourbon County Courthouse in the city of Ft. Scott which caused damage to the roof and significant damage to electronics inside the courthouse.
- **May 19, 2010:** During the predawn hours, lightning struck a residence in rural Kingman County. The house was set ablaze and the century-old house was deemed a total loss.
- **August 27, 2009:** A rural home a few miles east of Arkansas City was destroyed by fire after being hit by lightning during the early morning hours. No one was injured. The Winfield Daily Courier contributed to this report**.**
- **December 27 2008:** Lightning from a broken line of strong to severe thunderstorms sparked a house fire in the community of Colony during the predawn hours of the 27th. The residence was completely destroyed. Fortunately, no one was home at the time. Information courtesy of the Iola Register.
- **August 25, 2006:** A lightning strike set a 14-unit building on fire at Twin Lakes Apartment Complex. The fire destroyed the roof and top floors of the building. Fortunately, no one was injured from the blaze. Information courtesy of the Wichita Eagle.

Insured Crop Loss Data

According to the USDA's Risk Management Agency, there have not been any payments for insured crop losses specifically for lightning but payments have been made for the associated flooding, hail and wind. The NCDC database lists only $6,000 for crop damages in the 2006-2012 timeframe.

Probability of Future Hazard Events

According to the National Climatic Data Center Storm Events database, there were 138 lightning events in Kansas between 2006 and 2012 that resulted in fatality, injury and/or property and crop damage (events that do not cause fatalities/injuries or damage are not reported). Based on this information, the probability that at least one damaging lightning event

will occur in Kansas in any given year is 100 percent. This hazard's CPRI probability is "**Highly Likely**" within the calendar year.

State Vulnerability Analysis

Based on NCDC data, Kansas can expect approximately $505,429 in lightning-related losses and two lightning related injuries each year. The eastern and central portions of the State are more likely to experience lightning impacts, but the entire state is susceptible. More injuries and deaths can be expected as a result of lightning strikes during the months of May-September, with the greatest risk to people outdoors for work or recreation. Risk to specific communications, power and warning infrastructure are best conducted on a facility-by-facility basis. Risk assessments conducted on certain state infrastructure is addressed in Section 3.4 State Facilities: Vulnerability of Potential Losses.

All 105 counties in Kansas are vulnerable to lightning. The statistical analysis method was used to refine and assess the relative vulnerability of each of Kansas' counties to lightning. 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 and crop exposure (annualized crop losses were not used since USDA did not have insured crop loss amounts to use in the tabulation). Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties.

The following are the data sources of the six factors: Social Vulnerability Index for 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) and USDA's Census of Agriculture (2007). It was determined that since lightning is a common occurrence in Kansas, that using historical events and property damages from 2006 forward provides adequate events to describe the lightning problem in Kansas.

Table 3.112 below provides the available data for each of the six factors described above taken into consideration to determine overall vulnerability to lightning. The data is provided by county, organized by Mitigation planning Region.

Table 3.112. Vulnerability of Kansas Counties Factor Amounts for Lightning

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)
Mitigation Planning Region A							
Cheyenne	5	0	$0	$0	$189,307	2.7	$52,458,000
Decatur	5	0	$0	$0	$232,035	3.3	$49,747,000
Gove	4	0	$0	$0	$224,662	2.5	$59,084,000
Logan	4	0	$0	$0	$223,349	2.6	$47,558,000
Rawlins	5	5	$102,000	$14,571	$205,462	2.4	$59,406,000
Sheridan	5	1	$0	$0	$200,661	2.9	$95,542,000
Sherman	4	1	$0	$0	$461,185	5.7	$108,370,000
Thomas	4	2	$70,000	$10,000	$599,973	7.4	$129,521,000
Wallace	3	1	$0	$0	$117,421	1.6	$47,203,000
Subtotal		**10**	**$172,000**	**$24,571**	**$2,454,055**		**$648,889,000**
Mitigation Planning Region B							
Ellis	2	1	$0	$0	$1,735,474	31.6	$27,729,000
Graham	4	0	$0	$0	$201,852	2.9	$42,105,000
Ness	5	0	$0	$0	$241,794	2.9	$37,636,000
Norton	5	1	$15,000	$2,143	$371,491	6.5	$42,614,000
Phillips	4	0	$0	$0	$439,444	6.4	$41,104,000
Rooks	4	0	$0	$0	$601,846	5.8	$46,688,000
Rush	5	0	$0	$0	$202,357	4.6	$33,863,000
Russell	4	2	$10,000	$1,429	$488,994	7.9	$23,659,000
Trego	5	0	$0	$0	$215,776	3.4	$30,057,000
Subtotal		**4**	**$25,000**	**$3,571**	**$4,499,028**		**$325,455,000**
Mitigation Planning Region C							
Grant	3	0	$0	$0	$469,849	13.6	$63,853,000
Greeley	4	0	$0	$0	$131,666	1.6	$64,552,000
Hamilton	4	0	$0	$0	$187,869	2.7	$51,817,000
Kearny	4	0	$0	$0	$228,723	4.6	$66,321,000
Lane	4	0	$0	$0	$162,362	2.4	$31,082,000
Morton	4	0	$0	$0	$230,152	4.4	$42,645,000
Scott	2	0	$0	$0	$350,514	6.9	$71,718,000
Stanton	4	0	$0	$0	$151,658	3.3	$76,592,000
Stevens	2	0	$0	$0	$293,762	7.9	$124,066,000
Wichita	5	0	$0	$0	$175,679	3.1	$0
Subtotal		**0**	**$0**	**$0**	**$2,382,234**		**$592,646,000**
Mitigation Planning Region D							
Clark	5	0	$0	$0	$182,482	2.3	$15,466,000
Finney	2	0	$0	$0	$2,042,592	28.2	$140,746,000
Ford	2	0	$0	$0	$1,731,663	30.8	$87,004,000
Gray	2	0	$0	$0	$360,141	6.9	$109,340,000
Haskell	3	0	$0	$0	$252,803	7.4	$116,154,000
Hodgeman	3	0	$0	$0	$131,155	2.2	$41,068,000
Meade	4	0	$0	$0	$295,936	4.7	$91,206,000
Seward	2	0	$0	$0	$1,021,471	35.9	$81,688,000
Subtotal		**0**	**$0**	**$0**	**$6,018,243**		**$682,672,000**

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)
Mitigation Planning Region E							
Barber	4	1	$0	$0	$388,136	4.3	$15,969,000
Barton	3	0	$0	$0	$1,772,118	30.9	$65,249,000
Comanche	5	0	$0	$0	$135,138	2.4	$13,395,000
Edwards	4	0	$0	$0	$232,382	4.9	$73,732,000
Kiowa	4	0	$0	$0	$237,655	3.5	$34,681,000
Pawnee	5	0	$0	$0	$449,592	9.2	$67,357,000
Pratt	3	0	$0	$0	$689,239	13.1	$62,967,000
Stafford	4	0	$0	$0	$295,331	5.6	$74,613,000
Subtotal		**1**	**$0**	**$0**	**$4,199,591**		**$407,963,000**
Mitigation Planning Region F							
Clay	3	0	$0	$0	$599,823	13.2	$47,769,000
Cloud	5	0	$0	$0	$691,783	13.3	$55,096,000
Dickinson	4	2	$101,000	$14,429	$1,262,865	23.3	$50,121,000
Ellsworth	5	0	$0	$0	$459,624	9.1	$19,376,000
Jewell	5	0	$0	$0	$254,815	3.4	$61,168,000
Lincoln	4	1	$3,000	$429	$234,746	4.5	$32,667,000
Mitchell	4	0	$0	$0	$510,997	9.1	$61,762,000
Osborne	5	0	$0	$0	$343,004	4.3	$37,801,000
Ottawa	2	0	$0	$0	$418,316	8.5	$35,560,000
Republic	5	0	$0	$0	$417,216	6.9	$79,639,000
Saline	2	3	$60,000	$8,571	$3,591,872	77.2	$26,903,000
Smith	5	0	$0	$0	$278,296	4.3	$54,022,000
Subtotal		**6**	**$164,000**	**$23,429**	**$9,063,357**		**$561,884,000**
Mitigation Planning Region G							
Butler	1	1	$0	$0	$3,509,143	46.1	$41,249,000
Cowley	3	4	$210,000	$30,000	$2,180,637	32.3	$23,126,000
Harper	4	0	$0	$0	$455,272	7.5	$17,809,000
Harvey	2	0	$0	$0	$2,143,090	64.3	$49,189,000
Kingman	3	0	$0	$0	$606,598	9.1	$25,749,000
McPherson	4	0	$0	$0	$762,377	13.4	$43,687,000
Marion	2	0	$0	$0	$854,909	32.5	$57,227,000
Reno	3	2	$30,000	$4,286	$4,120,706	51.4	$69,497,000
Rice	4	0	$0	$0	$668,411	13.9	$53,225,000
Sedgwick	1	5	$2,035,000	$290,714	$31,528,899	499.6	$56,918,000
Sumner	2	0	$0	$0	$1,574,242	20.4	$50,711,000
Subtotal		**12**	**$2,275,000**	**$325,000**	**$48,404,284**		**$488,387,000**
Mitigation Planning Region H							
Allen	3	1	$150,000	$21,429	$983,778	26.7	$15,462,000
Bourbon	4	4	$22,000	$3,143	$1,102,488	23.9	$9,918,000
Chautauqua	5	0	$0	$0	$285,438	5.7	$4,971,000
Cherokee	4	0	$0	$0	$1,293,753	36.8	$53,420,000
Crawford	3	0	$0	$0	$2,588,817	66.4	$34,463,000
Elk	5	0	$0	$0	$187,291	4.5	$0
Greenwood	5	0	$0	$0	$491,412	5.9	$8,087,000

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)
Labette	4	1	$100,000	$14,286	$1,453,850	33.5	$22,765,000
Montgomery	4	0	$0	$0	$2,432,183	55.1	$16,616,000
Neosho	4	2	$47,000	$6,714	$1,174,150	28.9	$17,811,000
Wilson	4	2	$12,000	$1,714	$671,059	16.5	$26,882,000
Woodson	5	2	$0	$0	$207,905	6.6	$14,486,000
Subtotal		**12**	**$331,000**	**$47,286**	**$12,872,124**		**$224,881,000**
Mitigation Planning Region I							
Chase	3	0	$0	$0	$9,835,676	292.4	$135,033,000
Geary	3	0	$0	$0	$518,401	14	$33,029,000
Lyon	2	2	$22,000	$3,143	$670,953	13.7	$25,497,000
Morris	2	0	$0	$0	$1,598,004	45.5	$32,349,000
Pottawatomie	1	1	$1,000	$143	$659,126	16.3	$13,053,000
Riley	2	5	$229,000	$32,714	$2,106,266	57	$27,726,000
Wabaunsee	2	0	$0	$0	$977,110	23.1	$27,618,000
Subtotal		**8**	**$252,000**	**$36,000**	**$11,828,241**		**$32,959,000**
Mitigation Planning Region J							
Anderson	3	1	$50,000	$7,143	$518,401	14	$33,029,000
Coffey	3	2	$0	$0	$670,953	13.7	$25,497,000
Franklin	2	1	$1,000	$143	$1,598,004	45.5	$32,349,000
Linn	2	0	$0	$0	$659,126	16.3	$13,053,000
Miami	1	1	$1,000	$143	$2,106,266	57	$27,726,000
Osage	2	1	$0	$0	$977,110	23.1	$27,618,000
Shawnee	2	5	$31,000	$4,429	$11,828,241	327.1	$32,959,000
Subtotal		**11**	**$83,000**	**$11,857**	**$18,358,101**		**$192,231,000**
Mitigation Planning Region K							
Atchison	3	0	$0	$0	$1,333,363	39.3	$42,536,000
Brown	5	2	$6,000	$857	$713,225	17.5	$86,532,000
Doniphan	3	0	$0	$0	$557,109	20.2	$67,800,000
Douglas	1	0	$0	$0	$6,614,269	243.1	$27,973,000
Jackson	3	2	$75,000	$10,714	$788,323	20.5	$21,169,000
Jefferson	1	1	$0	$0	$1,130,852	35.9	$33,429,000
Marshall	4	0	$0	$0	$2,054,603	11.2	$81,815,000
Nemaha	4	0	$0	$0	$711,896	14.2	$67,091,000
Washington	4	0	$0	$0	$396,656	6.5	$65,762,000
Subtotal		**5**	**$81,000**	**$11,571**	**$14,300,296**		**$494,107,000**
Mitigation Planning Region L							
Johnson	1	1	$150,000	$21,429	$43,871,468	1,149.60	$29,472,000
Leavenworth	1	1	$0	$0	$4,877,783	164.7	$20,983,000
Wyandotte	3	1	$5,000	$714	$12,066,666	1,039.00	$0
Subtotal		**3**	**$155,000**	**$22,143**	**$60,815,917**		**$50,455,000**
Statewide Total		**72**	**$3,538,000**	**$505,429**	**$193,202,906**		**$4,804,603,000**

Note: The Census of Agriculture did not publish crop exposure in Elk, Wichita and Wyandotte Counties to avoid disclosure of individual operations.

Table 3.113 provides the ranges for the 1-10 lightning vulnerability factor ratings. These factor ranges are calculated based on that range of data not comparing the range to another factor‘s ratings range. Ranges may be different for each hazard. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.113. Ranges for Lightning Vulnerability Factor Ratings

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

* Population density is the number of people per square mile.
n/a relates to not applicable because no county had more than 5 prior events.
Note: The assigned 1-10 range would be based on the range of dollar losses, not comparing the range of losses to another factor‘s range.

Table 3.114 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and **Table 3.115** provides the rating values assigned that were considered in determining overall vulnerability to lightning. **Figure 3.94** that follows provides the mapped results of this analysis by county.

Table 3.114. Ranges for Overall Lightning Vulnerability

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

Table 3.115. Vulnerability of Kansas Counties to Lightning

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Overall Vulnerability Rating	Lightning Vulnerability
Mitigation Planning Region A								
Cheyenne	10	0	0	1	1	4	16	Medium-Low
Decatur	10	0	0	1	1	4	16	Medium-Low
Gove	8	0	0	1	1	4	14	Medium-Low
Logan	8	0	0	1	1	4	14	Medium-Low
Rawlins	10	5	5	1	1	5	27	Medium-High
Sheridan	10	1	0	1	1	7	20	Medium
Sherman	8	1	0	1	1	8	19	Medium
Thomas	8	2	3	1	1	10	25	Medium-High
Wallace	6	1	0	1	1	4	13	Low
Mitigation Planning Region B								
Ellis	4	1	0	1	1	2	9	Low
Graham	8	0	0	1	1	3	13	Low
Ness	10	0	0	1	1	3	15	Medium-Low
Norton	10	1	1	1	1	3	17	Medium-Low
Phillips	8	0	0	1	1	3	13	Low
Rooks	8	0	0	1	1	4	14	Medium-Low
Rush	10	0	0	1	1	3	15	Medium-Low
Russell	8	2	1	1	1	2	15	Medium-Low
Trego	10	0	0	1	1	2	14	Medium-Low
Mitigation Planning Region C								
Grant	6	0	0	1	1	5	13	Low
Greeley	8	0	0	1	1	5	15	Medium-Low
Hamilton	8	0	0	1	1	4	14	Medium-Low
Kearny	8	0	0	1	1	5	15	Medium-Low
Lane	8	0	0	1	1	2	12	Low
Morton	8	0	0	1	1	3	13	Low
Scott	4	0	0	1	1	5	11	Low
Stanton	8	0	0	1	1	6	16	Medium-Low
Stevens	4	0	0	1	1	9	15	Medium-Low
Wichita	10	0	0	1	1	1	13	Low
Mitigation Planning Region D								
Clark	10	0	0	1	1	1	13	Low
Finney	4	0	0	1	1	10	16	Medium-Low
Ford	4	0	0	1	1	7	13	Low
Gray	4	0	0	1	1	8	14	Medium-Low
Haskell	6	0	0	1	1	9	17	Medium-Low
Hodgeman	6	0	0	1	1	3	11	Low
Meade	8	0	0	1	1	7	17	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Overall Vulnerability Rating	Lightning Vulnerability
Seward	4	0	0	1	1	6	12	Low
Mitigation Planning Region E								
Barber	8	1	0	1	1	1	12	Low
Barton	6	0	0	1	1	5	13	Low
Comanche	10	0	0	1	1	1	13	Low
Edwards	8	0	0	1	1	6	16	Medium-Low
Kiowa	8	0	0	1	1	3	13	Low
Pawnee	10	0	0	1	1	5	17	Medium-Low
Pratt	6	0	0	1	1	5	13	Low
Stafford	8	0	0	1	1	6	16	Medium-Low
Mitigation Planning Region F								
Clay	6	0	0	1	1	4	12	Low
Cloud	10	0	0	1	1	4	16	Medium-Low
Dickinson	8	2	5	1	1	4	21	Medium
Ellsworth	10	0	0	1	1	2	14	Medium-Low
Jewell	10	0	0	1	1	5	17	Medium-Low
Lincoln	8	1	1	1	1	3	15	Medium-Low
Mitchell	8	0	0	1	1	5	15	Medium-Low
Osborne	10	0	0	1	1	3	15	Medium-Low
Ottawa	4	0	0	1	1	3	9	Low
Republic	10	0	0	1	1	6	18	Medium-Low
Saline	4	3	3	1	1	2	14	Medium-Low
Smith	10	0	0	1	1	4	16	Medium-Low
Mitigation Planning Region G								
Butler	2	1	0	1	1	3	8	Low
Cowley	6	4	9	1	1	2	23	Medium
Harper	8	0	0	1	1	1	11	Low
Harvey	4	0	0	1	1	4	10	Low
Kingman	6	0	0	1	1	2	10	Low
McPherson	8	0	0	1	1	3	13	Low
Marion	4	0	0	1	1	4	10	Low
Reno	6	2	2	1	1	5	17	Medium-Low
Rice	8	0	0	1	1	4	14	Medium-Low
Sedgwick	2	5	10	8	5	4	34	High
Sumner	4	0	0	1	1	4	10	Low
Mitigation Planning Region H								
Allen	6	1	6	1	1	1	16	Medium-Low
Bourbon	8	4	2	1	1	1	17	Medium-Low
Chautauqua	10	0	0	1	1	1	13	Low
Cherokee	8	0	0	1	1	4	14	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Overall Vulnerability Rating	Lightning Vulnerability
Crawford	6	0	0	1	1	3	11	Low
Elk	10	0	0	1	1	1	13	Low
Greenwood	10	0	0	1	1	1	13	Low
Labette	8	1	4	1	1	2	17	Medium-Low
Montgomery	8	0	0	1	1	1	11	Low
Neosho	8	2	2	1	1	1	15	Medium-Low
Wilson	8	2	1	1	1	2	15	Medium-Low
Woodson	10	2	0	1	1	1	15	Medium-Low
Mitigation Planning Region I								
Chase	6	0	0	1	1	1	9	Low
Geary	4	0	0	1	1	1	7	Low
Lyon	6	2	1	1	1	2	13	Low
Morris	6	0	0	1	1	2	10	Low
Pottawatomie	2	1	1	1	1	2	8	Low
Riley	4	5	9	1	2	2	23	Medium
Wabaunsee	4	0	0	1	1	1	7	Low
Mitigation Planning Region J								
Anderson	6	1	2	1	1	3	14	Medium-Low
Coffey	6	2	0	1	1	2	12	Low
Franklin	4	1	1	1	1	3	11	Low
Linn	4	0	0	1	1	1	7	Low
Miami	2	1	1	1	1	2	8	Low
Osage	4	1	0	1	1	2	9	Low
Shawnee	4	5	2	3	3	3	20	Medium
Mitigation Planning Region K								
Atchison	6	0	0	1	1	3	11	Low
Brown	10	2	1	1	1	7	22	Medium
Doniphan	6	0	0	1	1	5	13	Low
Douglas	2	0	0	2	3	2	9	Low
Jackson	6	2	3	1	1	2	15	Medium-Low
Jefferson	2	1	0	1	1	3	8	Low
Marshall	8	0	0	1	1	6	16	Medium-Low
Nemaha	8	0	0	1	1	5	15	Medium-Low
Washington	8	0	0	1	1	5	15	Medium-Low
Mitigation Planning Region L								
Johnson	2	1	6	10	10	2	31	High
Leavenworth	2	1	0	2	2	2	9	Low
Wyandotte	6	1	1	3	10	1	22	Medium

Figure 3.94. Vulnerability Summary for Lightning

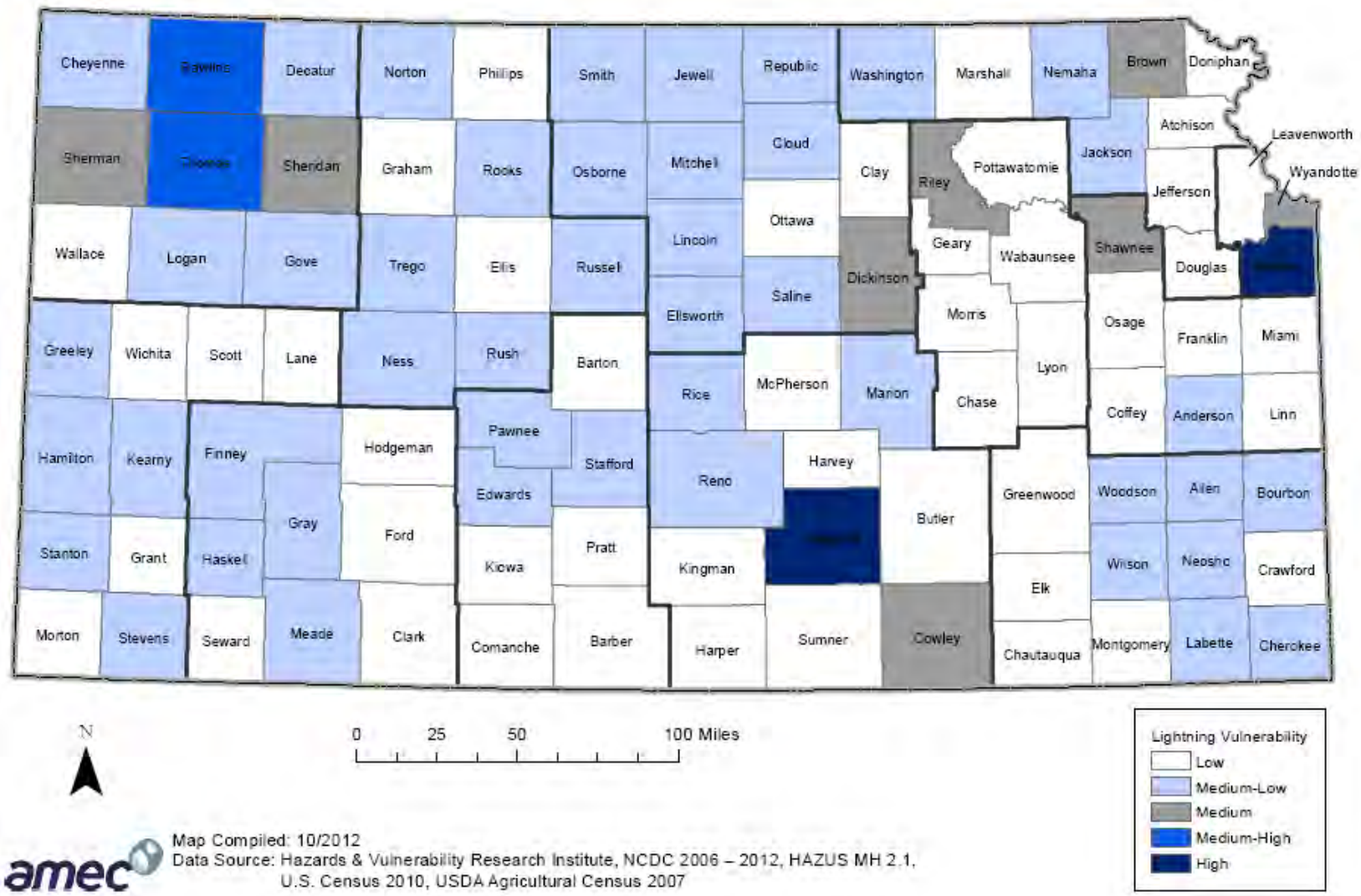


Table 3.116 below lists the top ten vulnerable counties in Kansas relative to each other concerning lightning events. .

Table 3.116. Top Ten Counties: Vulnerable to Lightning

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

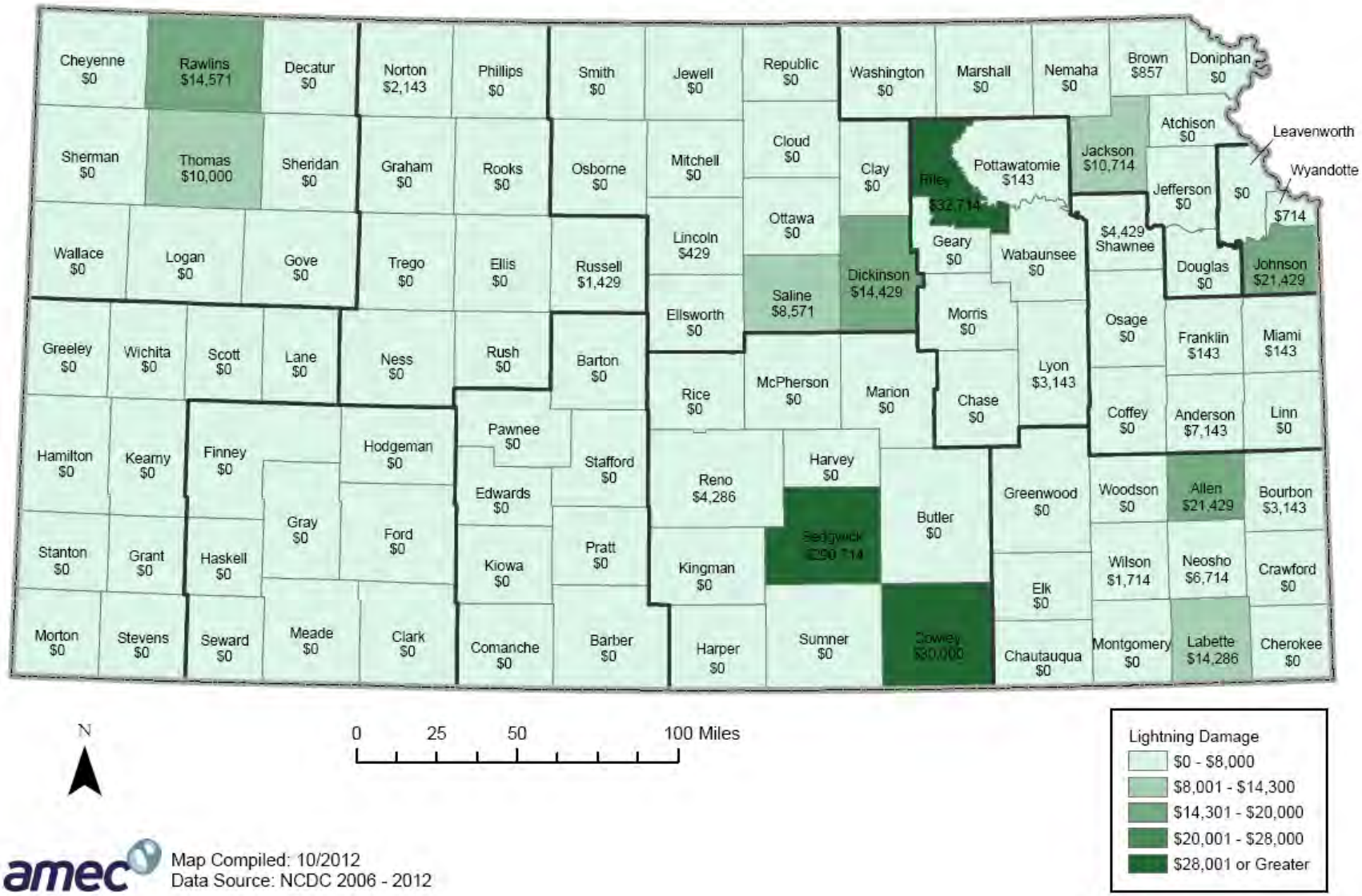
State Estimates of Potential Losses

Severe thunderstorms and the associated lightning events will continue to cause damage to anything and everything exposed to the weather elements. Historically NCDC has reported 32 injuries in Kansas from 2006 through 2012 which calculates to an annualized occurrence of four injuries.

To determine potential financial loss estimates to lightning in Kansas, the available historical loss data was annualized. In the case of frequently occurring weather-related hazards such as lightning, annualized historical loss data is considered to be the best resource for determining future potential losses. As discussed above in the vulnerability overview for lightning, the planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (2006 – 2012). According to this data, the annualized property loss for the State of Kansas from lightning is $3,538,000 as can be viewed in **Table 3.112** (vulnerability overview section).

Figure 3.95 provided the potential annualized property loss estimates per county. There is no distinct pattern of loss that can be inferred for property loss other than the highest county, Sedgwick, also has high building exposure. This analysis demonstrates the random distribution of this hazard and its impacts statewide.

Figure 3.95. Annualized Property Loss from Lightning, by County, 2006 - 2012



Development in Hazard Prone Areas

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

Consequence Analysis

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

Table 3.117. EMAP Consequence Analysis: Lightning

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

3.3.14. Major Disease Outbreak

Calculated Priority Risk Index	Planning Significance
2.65	Moderate

Description/Location

Infectious diseases affecting humans may be caused by viruses, bacteria, parasites, and fungi. They may be spread by direct contact with an infected person or animal, ingesting contaminated food or water, vectors such as mosquitoes or ticks, contact with contaminated surroundings such as animal droppings, infected respiratory droplets, or by aerosolization. Kansas's public health and health care communities must be prepared to rapidly identify and contain a wide range of biological agents. Each year local public health departments and the Kansas Department of Health & Environment investigate outbreaks of common diseases, such as food borne illness, sexually transmitted diseases, and vaccine-preventable diseases. There have also been outbreaks of vaccine-preventable diseases such as mumps. During 2009, an influenza pandemic stressed the capabilities of the public health and medical care communities, requiring a surge of personnel, pharmaceuticals, equipment and public education to manage the outbreak.

While there are a number of infectious diseases that commonly reported among Kansas residents, the following categories of disease have significant, recurring morbidity in the United States and are addressed in this plan: vaccine-preventable disease, foodborne disease, and community-associated infections. The following descriptions are general and it should be noted that individuals may experience more or less severe consequences based upon their own circumstances.

Vaccine Preventable Disease

Measles

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

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

Mumps

Mumps is a contagious disease that is caused by the mumps virus. Mumps typically starts with a few days of fever, headache, muscle aches, tiredness, and loss of appetite, and is followed by swelling of salivary glands. Anyone who is not immune from either a previous mumps infection or from vaccination can get mumps.

Most people with mumps recover fully. However, mumps can occasionally cause complications, and some of them can be serious. Complications may occur even if a person does not have swollen salivary glands (parotitis) and are more common in people who have reached puberty.

Complications of mumps can include:

- Inflammation of the testicles (orchitis) in males who have reached puberty, which rarely leads to sterility
- Inflammation of the brain (encephalitis) and/or tissue covering the brain and spinal cord (meningitis)
- Inflammation of the ovaries (oophoritis) and/or breasts (mastitis) in females who have reached puberty
- Temporary or permanent deafness

Pertussis

Pertussis is a highly communicable, vaccine-preventable disease that lasts for many weeks and is typically manifested in children with paroxysmal spasms of severe coughing, whooping, and posttussive vomiting. Major complications are most common among infants and young children and include hypoxia, apnea, pneumonia, seizures, encephalopathy, and malnutrition. Children who are too young to be fully vaccinated and those who have not completed the primary vaccination series are at highest risk for severe illness and death. Pertussis is endemic in the United States. Although cyclical in nature, a gradual and sustained increase has been observed in the United States after reaching historic lows in the 1970s. In 2010, 27,550 pertussis cases were reported. Year-to-date case counts from 2012 have surpassed those from the previous 5 years for the same period.

Pertussis outbreaks are common, and can stress both the public health system and the medical community. An epidemic was declared in Washington in 2012. By mid-year, the reported number of cases had reached 2,520 (37.5 cases per 100,000 residents), a 1,300 percent increase compared with the same period in 2011 and the highest number of cases reported in any year since 1942. Kansas also experienced an epidemic in 2012. Approximately 420 confirmed cases were reported, compared to only 52 reported during 2011. (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6128a1.htm)

Influenza

Influenza (flu) is a viral infection of the nose, throat, bronchial tubes, and lungs. There are two main types of virus: A and B. Each type includes many different strains, which tend to change each year. In Kansas, influenza occurs most often in the winter months.

Influenza is highly contagious and is easily transmitted through contact with droplets from the nose and throat of an infected person during coughing and sneezing. Typical symptoms include headache, fever, chills, cough, and body aches. Although most people are ill for only a few days some may have secondary infections, such as pneumonia, and may need to be hospitalized. Anyone can get influenza, but it is typically more serious in the elderly and people with chronic illnesses such as cancer, emphysema, or diabetes or weak immune systems.

One study found that during the 1990s, seasonal flu-related deaths in the United States ranged from an estimated 17,000 during the mildest season to 52,000 during the most severe season (36,000 average). Over a period of 31 seasons between 1976 and 2007, estimates of flu-associated deaths in the United States range from a low of about 3,000 to a high of about 49,000 people. During a regular flu season, about 90 percent of deaths occur in people 65 years and older. (http://www.cdc.gov/flu/about/disease/symptoms.htm)

Pandemic Influenza

A flu pandemic is a global outbreak of influenza. Pandemics are caused by novel strains of viruses, for which people have little or no immunity.

This disease spreads easily person-to-person, causing serious illness, and can sweep across the country and around the world in a very short time. The Centers for Disease Control and Prevention (CDC) and the World Health Organization work to strengthen surveillance systems and to assist with pandemic planning and preparation.

A severe influenza pandemic could lead to high levels of illness, death, social disruption, and economic loss. Impacts could range from school and business closings to the interruption of basic services such as public transportation, health care, and the delivery of food and essential medicines.

Because of the process utilized to prepare vaccines, it is impossible to have vaccine pre-prepared to combat pandemics. A portion of the human and financial cost of a pandemic is related to lag time to prepare a vaccine to prevent future spread of the novel virus. In some cases, current vaccines may have limited activity against novel strains.

Food borne Disease

Eight known pathogens account for the vast majority of foodborne illnesses, hospitalizations, and deaths: norovirus, *Salmonella spp*., *Clostridium perfringens*, *Campylobacter spp.*, *Staphylococcus aureus*, *Toxoplasma gondii*, *E. coli* (STEC) O157:H7, and *Listeria monocytogenes*. http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html

Foodborne diseases typically cause gastrointestinal illness, including diarrhea, nausea, vomiting, and abdominal cramps. Illnesses can last from one to seven days, and most persons recover without treatment. However, in some cases, the patient may need to be hospitalized. Complications can include dehydration, sepsis, and hemolytic uremic syndrome. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness. Foodborne diseases are estimated to cause approximately 3,000 deaths each year in the United States.

Norovirus

Noroviruses are a group of related, single-stranded RNA, non-enveloped viruses that cause acute gastroenteritis in humans. The most common symptoms of acute gastroenteritis are diarrhea, vomiting, and stomach pain.

The incubation period for norovirus-associated gastroenteritis in humans is usually between 24 and 48 hours, but cases can occur within 12 hours of exposure. Norovirus infection usually presents as acute-onset vomiting, watery non-bloody diarrhea with abdominal cramps, and nausea. Low-grade fever also occasionally occurs, and diarrhea is more common than vomiting in children. Dehydration is the most common complication, especially among the young and elderly, and may require medical attention. The symptoms of norovirus infection usually last 24 to 72 hours.

Recovery is usually complete and there is no evidence of any serious long-term sequelae. Studies with volunteers given the virus have shown that asymptomatic infection may occur in as many as 30 percent of infections, although the role of asymptomatic infection in norovirus transmission is not well understood.

Noroviruses are transmitted primarily through the fecal-oral route, either by consumption of fecally contaminated food or water or by direct person-to-person spread. Environmental and fomite contamination may also act as a source of infection. Good evidence exists for transmission due to aerosolization of vomitus that presumably results in droplets contaminating surfaces or entering the oral mucosa and being swallowed. No evidence suggests that infection occurs through the respiratory system.

Noroviruses are highly contagious and as few as 10 viral particles may be sufficient to infect an individual. During outbreaks of norovirus gastroenteritis, several modes of transmission have been documented; for example, initial food borne transmission in a restaurant, followed by secondary person-to-person transmission to household contacts. Although pre-symptomatic viral shedding may occur, shedding usually begins with the onset of symptoms and may continue for two weeks or more after recovery. It is unclear to what extent viral shedding over 72 hours after recovery signifies continued infectivity.

Outbreaks caused by norovirus are frequently reported in Kansas. Schools and long-term care facilities (LTCFs) are commonly affected. From 2008-2012, 14 LTCF outbreaks were attributed to norovirus. In August 2012, 83 students and 16 staff members of a Johnson County elementary school were ill with norovirus. The number of ill individuals was so great that the school decided to close for two days.

Salmonellosis

Salmonellosis is an infection with bacteria called *Salmonella*. Most persons infected with *Salmonella* develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The illness usually lasts four to seven days, and most persons recover without treatment. However, in some persons, the diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with

antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

Salmonella is actually a group of bacteria that can cause diarrheal illness in humans. They are microscopic living creatures that pass from the feces of people or animals to other people or other animals. There are many different kinds of Salmonella bacteria. Salmonella serotype Typhimurium and Salmonella serotype Enteritidis are the most common in the United States. Salmonella germs have been known to cause illness for over 100 years. They were discovered by an American scientist named Salmon, for whom they are named.

Many different kinds of illnesses can cause diarrhea, fever, or abdominal cramps. Determining that *Salmonella* is the cause of the illness depends on laboratory tests that identify *Salmonella* in the stool of an infected person. Once *Salmonella* has been identified, further testing can determine its specific type.

Previous Occurrences

Pandemic Influenza

There have been four acknowledged pandemics in the past century:

- **1918–19 Spanish flu (H1N1):** This flu is estimated to have sickened 20-40 percent of the world's population. Over 20 million people lost their lives. Between September 1918 and April 1919, 500,000 Americans died. The flu spread rapidly; many died within a few days of infection, others from secondary complications. The attack rate and mortality was highest among adults 20-50 years old; the reasons for this are uncertain. Recently, the origin of the pandemic was traced to an outbreak of influenza in Haskell County, Kansas, in January 1918. Army personnel in Haskell County reported to Camp Funston (now Ft. Riley), which meant soldiers and their friends and families likely carried the virus from the county to the camp. Camp Funston sent a constant stream of soldiers to other American locations and to Europe, enabling the spread of the disease throughout the country and around the world. By the end of 1918, the Kansas death toll was around 12,000.
- **1957–58 Asian flu (H2N2):** This virus was quickly identified because of advances in technology, and a vaccine was produced. Infection rates were highest among school children, young adults, and pregnant women. The elderly had the highest rates of death. A second wave developed in 1958. In total, there were about 70,000 deaths in the United States. Worldwide deaths were estimated between one and two million. Information about how this pandemic affected Kansas was not available.
- **1968–69 Hong Kong flu (H3N2):** This strain caused approximately 34,000 deaths in the United States and more than 700,000 deaths worldwide. It was first detected in Hong Kong in early 1968 and spread to the United States later that year. Those over age 65 were most likely to suffer fatal consequences. This virus returned in 1970 and 1972 and still circulates today.
- **2009 H1N1 Influenza:** The 2009 H1N1 Pandemic Influenza began in Kansas with the first identified case on April 24, 2009. Kansas was the third state to positively identify this novel strain of influenza and was the first non-border state to confirm a positive identification.

During the 2009 H1N1 Pandemic a total of 29 Kansans died as a result of confirmed infection with the disease.

Other Reportable Diseases

Table 3.118 and **Table 3.119** provide the numbers of reportable diseases by county from 2002 to 2011 organized by Mitigation Planning Region.

Table 3.118. Reportable Diseases by County 2002-2011 (1 of 2)

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Chlamydia	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	Gonorrhea	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	HIV/AIDS	Legionellosis	Listeriosis
Mitigation Planning Region A																		
Cheyenne	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	*	0	0
Decatur	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Gove	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	*	0	0
Logan	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	*	0	0
Rawlins	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	0	0
Sheridan	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	*	0	0
Sherman	0	0	0	1	7	0	0	0	0	0	0	0	0	1	0	*	0	0
Thomas	0	0	0	1	18	0	0	0	0	0	0	0	0	0	0	*	0	0
Wallace	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	*	0	0
Subtotal	**0**	**0**	**0**	**17**	**32**	**0**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Mitigation Planning Region B																		
Ellis	0	0	0	4	156	0	0	0	1	13	1	0	0	0	0	*	0	0
Graham	0	0	0	6	3	0	0	0	2	0	0	0	0	0	0	*	0	0
Ness	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	*	0	0
Norton	0	0	0	2	5	0	0	0	0	1	0	0	0	0	0	*	0	0
Phillips	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Rooks	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	*	0	0
Rush	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	*	0	0
Russell	0	0	0	1	14	0	0	0	0	0	0	0	0	0	0	*	0	0
Trego	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	*	0	0
Subtotal	**0**	**0**	**0**	**19**	**192**	**0**	**0**	**0**	**3**	**16**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mitigation Planning Region C																		
Grant	0	0	0	1	14	0	0	0	0	1	1	0	0	0	0	*	0	0
Greeley	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	*	0	0

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Chlamydia	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	Gonorrhea	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	HIV/AIDS	Legionellosis	Listeriosis
Hamilton	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Kearny	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	*	0	0
Lane	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	*	0	0
Morton	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	*	0	0
Scott	0	0	0	2	14	0	0	0	0	2	0	0	0	0	0	*	0	0
Stanton	0	0	0	1	6	0	0	0	0	0	0	0	0	0	0	*	0	0
Stevens	0	0	0	1	7	0	0	0	0	0	0	0	0	0	0	*	0	0
Washington	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	*	0	0
Subtotal	**0**	**0**	**0**	**9**	**71**	**0**	**0**	**0**	**0**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mitigation Planning Region D																		
Clark	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Finney	1	0	0	16	190	0	0	0	3	18	0	0	0	0	0	*	0	1
Ford	0	0	0	8	118	0	0	0	1	6	0	0	0	0	0	*	0	0
Gray	0	0	0	3	9	0	0	0	0	0	0	0	0	0	0	*	0	0
Haskell	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	*	0	0
Hodgeman	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	*	0	0
Meade	0	0	0	0	7	0	0	0	0	1	0	0	0	0	0	*	0	0
Seward	0	0	0	6	106	0	0	0	2	26	0	0	0	0	0	*	1	0
Subtotal	**1**	**0**	**0**	**36**	**440**	**0**	**0**	**0**	**7**	**51**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Mitigation Planning Region E																		
Barber	0	0	0	0	15	0	0	0	0	0	0	0	0	0	1	*	0	0
Barton	0	0	0	2	87	0	0	0	1	1	0	0	0	0	0	*	0	0
Comanche	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Edwards	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Kiowa	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Pawnee	0	0	0	3	14	0	0	0	0	0	0	0	0	0	0	*	0	0
Pratt	0	0	0	1	20	0	0	0	0	5	0	0	0	0	0	*	0	0
Stafford	0	0	0	0	6	0	0	0	1	0	0	0	0	0	0	*	0	0
Subtotal	**0**	**0**	**0**	**8**	**151**	**0**	**0**	**0**	**2**	**6**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
Mitigation Planning Region F																		
Clay	0	0	0	0	13	0	0	0	0	1	0	0	0	0	0	*	0	0
Cloud	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	*	0	0
Dickinson	0	0	0	3	40	0	0	0	0	3	0	0	0	0	0	*	0	0
Ellsworth	0	0	0	1	5	0	0	0	1	0	0	0	0	0	0	*	0	0

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Chlamydia	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	Gonorrhea	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	HIV/AIDS	Legionellosis	Listeriosis
Jewell	0	0	0	2	3	0	1	0	1	0	0	1	0	0	0	*	0	0
Lincoln	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	*	0	0
Mitchell	0	0	0	1	8	0	4	0	0	1	0	0	0	0	0	*	0	0
Osborne	0	0	0	1	4	0	0	0	1	0	0	0	0	0	0	*	0	0
Ottawa	0	0	0	1	12	0	0	0	0	1	0	0	0	0	0	*	0	0
Republic	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	*	0	0
Saline	0	0	0	11	297	0	2	0	6	56	0	0	0	2	0	*	0	0
Smith	0	0	0	4	2	0	0	0	0	2	0	0	0	0	0	*	0	0
Subtotal	**0**	**0**	**0**	**26**	**420**	**0**	**7**	**0**	**9**	**64**	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**
Mitigation Planning Region G																		
Butler	0	0	0	7	172	0	1	0	2	16	0	0	0	0	0	*	0	1
Cowley	0	0	0	4	164	0	0	0	4	30	0	0	0	0	0	*	0	1
Harper	0	0	0	1	12	0	0	0	1	4	0	0	0	0	0	*	0	0
Harvey	0	0	0	4	99	0	0	0	2	5	1	0	0	0	0	*	0	0
Kingman	0	0	0	2	7	0	0	0	1	1	0	0	0	0	0	*	0	0
Marion	0	0	0	1	18	0	0	0	0	2	0	0	0	0	0	*	0	0
McPherson	0	0	0	1	55	0	0	0	0	11	0	0	0	0	0	*	0	0
Reno	0	0	0	5	191	0	0	0	0	38	2	0	0	1	0	*	1	0
Rice	0	0	0	2	34	0	0	0	0	1	0	0	0	0	0	*	0	0
Sedgwick	1	0	0	37	2,697	0	2	0	23	799	8	1	1	5	1	47	3	6
Sumner	0	0	1	5	57	0	0	0	0	2	0	0	0	0	0	*	0	0
Subtotal	**1**	**0**	**1**	**69**	**3,506**	**0**	**3**	**0**	**33**	**909**	**11**	**1**	**1**	**6**	**1**	**47**	**4**	**8**
Mitigation Planning Region H																		
Allen	0	0	0	0	28	0	0	0	0	0	1	0	0	0	0	*	0	0
Bourbon	0	0	0	4	34	0	2	0	1	2	0	0	0	0	0	*	0	0
Chautauqua	0	0	0	1	8	0	0	0	0	0	0	0	0	0	0	*	0	0
Cherokee	0	0	0	0	56	0	0	0	2	2	0	0	0	1	0	*	0	0
Crawford	0	0	0	4	128	0	0	0	0	13	0	0	0	0	1	*	0	0
Elk	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	*	0	0
Greenwood	0	0	0	1	7	0	0	0	0	2	0	0	0	0	0	*	0	0
Labette	0	0	0	1	67	0	0	0	0	16	0	0	0	0	0	*	0	0
Montgomery	0	0	0	1	114	0	0	0	3	20	0	0	0	0	1	*	0	0
Neosho	0	0	0	1	44	0	0	0	0	2	0	0	0	1	0	*	0	0
Wilson	0	0	0	0	18	0	0	0	0	4	0	0	0	0	0	*	0	0
Woodson	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	*	0	0

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Chlamydia	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	Gonorrhea	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	HIV/AIDS	Legionellosis	Listeriosis
Subtotal	**0**	**0**	**0**	**13**	**514**	**0**	**2**	**0**	**6**	**61**	**1**	**0**	**0**	**2**	**2**	**0**	**0**	**0**
Mitigation Planning Region I																		
Chase	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	*	0	0
Geary	0	0	0	1	289	0	0	0	0	59	0	0	0	0	1	*	0	0
Lyon	0	0	0	1	125	0	0	0	0	21	0	0	0	0	0	*	0	0
Morris	0	0	0	1	6	0	0	0	0	1	0	0	0	0	0	*	0	0
Pottawatomie	0	0	0	2	32	0	0	1	0	3	0	0	0	0	0	*	0	0
Riley	0	0	0	7	341	1	0	0	4	46	0	0	0	0	1	*	0	1
Wabaunsee	0	0	0	1	9	0	0	0	0	2	0	0	0	0	0	*	0	0
Subtotal	**0**	**0**	**0**	**13**	**805**	**1**	**0**	**1**	**4**	**132**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**1**
Mitigation Planning Region J																		
Anderson	0	0	0	1	24	0	0	0	1	1	0	0	0	0	0	*	0	0
Coffey	0	0	0	0	15	0	0	0	1	1	0	0	0	0	0	*	0	0
Franklin	0	0	0	3	95	0	0	0	4	7	0	0	0	0	0	*	0	0
Linn	0	0	0	2	14	0	1	1	1	1	0	0	1	0	0	*	0	0
Miami	0	0	0	3	58	0	1	0	0	4	0	0	0	0	0	*	0	0
Osage	0	0	0	0	32	0	0	0	2	6	0	0	0	0	0	*	0	0
Shawnee	0	0	0	9	816	0	0	0	5	253	0	0	0	0	0	13	0	0
Subtotal	**0**	**0**	**0**	**18**	**1,054**	**0**	**2**	**1**	**14**	**273**	**0**	**0**	**1**	**0**	**0**	**13**	**0**	**0**
Mitigation Planning Region K																		
Atchison	0	0	0	0	49	0	0	0	0	5	2	0	0	0	0	*	0	0
Brown	0	0	0	0	28	0	0	0	1	0	0	0	0	0	0	*	0	0
Doniphan	0	1	0	2	18	0	0	0	0	0	0	0	0	0	0	*	0	0
Douglas	0	0	0	11	459	0	3	2	6	52	0	0	0	0	1	6	0	0
Jackson	0	0	0	1	38	0	0	0	0	3	0	0	0	0	0	*	0	0
Jefferson	0	0	0	1	33	0	0	1	1	3	1	0	0	0	0	*	0	0
Marshall	0	0	0	3	16	0	0	0	3	1	0	0	0	0	0	*	0	0
Nemaha	0	0	0	0	7	0	0	0	1	0	0	0	0	0	0	*	0	0
Wallace	0	0	0	5	6	0	0	0	0	0	0	0	0	0	0	*	0	0
Subtotal	**0**	**1**	**0**	**23**	**654**	**0**	**3**	**3**	**12**	**64**	**3**	**0**	**0**	**0**	**1**	**6**	**0**	**0**
Mitigation Planning Region L																		
Johnson	0	0	0	37	1,312	0	18	2	38	187	3	1	1	3	0	48	7	3
Leavenworth	0	0	0	5	264	0	0	0	1	53	1	0	0	0	0	*	0	0

County	Amebiasis	Arboviral Disease	Botulism	Campylobacteriosis	Chlamydia	Cholera	Cryptosporidiosis	Ehrlichiosis/Anaplasmosis	Giardiasis	Gonorrhea	H. influenzae, invasive	Hemolytic Uremic Syndrome (HUS)	Hepatitis A	Hepatitis B, acute	Hepatitis C, acute	HIV/AIDS	Legionellosis	Listeriosis
Wyandotte	0	0	0	7	1,187	0	7	0	6	389	2	0	1	1	0	19	2	1
Subtotal	0	0	0	49	2,763	0	25	2	45	629	6	1	2	4	0	67	9	4
Statewide Totals																		
Totals	**2**	**1**	**1**	**300**	**10,602**	**1**	**42**	**7**	**138**	**2,210**	**23**	**3**	**4**	**15**	**7**	**133**	**14**	**14**

Source: Kansas Department of Health and Environment, *Zero to five cases reported. Not shown to protect confidentiality.

Table 3.119. Reportable Diseases by County 2002-2011 (2 of 2)

County	Lyme Disease	Malaria	Measles	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	Syphilis, 1° & 2°	Syphilis, early latent	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Mitigation Planning Region A																				
Cheyenne	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Decatur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gove	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0
Logan	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Rawlins	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sheridan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sherman	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Thomas	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0
Wallace	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**10**	**3**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mitigation Planning Region B																				
Ellis	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Graham	0	0	0	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0
Ness	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Norton	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1
Phillips	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0

County	Lyme Disease	Malaria	Measles	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	Syphilis, 1° & 2°	Syphilis, early latent	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Rooks	0	0	0	0	0	0		1	0	0	0	1	0	0	0	0	0	0	0	0
Rush	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Russell	0	0	0	0	0	0		0	2	3	0	0	0	0	0	0	0	0	0	0
Trego	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**4**	**6**	**12**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Mitigation Planning Region C																				
Grant	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0
Greeley	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Hamilton	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Kearny	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Lane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Morton	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Scott	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Stanton	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Stevens	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**8**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**
Mitigation Planning Region D																				
Clark	0	0	0	0	0	0	0	0	3	1	3	0	0	0	0	0	0	0	0	0
Finney	0	0	1	0	0	0	0	0	12	0	3	0	1	1	1	0	0	0	0	0
Ford	0	0	0	0	0	0	5	1	11	1	0	0	4	0	0	0	1	0	0	1
Gray	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0
Haskell	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1
Hodgeman	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0
Meade	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Seward	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	1	0	0	0
Subtotal	**0**	**0**	**1**	**0**	**0**	**0**	**6**	**2**	**38**	**2**	**10**	**1**	**5**	**1**	**1**	**0**	**2**	**0**	**0**	**2**
Mitigation Planning Region E																				
Barber	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Barton	0	0	0	0	0	0	0	0	9	3	0	0	1	0	0	0	0	0	0	6
Comanche	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Edwards	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0
Kiowa	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
Pawnee	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0

County	Lyme Disease	Malaria	Measles	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	Syphilis, 1° & 2°	Syphilis, early latent	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Pratt	0	0	0	0	0	0	0	1	4	0	2	0	0	0	0	0	0	0	0	0
Stafford	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**20**	**5**	**3**	**2**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**6**
Mitigation Planning Region F																				
Clay	0	0	0	0	0	0	1	0	2	1	1	0	1	0	0	0	0	0	0	0
Cloud	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
Dickinson	0	0	0	0	0	0	6	0	7	0	0	1	0	0	0	0	0	1	0	1
Ellsworth	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	4
Jewell	0	0	0	0	0	0	0	0	3	1	0	0	1	0	0	0	0	0	0	1
Lincoln	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0
Mitchell	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Osborne	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ottawa	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0
Republic	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Saline	0	0	0	0	0	0	0	2	8	0	0	2	11	1	1	0	1	0	0	0
Smith	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**3**	**31**	**10**	**1**	**4**	**14**	**1**	**1**	**0**	**1**	**1**	**0**	**6**
Mitigation Planning Region G																				
Butler	1	2	0	0	0	0	0	1	7	1	1	0	2	0	1	0	0	0	0	2
Cowley	1	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	2	0	0	3
Harper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harvey	0	0	0	0	0	0	0	0	5	0	0	0	2	1	0	0	0	0	0	0
Kingman	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	8
Marion	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
McPherson	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0
Reno	0	1	0	0	0	0	0	3	11	0	0	2	10	0	0	0	1	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Sedgwick	1	1	0	1	1	1	3	3	46	12	6	1	26	2	10	0	7	3	2	29
Sumner	0	0	0	0	0	0	0	2	3	1	1	0	0	0	0	1	0	0	0	0
Subtotal	**3**	**4**	**0**	**1**	**1**	**1**	**3**	**10**	**82**	**15**	**8**	**3**	**44**	**3**	**11**	**1**	**10**	**3**	**2**	**44**
Mitigation Planning Region H																				
Allen	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0
Bourbon	1	0	0	0	0	0	0	0	4	1	3	0	0	0	0	0	0	0	0	0
Chautauqua	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0

County	Lyme Disease	Malaria	Measles	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	Syphilis, 1° & 2°	Syphilis, early latent	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Cherokee	0	0	0	0	0	0	0	0	4	2	5	0	0	0	0	0	0	0	0	1
Crawford	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0
Elk	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Greenwood	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Labette	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	1
Montgomery	1	0	0	0	0	0	4	0	0	1	1	0	0	0	0	0	0	0	0	5
Neosho	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0
Wilson	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Woodson	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**2**	**0**	**0**	**1**	**0**	**0**	**4**	**1**	**32**	**10**	**9**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**7**
Mitigation Planning Region I																				
Chase	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Geary	0	0	0	0	0	1	2	1	6	2	0	0	2	0	1	0	1	0	0	1
Lyon	0	0	0	0	0	0	0	0	15	0	1	0	1	0	0	0	0	0	0	3
Morris	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0
Pottawatomie	0	0	0	0	0	0	0	0	12	0	2	0	0	0	0	0	0	0	0	0
Riley	0	0	0	0	0	1	0	1	13	5	1	0	1	0	1	1	0	0	0	1
Wabaunsee	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	2	3	2	50	8	4	1	4	0	2	1	1	0	0	5
Mitigation Planning Region J																				
Anderson	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Coffey	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0
Franklin	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0
Linn	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	4
Miami	0	0	0	0	0	0	0	0	8	1	0	0	1	0	0	0	0	0	0	1
Osage	0	0	0	1	0	0	7	1	5	0	0	0	1	0	0	0	0	0	0	2
Shawnee	0	1	0	2	0	1	0	1	23	8	2	1	9	5	4	2	0	0	0	2
Subtotal	**0**	**1**	**0**	**3**	**0**	**1**	**7**	**3**	**49**	**9**	**2**	**1**	**12**	**6**	**4**	**2**	**1**	**0**	**0**	**9**
Mitigation Planning Region K																				
Atchison	0	0	0	0	0	0	0	0	3	1	2	0	2	0	0	0	0	0	0	1
Brown	0	0	0	0	0	0	0	1	0	1	4	0	2	0	0	0	0	0	0	2
Doniphan	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0
Douglas	0	0	0	1	0	0	9	0	18	3	0	2	9	2	6	0	1	1	0	1
Jackson	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	3	0	0	0

County	Lyme Disease	Malaria	Measles	Meningitis, non-HiB, non-Neisseria	Meningococcal Disease	Mumps	Pertussis	Rabies, animal	Salmonellosis	Shiga toxin-producing E. coli	Shigellosis	Strep., Group A, invasive	Strep. pneumoniae, invasive	Syphilis, 1° & 2°	Syphilis, early latent	TSE or Prion Disease	Tuberculosis, active	Tularemia	Typhoid Fever	Varicella
Jefferson	0	0	0	0	0	0	0	0	7	1	1	1	1	0	0	0	0	0	0	2
Marshall	0	0	0	0	0	0	1	1	1	1	0	0	2	0	0	0	0	0	0	2
Nemaha	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0	0	0	0
Wallace	0	0	0	0	0	0	0	1	2	2	0	0	2	0	0	0	0	0	0	0
Subtotal	**0**	**0**	**0**	**2**	**0**	**0**	**10**	**3**	**41**	**10**	**10**	**3**	**18**	**2**	**6**	**0**	**4**	**1**	**0**	**8**
Mitigation Planning Region L																				
Johnson	3	4	6	1	2	0	2	0	68	21	8	11	13	8	5	1	7	0	2	16
Leavenworth	2	0	0	0	0	0	0	0	8	0	2	1	1	0	0	0	1	0	0	2
Wyandotte	1	1	0	0	1	0	10	0	20	1	9	3	10	3	3	0	5	0	0	0
Subtotal	**6**	**5**	**6**	**1**	**3**	**0**	**12**	**0**	**96**	**22**	**19**	**15**	**24**	**11**	**8**	**1**	**13**	**0**	**2**	**18**
Statewide Totals																				
Totals	11	10	7	9	5	4	52	31	463	108	67	32	124	24	34	5	35	5	4	108

Source: Kansas Department of Health and Environment

Probability of Future Hazard Events

Each year, the Kansas Department of Health and Environment produces a report that details the legally —reportable diseases" in each county in Kansas. While over time this report can serve as a predictor of the likelihood of future disease, it is impossible to predict outbreaks. Based on the relatively limited/controlled outbreak history in the State, the KHMT determined the possibility of a large-scale major disease outbreak to be **–Possible".**

In 2010 a four-year campaign by the Kansas Healthcare Collaborative* (KHC) to increase the number of hospital health care workers receiving yearly influenza vaccinations as part of the effort to decrease health care associated infections was begun. This effort to reduce the spread of influenza and to protect the health of both patients and health care workers recommended that all health care workers, including medical staff, receive the seasonal influenza vaccine. KHC established a statewide goal to increase the Kansas hospital health care worker seasonal influenza immunization rate to 100 percent by 2014. Kansas hospitals continue to make progress towards this goal. In a survey conducted in 2011, results indicated that 78 percent of hospital health care workers, including medical staff, were vaccinated against seasonal influenza for the 2010-2011 flu season.

State Vulnerability Analysis

The entire state is vulnerable to a major disease outbreak. As evidenced by annual infectious disease summaries (http://www.kdheks.gov/epi/index.html) and reports of investigations (http://www.kdheks.gov/epi/outbreaks.htm) completed by the KDHE Bureau of Epidemiology and Public Health Informatics, many Kansas counties experience one or multiple disease outbreaks each year. Potential casualty losses are anticipated to be greatest in counties with higher populations, higher pediatric populations and higher elderly populations. (See **Section 3.1.2**, Population and **Figure 3.47** and **Figure 3.48** for distribution of elderly and pediatric populations). Health professional shortage areas and rural areas are more susceptible to having limited medical capabilities and by extension are more susceptible to the possibility of being overwhelmed because of a large surge of patients seeking care. The percentage of uninsured Kansans for 2008-2009 was 13 percent compared to 17 percent nationally. National data suggest that males are more likely to be uninsured (17 percent) than females (13 percent). In Kansas, the percentage of males and females that are uninsured is 14 and 12 respectively.

Although infectious diseases do not respect geographic boundaries, several populations in Kansas are at specific risk to infectious diseases. Communicable diseases are most likely to spread quickly in institutional settings such as dormitories, long-term care facilities, day care facilities, schools, etc.

The HMPC ranked the disease outbreak as catastrophic based on a pandemic scenario. The magnitude of an infectious disease outbreak is related to the ability of the public health and medical communities to stop the spread of the disease. Most disease outbreaks that cause catastrophic numbers of deaths are infectious in nature, meaning that they are spread from person to person. The key to reducing the catastrophic nature of the event is to stop the spread of disease. This is generally done in three ways: (1) identification and isolation of the ill, (2) quarantine of those exposed to the illness to prevent further spread, and (3) education of the public about methods to prevent transmission. The public health and health care providers in Kansas County routinely utilize all three methods to reduce morbidity and mortality from infectious disease. However, the capacity of the health care system is limited. For example, local health departments have specific pandemic influenza response plans, and mass prophylaxis plans, but most departments have only a few staff members. Most local health departments would need to rely on volunteers, pre-scripted messages and procedures and the cooperation of the public in order to respond effectively to a large scale pandemic. Similarly, hospitals in Kansas have emergency response and pandemic influenza plans, but little excess capacity exists to care for and/or isolate hundreds, even thousands of patients. Because of these limitations in personnel and equipment, the health care community is planning to utilize —ommunity containment" measures. These measures which could include closure of schools, day cares and other public events would have far-reaching economic impacts on the community and might shutdown facilities for 30 days or more. Closure of the day cares or schools would have a serious impact on business as parents might not be able to find child care elsewhere.

State Estimates of Potential Losses

According to *The annual impact of seasonal influenza in the US: Measuring disease burden and costs* by Molinari et al., nationally the economic burden of influenza medical costs, medical costs plus lost earnings, and the total economic burden were $10.4 billion, $26.8 billion and $87.1 billion respectively. The financial burden of healthcare-associated infections nationally has been estimated at $33 billion annually. There is no data currently available on the economic impact of previous illness in Kansas. Using pandemic influenza as the worst case scenario for estimating potential losses, the Kansas Department of Health and Environment's Pandemic Influenza Planning includes the following vulnerability estimates. It has been estimated that a medium-level pandemic could cause, in Kansas:

- Between 229,203 and 534,807 persons may require outpatient care
- Between 5,016 and 11,706 may require hospitalization
- Between 1,163 and 2,714 individuals may die

The majority of these deaths, hospitalizations, etc would occur in more highly populated counties.

The U.S. Centers for Disease Control and Prevention (CDC) estimates 76 million people suffer foodborne illnesses each year in the United States, accounting for 325,000 hospitalizations and more than 5,000 deaths. Foodborne disease is extremely costly. Health experts estimate that the yearly cost of all foodborne diseases in this country is $5 to $6 billion in direct medical expenses and lost productivity. Infections with the bacteria *Salmonella* alone account for $1 billion yearly in direct and indirect medical costs.

Development in Hazard Prone Areas

Buildings, infrastructure, and critical facilities are not vulnerable to this hazard. It affects only persons susceptible to the illness. The impacts and potential losses are largely economic and are dependent on the type, extent, and duration of the illness. As the population of Kansas ages, the vulnerability to this hazard is likely to increase.

Hazard Impact Overview

The information in **Table 3.120** provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.120. EMAP Impact Analysis: Major Disease Outbreak

Subject	Ranking	Impacts/Major Disease Outbreak
Health and Safety of Persons in the Area of the Incident	Severe	Impact over a widespread area could be severe depending on type of outbreak and whether it is a communicable disease. Casualties are dependent on warning systems, warning times and the availability of vaccines, antidotes, & medical svc.
Responders	Severe	Impact to responders could be severe, especially if they reside in the area and or their type of exposure during response. With proper precautions and safety nets in place the impact is lessened.
Continuity of Operations	Minimal	Continuity of Operations will be greatly dependent on availability of healthy individuals. COOP is not expected to be exercised (minimal).
Property, Facilities, and Infrastructure	Minimal	Access to facilities and infrastructure could be affected until decontamination is completed
Delivery of Services	Minimal	Delivery of services could be affected if there are road blocks or mass hysteria of any level (minimal).
Environment	Severe	Impact could be severe for the immediate impacted area depending on the source of the outbreak. Impact could have far-reaching implications if disease is transferable between humans and animals or to wildlife.
Economic Conditions	Severe	Impacts to the economy could be severe if the disease is communicable. Loss of tourism, revenue, and business as usual will greatly affect the local economy and the state as a whole.
Public Confidence in Jurisdiction‘s Governance	Severe	Response and recovery will be in question if not timely and effective. Availability of medical supplies, vaccines, and treatments will come into question (minimal to severe).

3.3.15. Radiological

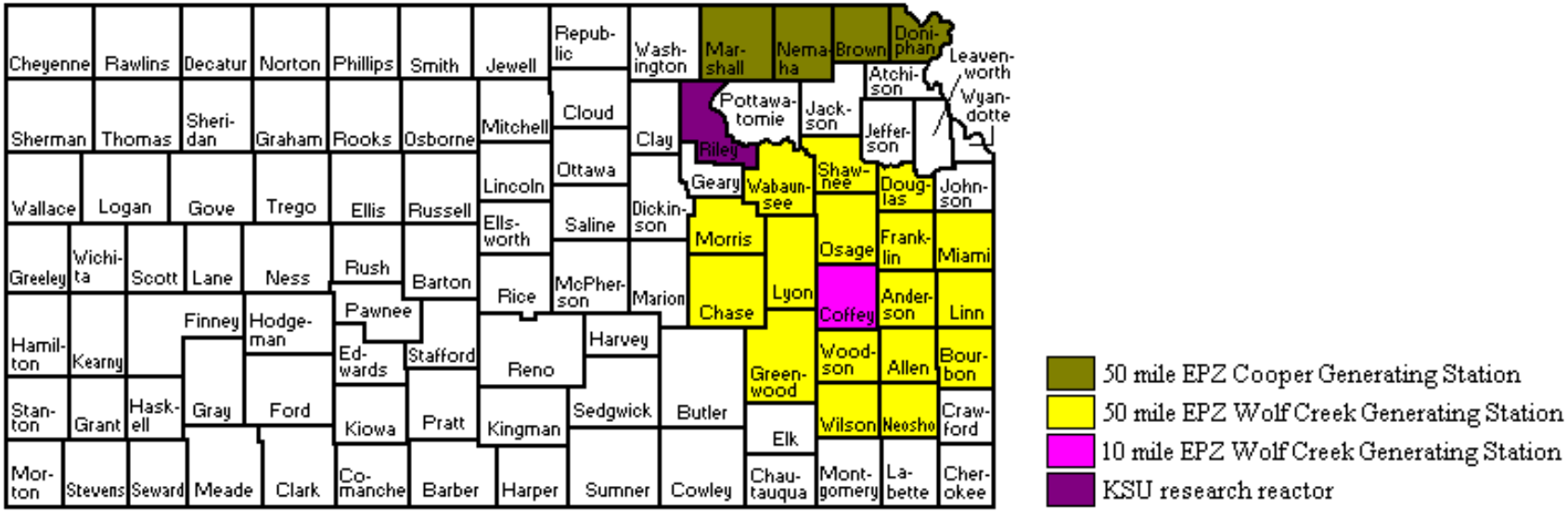
Calculated Priority Risk Index	Planning Significance
1.95	Low

Description/Location

An accident involving radioactive materials could occur in Kansas from a variety of sources: nuclear reactors, transportation accidents (see **Section 3.3.10**, Hazardous Materials), industrial and medical uses and lost or stolen sources to which the public could be exposed, or contaminated, with a high level of radiation. Radiological accidents could cause injury or death, contaminate property and valuable environmental resources, as well as disrupt the functioning of communities and their economies. There have been no reported events of this type in the State of Kansas, and all information contained in this hazard profile remains valid and current for the 2013 update.

There are several Kansas counties included in 10-mile and 50-mile emergency planning zones (EPZ) for nuclear power plants. There are two commercial plants that could pose a threat to Kansas: The Wolf Creek Nuclear Power Plant in Coffey County and the Cooper Nuclear Station in Nemaha County, Nebraska (southeast).There is also Kansas State University‘s TRIGA research reactor that supports education, research, training, and regional industries. **Figure 3.96** illustrates counties impacted by nuclear power plant emergency planning or the university reactor.

Figure 3.96. Counties Impacted by Nuclear Power Plants or Reactors in Kansas



Source: Kansas Department of Health and Environment

There are over 300 licensees for radioactive material that varies in size from small sources to large sources. Most uses of radioactive materials are spread across the State and the highest amount of uses is in the populated areas. Diagnostic and therapy medical sources are common at most hospitals. Universities often have some radioactive material for research and education. Commercially used radioactive materials are more common in the eastern third of Kansas. Radioactive materials used in water and hydrocarbon extraction are commonly used in western Kansas. These sources of radioactive materials are not considered significant concerns as they are highly regulated by the State.

It is common for materials, including pharmaceuticals, industrial sources and nuclear fuel rods destined to nuclear reactors, to be transported across Kansas highways and railroads (see map of transportation infrastructure in **Section 0**, Utility/Infrastructure Failure).

Previous Occurrences

There have been a couple occurrences at Wolf Creek Nuclear Generating Station and radiological accidents in Kansas during operation and transportation of devices and sources. Most notably, none have caused serious injury or death. Incidents include lost and stolen sources, well-logging sources lost down holes, overexposures and fires involving gauges and materials.

Notable Events at Wolf Creek Nuclear Generating Station

- **September 12, 2012:** The NRC issued a Notice of Violation to Wolf Creek Nuclear Operating Corporation (Wolf Creek) for a violation of Technical Specification 5.4.1(a) and Regulatory Guide 1.33, Appendix A, Section 9.a, associated with a Yellow Significance Determination Process finding. The finding involved Wolf Creek‘s failure to implement maintenance that affected safety-related equipment in accordance with written procedures. Specifically, although required by a work order, Wolf Creek failed to install insulating sleeves on two splices associated with a startup transformer protective relay circuit. The startup transformer subsequently experienced a trip and lockout during a plant trip because the two uninsulated wires touched and provided a false high phase differential signal to the protective relaying circuit. The protective lockout caused prolonged loss of offsite power to all Train B equipment and all non-safety related buses.
- **April 3, 1997:** The action is based on a Severity Level III problem consisting of three violations involving: (1) the failure to correct erroneous Technical Specification clarifications after being alerted of their existence by licensee Quality Assurance findings, (2) the continued existence of an erroneous Technical Specification clarification after being informed by the NRC that it was incorrect, and (3) an unauthorized change to the Technical Specifications.
- **July 1, 1996:** Frazil ice renders on train of ESW inoperable and the other train degraded; inoperable turbine driven AFW; operational inadequacies in response to icing event.

Other Notable Radiological Events

- **July 12, 2005:** Destroyed moisture/density gauge: A moisture/density gauge was destroyed when the operator of a passenger car failed to follow a pilot car at a construction site, entered a closed lane and ran over the gauge while in operation.
- **May 17, 2002:** Destroyed moisture/density gauge: A moisture/density gauge was destroyed when it was run over by an earthmover. The case and source rod were intact and undamaged, the guide rod for the source rod was bent.
- **March 22, 1979:** Transportation spill: At the I-235 underpass near the Meriden Street exit, in Wichita, a truck carrying refined uranium, yellow cake, overturned and several container drums were breached. Soil and the refined uranium were removed, over packed, and shipped to a facility out of the State.

Probability of Future Hazard Events

Based on the small number of notable radiological events for the State of Kansas, this hazard's CPRI probability is ~~"~~**Unlikely**" within the next ten years.

State Vulnerability Analysis

Counties within the 10-mile EPZ for commercial nuclear power plants (in Kansas, this is only Coffey County) have a relatively higher radiological risk than other counties, but the potential for an incident is extremely low. Nemaha, Brown and Doniphan Counties have moderate vulnerability since they are the closest counties to the Cooper Nuclear Plant in Nebraska. In general, radioactive material is distributed across the State proportionally to population density. Areas near interstates and major highways have an increased risk of transportation accidents. Remote areas also have to account for long response times from hazardous materials and health physics personnel. Stolen and lost sources can put the public at elevated risks if the material is unidentified and lost, abandoned or intentionally placed in a public area. Field radiography cameras are used extensively in pipeline construction and repair.

State Estimates of Potential Losses

The potential danger from an accident is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume (cloud-like formation) of radioactive gases and particles. The major hazards to people in the vicinity of the plume are radiation exposure to the body from the cloud and particles deposited on the ground, inhalation of radioactive materials and ingestion of radioactive materials.

Development in Hazard Prone Areas

Federal regulations require emergency planning for the area within up to a 50-mile radius of a nuclear power plant. The two areas affected by this, while experiencing some development and growth, are not increasing in population at such a rate to modify the risk substantially in the near future.

Contaminated sites in urban environments are a concern as often the sewer system and other underground structures can act as conduits for the migration of nonsoluble radionuclides in the

subsurface. This should be a consideration for excavation near or down gradient from a known contaminated site.

During all lawful operations of radioactive materials, the licensee is responsible for ensuring that the area around the source material is cordoned off or shielding is used to prevent unnecessary exposures. Inspections of practices and security measures are regularly conducted to ensure compliance and conformity to regulations in order to protect the public. The frequency of inspections can be adjusted in response to perceived risk. Public risk can be reduced by minimizing the duration of exposure, shielding the source material and maximizing the distance from the source.

Consequence Analysis

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

Table 3.121. EMAP Consequence Analysis: Radiological

Subject	Ranking	Impacts/Radiological
Health and Safety of Persons in the Area of the Incident	Severe	Impact expected to be severe for persons within the incident area. Protection capabilities and warning times will greatly affect the severity.
Responders	Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Temporary relocation could be necessary if government facilities are in close proximity to the incident area. This temporary relocation could become significant depending on clean-up (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe to property, facilities, and infrastructure.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the affected area (minimal to severe).
Environment	Severe	Localized impact within the incident area could be severe to native plants, wildlife and natural habitats. Clean up and remediation will be required.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation (minimal to severe).
Public Confidence in Jurisdiction‘s Governance	Minimal to Severe	Impact will be dependent on whether or not the incident could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes (minimal to severe).

3.3.16. Soil Erosion and Dust

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description/Location

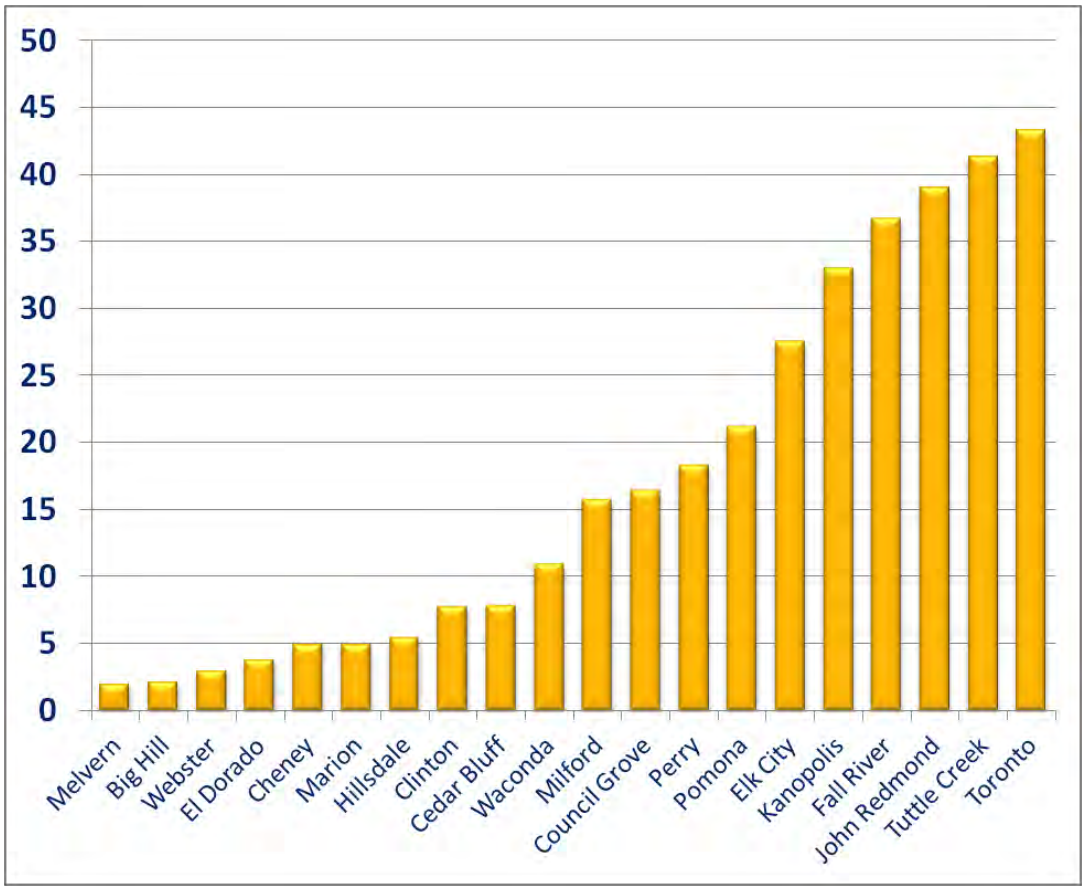
Soil erosion and dust are both ongoing problems for Kansas. Both can cause significant loss of valuable agricultural soils, damage crops, harm environmental resources and have adverse economic impacts. Soil erosion in Kansas is largely associated with periods of drought, when winds are able to move tremendous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

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

Stream bank erosion, which can remove agricultural land and damage or destroy roads and bridges and utility lines, occurs each year, particularly in the spring when high runoff is most common. A large proportion of all eroded soil material ends up in rivers, streams and lakes, which makes waterways more prone to flooding and contamination and reduces water supply storage space.

Federal reservoirs are a vital resource for public water suppliers in Kansas, providing regional sources of stored untreated water for more than two-thirds of the State‘s population. The silting of these reservoirs is impacting water supply and quality as well as flood storage. Because of differing climatic conditions, land uses and physical attributes in the various watersheds, sedimentation rates vary among the reservoirs. While sediment deposition is a concern at all federal reservoir sites where the State has water storage, the concerns vary with percent of storage loss and the demand placed on the reservoir. **Figure 3.97** shows Toronto, Tuttle Creek and John Redmond Reservoirs as having the highest percent of loss of capacity in Kansas. Human activities such as urbanization, agriculture and alteration of riparian and wetland habitats can also accelerate this process.

Figure 3.97. Federal Public Water Supply Reservoirs in Kansas, Percent of Loss of Capacity, May 2012



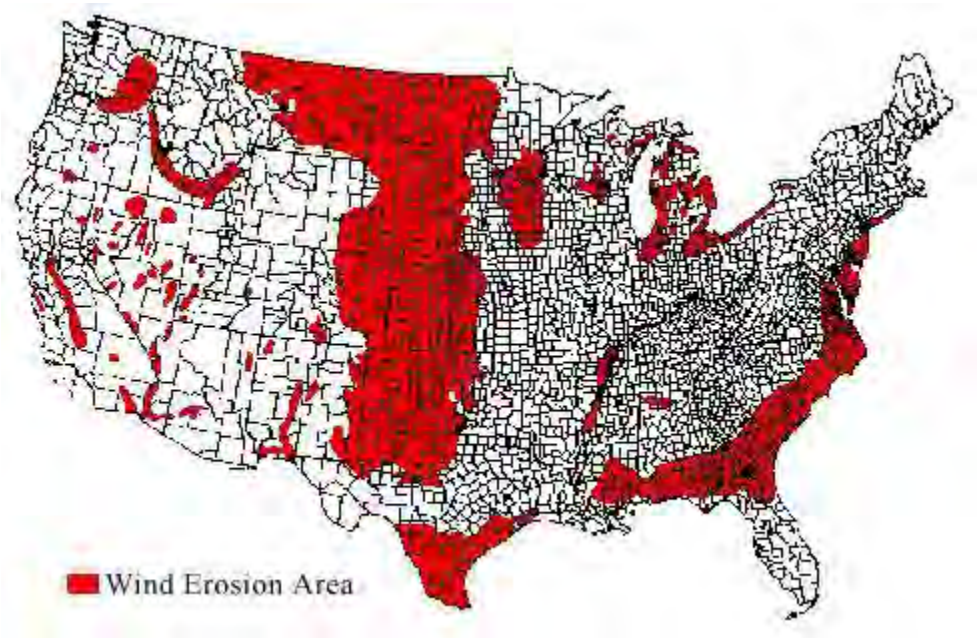
Source: Kansas Water Office, May 2012

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

The risk rating for dust or wind erosion is relatively low for the State, with a slightly higher risk defined for the western portion (see **Figure 3.98**). This higher risk in the western counties of Kansas correlates with the fact that this area of the State has higher wind velocities than central and eastern Kansas. The higher risk in western Kansas is also associated with the economic impacts to agriculture caused by wind erosion and dust. Following the flooding in 1993, silt and sand deposits that accumulated along the bottomlands in central and eastern Kansas were

incorporated into topsoil, which increased the soils, and thus the region‘s, susceptibility to wind erosion.

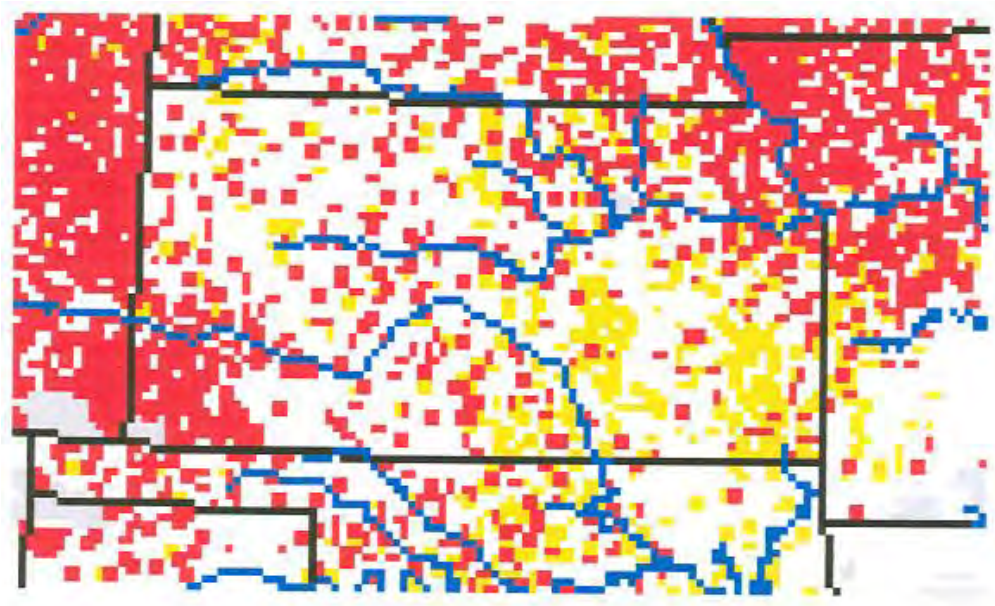
Figure 3.98. United States Wind Erosion Areas



Source: U.S. Department of Agriculture Agricultural Research Service Wind Erosion Research Unit, www.weru.ksu.edu

Figure 3.99 shows areas of excessive erosion of farmland in Kansas based on a 1997 analysis. Each red dot represents 5,000 acres of highly erodible land, and each yellow dot represents 5,000 acres of non-highly erodible land with excessive erosion above the tolerable soil erosion rate. This map suggests that most of Kansas is experiencing water and wind erosion.

Figure 3.99. Locations of Excessive Erosion of Farmland, 1997



Source: Natural Resources Conservation Service

Previous Occurrences

- **2007:** According to the 2007 Natural Resources Inventory (NRI) by the Natural Resources Conservation Service, Kansas lost 1.734 tons per acre to wind erosion on cultivated cropland.
- **May 29, 2004:** Severe thunderstorms in northwest Kansas and northeast Colorado and a cold front in northwest Kansas combined to create a huge dust cloud similar to the ones of the Dust Bowl days. Visibility in Wakeeney, Ellis, Ransom, and Alexander dropped to near zero for several hours. Visibilities were reduced to tens of feet in some instances. Traffic on I-70 was adversely affected. Several pileups occurred. Two lives were lost.
- **1948 to 1984:** Wind erosion likely caused a decline in silt and organic matter during this timeframe from USDA's Long Term Monitoring of Wind Erosion Induced Changes to Soil Properties in Western Kansas study (source: http://topsoil.nserl.purdue.edu/~flanagan/isele2011/presentations/11113-Tatarko.pdf).
- **1930s:** Kansas is well known for its role in the 1930s Dust Bowl, in which the Central Plains states suffered drought and resulting wind erosion for about a decade. It is estimated that 21.5 million acres were lost during this time.

Probability of Future Hazard Events

While soil erosion and dust occurs annually as part of natural processes, it was determined by the hazard mitigation team that this hazard's CPRI probability for **"notable"** events is **"Possible**" within the next five years.

Kansas State University‘s Wind Erosion Laboratory continues to study wind erosion to project future events. It strives to improve the Wind Erosion Prediction System (WEPS) for cropland and extending it to range, forest, military and disturbed lands.

Also the monitoring by USDA‘s Long Term Monitoring of Wind Erosion Induced Changes to Soil Properties in Western Kansas study concluded that adoption of conservation tillage and residue management appears to have stabilized or reversed the wind erosion trend in soil texture and organic matter. Thus the State can continue to encourage land owners to use conservation practices to minimize soil losses from the wind.

State Vulnerability Analysis

Essentially all of Kansas is prone to soil erosion, with the western half of the State more vulnerable to wind erosion and dust because of a greater amount of farmland and higher velocity winds.

State Estimates of Potential Losses

There have not been any state-wide studies to estimate the dollar value of top soil lost to soil erosion and dust.

The 2007 Natural Resources Inventory (NRI) by the Natural Resources Conservation Service **Table 3.122** shows the historical estimates for tons per acres soil lost annually for cultivated cropland, non-cultivated cropland, Conservation Reserve Program (CRP) land and pastureland. This estimate can continue as potential soil losses in Kansas.

Table 3.122. Kansas Average Wind Erosion in Tons/Acre/Year by Broad Cover/Use and Year

Broad Cover/Use	1982	1987	1992	1997	2002	2007
Cultivated Cropland	2.747	2.963	2.062	1.482	1.463	1.734
Noncultivated Cropland	.907	.830	.887	.339	.413	.501
CRP Land	n/a	10.478	.640	.328	.394	.860
Pastureland	.009	.016	.022	.015	.019	.034

Source: 2007 National Resources Inventory, http://www.ks.nrcs.usda.gov/technical/ks_nri.html, dated April 22, 2010
Note: Estimated average annual wind erosion is tons per acre per year with margins of error.

Development in Hazard Prone Areas

Buildings and infrastructure are generally not affected by dust. Buildings and infrastructure can be affected by soil erosion if the erosion creates an unstable building, bridge or infrastructure.

Consequence Analysis

Wind erosion can cause crop loss, fertility loss, moisture loss and loss of valuable top soil. Blowing soil causes dirt clouds, drifting sand and hard feelings between neighbors. Blowing soil cuts off growing crops, covers fences, closes roads and gives rural and urban communities a bad perception of farmers.

The information in **Table 3.123** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.123. EMAP Consequence Analysis: Soil Erosion and Dust

Subject	Ranking	Impacts/Soil Erosion and Dust
Health and Safety of Persons in the Area of the Incident	Minimal	Impact tends to be agricultural; however, dust can be a danger to susceptible individuals in the form of air pollutants (minimal).
Responders	Minimal	With proper preparedness and protection, impact to the responders is expected to be minimal.
Continuity of Operations	Minimal	Minimal expectation for utilization of the COOP.
Property, Facilities, and Infrastructure	Minimal to Moderate	Impact to property, facilities, and infrastructure could be severe, depending on the site of the soil erosion. This could adversely affect utility poles/lines, and facilities. Dust can also adversely affect machinery, air conditioners, etc.
Delivery of Services	Minimal	Impact on the delivery of services should be non-existent to minimal, unless roads and utilities are affected.
Environment	Severe	The impact to the environment could be severe. Soil erosion and dust can severely affect farming, ranching, wildlife and plants due to production losses and habitat changes.
Economic Conditions	Minimal	Impacts to the economy will be dependent on how extreme the soil erosion and dust are. Potentially it could severely affect crop yield and productivity. Seedling survival and growth is stressed by erosion and dust, as is the top soil which agriculture is dependent on.
Public Confidence in Jurisdiction's Governance	Minimal	Planning, response, and recovery may be questioned if not timely and effective (minimal).

3.3.17. Terrorism/Agri-terrorism

Calculated Priority Risk Index	Planning Significance
2.65	Moderate

Description/Location

The Federal Bureau of Investigation defines terrorism as —the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives." In addition to physical force or violent acts, terrorism can also take the form of cyber-terrorism. This type of terrorism involves malicious infiltration of computer systems. Society is increasingly more dependent on computer-based technology for day-to-day life and disruption of computer systems could severely impact the ability to conduct business and the daily routine of individuals. Cyber-terrorism is particularly of concern in the energy sector as many energy delivery systems are managed by computers. The threat of terrorism, both international and domestic, is ever present, and an attack is likely to occur when least expected.

The Southern Poverty Law Center reported that in 2012, there were three active hate groups in Kansas: one neo-Nazi group (National Socialist Movement in Lansing), one racist skinhead group (Midland Hammerskins in Wichita), and one anti-gay group (Westboro Baptist Church in Topeka). Other groups, such as the Animal Liberation Front (ALF), Earth Liberation Front (ELF), and People for the Ethical Treatment of Animal (PETA) have sympathizers in the State. Although no major terrorist acts have been attributed to any of these latter groups, their involvement in violent acts is meant to disrupt governmental functions and cannot be discounted.

Agri-terrorism consists of acts to intentionally contaminate, ruin, or otherwise make agricultural products unfit or dangerous for consumption or further use. Agriculture is an important industry in Kansas. The introduction of a biological agent into the population of 6.4 million cattle or the nearly 10 million acres of wheat would be financially devastating and would have a major impact on the food supply of the State and the nation. A major attack involving the nation‘s food supply could be launched in a rural area that has little capacity to respond. Potential terrorists‘ targets for livestock disease introduction would be concentration points, such as the State‘s licensed feedlots livestock markets. Additionally, Kansas has over 120 agricultural crop-dusters, many of which are configured for chemical spraying.

Previous Occurrences

The terrorist attacks on September 11, 2001, had nexus to Kansas: Three of the hijackers had at one time possessed Kansas drivers‘ licenses and at least one had ties to a state university. The subsequent anthrax crisis had a significant effect on Kansas law enforcement and the emergency response community. Hundreds of anthrax-related calls were answered by law enforcement, fire service, and public health personnel. Although there have been no confirmed

anthrax cases, the number of calls severally stressed state and local response capabilities and focused attention on training and equipment needs to deal with such incidents.

Although Kansas has been fortunate to escape a major terrorist incident, the State has experienced a number of smaller, less publicized incidents. Since the early 1990s, Kansas has experienced several incidents involving violence attributed to domestic extremist groups or individuals. Anti-abortion groups have been active in Wichita and Topeka. White supremacists have conducted rallies and have been suspected in assaults and cross burnings.

- **2009**: A man shot a well known and controversial doctor, who performed late-term abortions, as he sat in church.
- **2004**: There was a white supremacist rally in Topeka.
- **1993**: A lone gunman attacked the federal courthouse in Topeka with firearms and improvised explosive devices, killing and injuring several individuals. The same individual also set off explosive devices in the courthouse parking lot and at a law enforcement facility parking lot in an adjoining county.
- **1993:** A doctor was killed outside an abortion clinic in Wichita.
- **1995:** Timothy McVey and Terry Nichols used Kansas as a base of operations for their attack in Oklahoma City, OK. It is believed that Kansas City was identified as an alternate site for their attack. **Figure 3.100** show the damage to the Alfred P. Murrah Building in Oklahoma City, OK after the attack.

Figure 3.100. Alfred P. Murrah Building in Oklahoma City, OK after the devastating attack in 1995

Source: 2010 Kansas State Hazard Mitigation Plan

- **1998:** Kansas responded to an anthrax hoax against the Finney State Office Building. The hoax resulted in a major evacuation and decontamination of a number of the facility's occupants.
- **March 6, 1988:** A heavily armed man opened fire in a church in Emporia, killing one man and injuring four people. No motive was identified.
- **August 11, 1976**: A sniper on the 26th floor of the Holiday Inn Plaza in downtown Wichita shot and killed three men, wounded seven other people, and sent dozens more diving for cover. No motive was identified.

Probability of Future Hazard Events

While difficult to estimate, the CPRI probability for a terrorist or agri-terrorism event is "**Unlikely**" within the next 10 years. The nation has been on an "elevated" homeland security threat level or higher since September 11, 2001, which means there is a "significant risk of terrorist attacks" somewhere in the United States.

State Vulnerability Analysis

The level of risk posed by acts of terrorism against nonagricultural facilities and systems is low. This risk is somewhat elevated in the eastern and south central regions of the State, reflecting the greater level of urbanization and the larger number of potential targets.

The State has identified a growing vulnerability to terrorism. To respond to that vulnerability, Kansas faces some unique problems relating to geography and population distribution. A majority of the state‘s population is concentrated in three metropolitan areas (Kansas City, Topeka, and Wichita). The rest of the State is generally rural and has limited governmental and public health infrastructure. Kansas has four active military installations (Ft. Riley in Junction City, Ft. Leavenworth northeast of Kansas City, McConnell Air Force Base in Wichita, and Forbes Field Air National Guard Base in Topeka) and one active nuclear generating power plant (Coffey County). The northeast corner of the State is within the fifty-mile emergency planning zone of Nebraska‘s Cooper Nuclear Station. All of these are potential terrorist targets. The metropolitan Kansas City area, besides being a major population center, is home to a nationwide telecommunication provider, Wichita is home to a significant portion of the nation‘s aerospace industry, and Salina has the Kansas Regional Training Institute training grounds for the Army National Guard and is near a missile range.

The risk of agri-terrorism incidents is relatively higher in the central and western portions of the State. This corresponds with the location of the largest acreage of croplands and cattle range as well as the location of numerous large feedlots. It is believed that most communities in the State are not likely to experience terrorism, barring extraordinary and unpredictable circumstances.

A strategic nuclear, biological, or chemical attack on the United States could have the most devastating and far-reaching consequences. The use of these weapons against the United States is unlikely. Unfortunately, however, as long as such weapons exist, there is always a chance that they could be used. The potential for traditional war-related attacks, using conventional weapons, is a scenario that is more likely to occur, based on currently available information, however even attacks of that variety are rare. Attackers are likely to have either very specific targets such as Women‘s clinics, or desire large publicity from the attacks.

It is not possible to calculate a specific vulnerability for each county in Kansas. However, because of the desire for publicity following attacks, it is more likely that counties with greater population densities would be the target of attacks. Sparsely populated rural counties are less desirable targets for publicity-seeking terrorists. It is expected that the likelihood of attack is directly related to population density or more likely to an event that is occurring or to a specific location of importance to the attacker. For example, a large venue event, such as a sporting event attended by tens of thousands of people might be considered a desirable target. Most large public venues occur in densely populated areas since those areas are able to provide the infrastructure support (hotels, eateries, etc) for large numbers of people. A description of population density is contained in this plan in Section **3.1** and a table showing the population density of each Kansas county is found in **Table 3.16**

State Estimates of Potential Losses

Potential losses from Terrorism / Agri-terrorism include all infrastructure, critical facilities, crops, humans and animals. The degree of impact would be directly related to the type of incident and the target. Potential losses could include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses, loss of human life, injuries to persons, loss of food supplies, disruption of the food supply chain, and immediate damage to the surrounding environment. Secondary effects of infrastructure failure could include public safety hazards, spread of disease, increased morbidity and mortality among the local and distant populations, public panic and long-lasting damage to the environment. Terrorism events are rare occurrences and specific amounts of estimated losses for previous occurrences are not available due to the complexity and multiple variables associated with these types of hazards. In some instances, information about these events is secure and unavailable to the public in order to maintain national security and prevent future attacks.

As discussed previously, it is difficult to quantify potential losses in terms of the jurisdictions most threatened by CBRNE (chemical, biological, radiological, nuclear, and high yield explosive) attack events due to the many variables and human element. Therefore, for the purposes of this plan, the loss estimates will take into account several hypothetical scenarios. Please note that these hypothetical scenarios are included to provide a sample methodology for local jurisdictions to estimate potential losses. The hypothetical scenarios include: a chemical attack, a biological attack, an improvised explosive device (IED) attack, and a radiological attack. For comparative purposes, these hypothetical attack scenarios will all be staged at the same venue, a college football stadium in a university city in Kansas during a home football game. The hypothetical stadium is situated on less than one square mile in an urban area and has a seating capacity of approximately 35,000 persons. Surface area and parking structures are located adjacent to the stadium.

Analysis of vulnerable populations is aided by a program developed by Johns Hopkins University in 2006 called Electronic Mass Casualty Assessment and `Planning Scenarios (EMCAPS) http://www.hopkins-cepar.org/EMCAPS/EMCAPS.html which utilizes scenarios developed by the Department of Homeland Security.

****THE FOLLOWING HYPOTHETICAL SCENARIOS ARE FOR INSTRUCTIONAL AND ILLUSTRATIVE PURPOSES ONLY****

Chemical Attack – Mustard Gas

Scenario Overview: Mustard gas is released from a light aircraft onto the stadium during a home football game. The agent directly contaminates the stadium and the immediate surrounding area. This particular type of attack would cause harm to humans and could render portions of the stadium unusable for a short time period in order to allow for a costly clean-up. There might also be a fear by the public of long-term contamination of the stadium and subsequent boycott of games resulting in a loss of revenue and tourism dollars.

Assumptions: (1) The population density at the stadium on game day is high – approximately 93 percent of the seats, 33,250 are filled and an additional 5,000 persons remain outside the stadium in the adjacent parking areas. (2) Sulphur mustards are extremely toxic and may damage eyes, skin and respiratory tract. Death sometimes results from secondary respiratory infections. (3) The rate of —worried well" is equal to 9 times the number of infected cases.

Described Losses:

Severe Eye Injuries (1-2 hours)	28,688 persons
Severe Airway Injuries (1-2 hours)	28,688 persons
Severe Skin Injuries (2 hrs to days)	34,425 persons
Total —Worried Well" Cases (9 times the number of affected cases)	309,825 persons
Deaths	765 persons
Cost of Decontamination @ $12/person (assumes all persons with skin injuries will require decontamination and approximately 1/10 of the worried well will demand to be decontaminated) - total persons = 65,408	$ 784,896

Notes: Victims will require decontamination and both long and short term treatment. Services may need to be suspended at the area until all investigations are conducted.

Biological Attack – Pneumonic Plague

Scenario Overview: Canisters containing aerosolized pneumonic plague bacteria are opened in public bathrooms. Each release location will directly infect 110 people; hence, the number of release locations dictates the initial infected population. The secondary infection rate is used to calculate the total infected population. This particular weapon of mass destruction (WMD) attack method would not cause damages to buildings or other infrastructure, only to human populations.

Assumptions: (1) The population density at the stadium on game day is high. (2) The population density of the stadium city is high (5,572 persons / sq mile – assumes that the normal population is doubled on game day). (3) The number of dispersion devices is 30. Devices are assumed to be placed in crowded seating areas. (4) Pneumonic plague has a 1-15 percent mortality rate in treated cases and a 40-60 percent mortality rate in untreated cases. (5) The rate of —worried well" is equal to 9 times the number of infected cases.

Described Losses:

Initial Infected Populations	3,300 persons
Secondary Infected Population	6,623 persons
Total Plague Cases	9,923 persons
Total Deaths (Treated Cases 7 percent)	694 persons
Total —Worried Well" Cases (9 times the number of infected cases)	89,307 persons

Improvised Explosive Device Attack – ANFO

Scenario Overview: An Improvised Explosive Device (IED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a panel van to a parking area during a time when stadium patrons

are leaving their cars and entering the stadium and detonated. Potential losses with this type of scenario include both human and structural assets.

Assumptions: (1) The population density in the parking lot during the beginning and ending of the games is high, at least 1 person /25 square feet. (2) The quantity of ANFO used is 4,000 lbs, similar to that used by Timothy McVeigh in the Oklahoma City bombing. (3) The Lethal Air Blast Range for such a vehicle is 200 feet according to the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF) Standards. (4) The Falling Glass Hazard distance is 2,750 feet according to BATF Explosive Standards.

Described Losses:

Total Dead	1,391 persons
Total Traumatic Injuries	2,438 persons
Total Urgent Care Injuries	11,935 persons
Injuries not Requiring Hospitalization	4,467 persons
Structures and Other Physical Assets (Damages would certainly occur to vehicles and depending on the proximity of other structures, damages would occur to the stadium complex itself. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of structures nearby and the amount of insurance held by vehicle owners.)	Vehicles – Replacement cost for approximately 100 vehicles @ $15,000 per vehicle inside the 200 ft BATF described Lethal Air Blast range = $ 150,000 Repair / repainting cost for approximately 500 vehicles @ $ 4,000 per vehicle inside the BATF described Falling Glass Hazard = $2,000,000

Radiological Dispersion Device – Dirty Bomb Attack

Scenario Overview: An Improvised Explosive Device (IED) utilizing an ammonium nitrate/fuel oil (ANFO) mixture is carried in a panel van to a parking area during a time when stadium patrons are leaving their cars and entering the stadium and detonated. Potential losses with this type of scenario include both human and structural assets. The bomb also contains 2,700 Curies of Cesium-137 (Cs-137).

Assumptions: (1) The population density in the parking lot during the beginning and ending of the games is high, at least 1 person /25 square feet. (2) The quantity of ANFO used is 4,000 lbs, similar to that used by Timothy McVeigh in the Oklahoma City bombing. (3) The Lethal Air Blast Range for such a vehicle is 200 feet according to the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF) Standards. (4) The Falling Glass Hazard distance is 2,750 feet according to BATF Explosive Standards.

Described Losses:

Total Dead	1,391 persons
Total Traumatic Injuries	2,438 persons
Total Urgent Care Injuries	11,935 persons
Injuries not Requiring Hospitalization	4,467 persons
Radiological Poisoning Injuries that Need Aggressive Treatment	13

Radiological Poisoning Injuries that Need Non-Critical Treatment	440
Radiological Poisoning Injuries that could Self Medicate with Proper Public Information	62,378
Structures and Other Physical Assets (Damages would certainly occur to vehicles and depending on the proximity of other structures, damages would occur to the stadium complex itself. The exact amount of these damages is difficult to predict because of the large numbers of factors, including the type of structures nearby and the amount of insurance held by vehicle owners.)	Vehicles – Replacement cost for approximately 100 vehicles @ $15,000 per vehicle inside the 200 ft BATF described Lethal Air Blast range = $ 150,000 Repair / repainting cost for approximately 500 vehicles @ $ 4,000 per vehicle inside the BATF described Falling Glass Hazard = $2,000,000

Development in Hazard Prone Areas

As more and more large public events are held in Kansas, more potential may exist for these venues to become targets of attack. With human-caused hazards such as this that can have multiple variables involved, increases in development are not necessarily always factors in determining risk, although the physical cost of the event may increase with the increased or newly developed areas.

Hazard Impact Overview

The threat of a terrorist, suicide bomber attack is analyzed in KDEM's THIRA. 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 3.124** provides the Impact Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.124. EMAP Impact Analysis: Terrorism/ Agri-terrorism

Subject	Ranking	Impacts/Terrorism/Agri-Terrorism
Health and Safety of Persons in the Area of the Incident	Severe	Impact could be severe for persons in the incident area.
Responders	Minimal to Severe	Impact to responders could be severe if not trained and properly equipped. Responders that are properly trained and equipped will have a low to moderate impact.
Continuity of Operations	Minimal to Severe	Depending on damage to facilities/personnel in the incident area, re-location may be necessary and lines of succession execution (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Impact within the incident area could be severe for explosion, moderate to low for Hazmat.
Delivery of Services	Minimal to Severe	Delivery of services could be affected within and around the affected area especially if communications, road and railways, and facilities incur damage (minimal to severe).

Environment	Minimal to Severe	Localized impact within the incident area could be severe depending on the type of human caused incident.
Economic Conditions	Minimal to Severe	Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation (minimal to severe).
Public Confidence in Jurisdiction's Governance	Minimal to Severe	Impact will be dependent on whether or not the incident could have been avoided by government or non-government entities, clean-up and investigation times, and outcomes. (minimal to severe)

3.3.18. Tornado

Calculated Priority Risk Index	Planning Significance
3.4	High

Description/Location

The National Weather Service defines a tornado as —a violently rotating column of air extending from a thunderstorm to the ground." Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 mph, and damage paths can be more than one mile wide and 50 miles long. In an average year, more than 900 tornadoes are reported in the United States, resulting in approximately 80 deaths and more than 1,500 injuries. High winds not associated with tornadoes are profiled separately in this document in **Section 3.3.21** Windstorm.

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

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

Tornadoes are classified according to the EF- Scale (the original F – Scale was developed by Dr. Theodore Fujita, a renowned severe storm researcher). The Enhanced F- Scale (see **Table 3.125**) attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original F scale was implemented in the U.S. on February 1, 2007. Interestingly, since implementation of the new scale, Kansas was the location of both the first EF4 (February 28, 2007, Linn County) and EF5 (May 4, 2007, Greensburg) tornadoes.

Table 3.125. Enhanced Fujita Scale for Tornado Damage

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

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

The wind speeds for the EF scale and damage descriptions are based on information on the NOAA Storm Prediction Center as listed in **Table 3.126**. The damage descriptions are summaries. For the actual EF scale it is necessary to look up the damage indicator (type of

structure damaged) and refer to the degrees of damage associated with that indicator. Information on the Enhanced Fujita Scale's damage indicators and degrees are available at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3.126. Enhanced Fujita Scale with Potential Damage

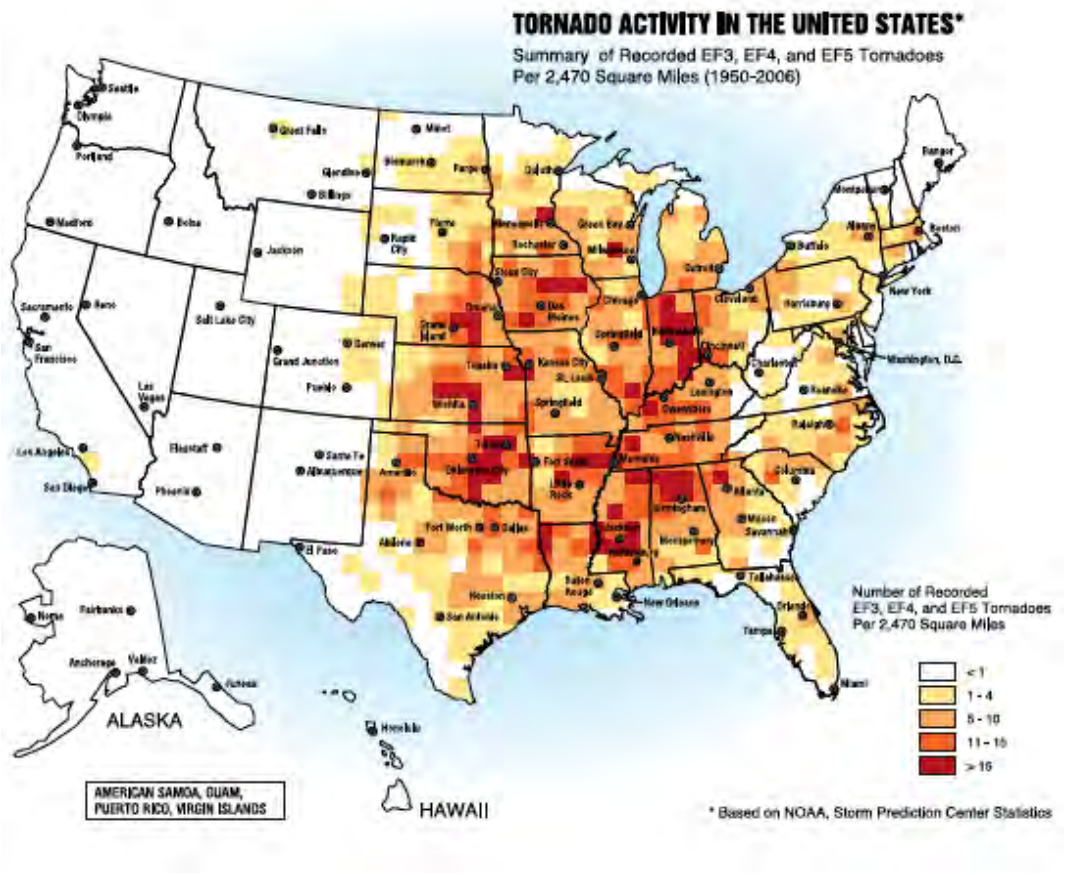
Enhanced Fujita Scale			
Scale	**Wind Speed (mph)**	**Relative Frequency**	**Potential Damage**
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e. those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center

The best lead time for a tornado is about 30 minutes. Tornadoes have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornadoes may not be visible on the ground due to evening hours, blowing dust or driving rain and hail. Therefore, there is very little, or no, warning of when a specific tornado may be on the ground.

Figure 3.101 illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 3,700 square miles between 1950 and 2006. **Figure 3.102** illustrates the wind zones in the United States. By noting the Kansas data from these two maps and matching them up in **Table 3.127**, it appears that all of Kansas is highly susceptible to tornadoes.

Figure 3.101. Tornado Activity in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition

Figure 3.102. Wind Zones in the United States

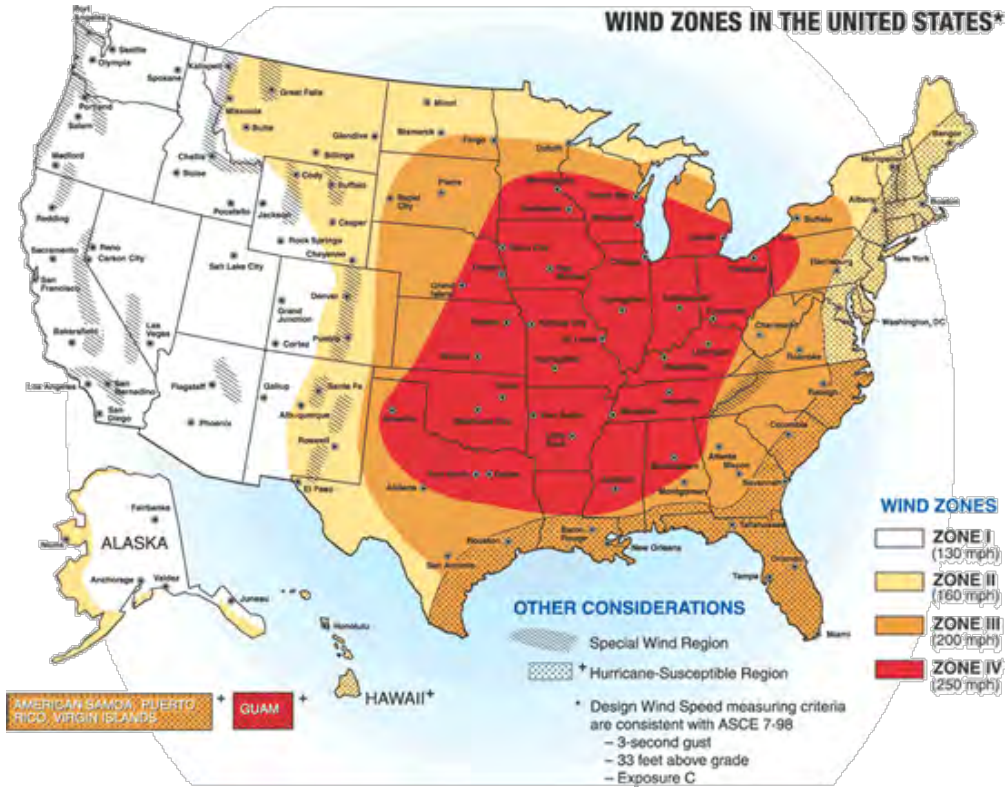


Table 3.127. Number of Events Compared with Wind Zones (gray shading indicates number of events and zones in Kansas)

Number of Tornadoes Per 3,700 square miles (See Figure 3.101)	Wind Zone (See Figure 3.102)			
	I	II	III	IV
<1	Low Risk	Low Risk	Low Risk	Moderate Risk
1-5	Low Risk	Moderate Risk	High Risk	High Risk
6-10	Low Risk	Moderate Risk	High Risk	High Risk
11-15	High Risk	High Risk	High Risk	High Risk
>15	High Risk	High Risk	High Risk	High Risk

Source: Taking Shelter from the Storm, FEMA, 2004
Note: Gray shading indicates number of events and zones in Kansas.

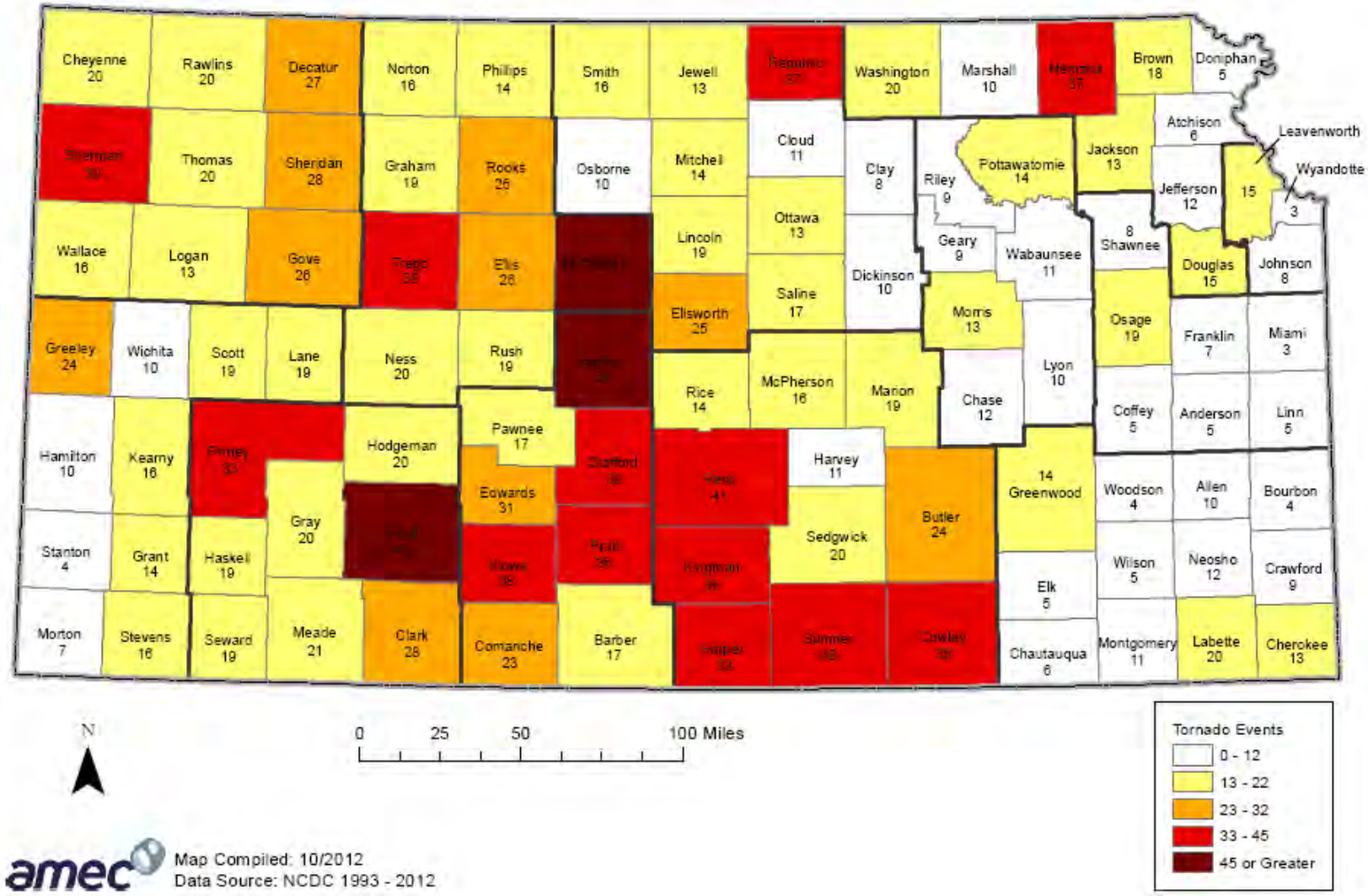
Previous Occurrences

Tornadoes have caused substantial property damage, injury, loss of life and economic disruption in Kansas. Based on data from The Disaster Center Tornado, Kansas, when compared with other states, ranks third in the nation for the frequency of tornadoes, eighth for the number of tornado-caused fatalities, 14th for injuries and third for the cost of damages.

According to the National Climatic Data Center Storm Events database, there were 1,922 tornadoes in Kansas between 1993 and 2012. Tornadoes reported in the database are in segments. One tornado can have multiple segments as the database counts a new segment when county boundaries are crossed. So, the number of past occurrences is really a reflection of the number of past tornado segments. Of these events, 1 was rated F5, and 12 were rated F4. Total property damage for these events is estimated at $1 billion. There were 36 deaths and 506 injuries in this time period. This suggests that Kansas experiences 96 tornadoes, $50 million in tornado property losses, two deaths and 25 injuries each year.

Figure 3.103 shows the number of Kansas Tornadoes by county from 1993 to 2012.

Figure 3.103. Kansas Tornadoes by County, 1993–2012



The State of Kansas has had 22 presidential declarations that involved tornadoes since 1955 (see **Table 3.128** for the details).

Table 3.128. Kansas Presidential Declarations Involving Tornadoes

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
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
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 (09/11-09/17/2008)	Severe Storms, Flooding, and Tornadoes	Anderson, Butler, Chase, Cowley, Greenwood, Harper, Harvey, Russell, and Sumner	$4,167,044
1776	07/09/2008 (05/22-06/16/2008)	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
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

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost**
1638	4/14/2006 (3/12-13/2006)	Severe Storms, Tornadoes, and Straight-Line Winds	Douglas, Wyandotte	$6,233,044
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
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
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
714	6/22/1984 (6/7-6/9/1984)	Severe Storms, Tornadoes, Flooding	Atchison, Brown, Doniphan, Jackson, Nemaha, Pottawatomie	$5,002,299
644	7/18/1981	Severe Storms, Flooding, Tornadoes	Barton, Douglas	$670,436
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
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

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost**
219	6/10/1966	Tornadoes, Severe Storms	Riley, Shawnee	$2,856,131
34	5/27/1955	Tornado	Cowley	$294,167

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

FEMA-4063-DR: Severe Storms, Tornadoes, Straight-line Winds and Flooding – May 24, 2012 (April 14 to April 15, 2012)

Multiple supercell thunderstorms affected central Kansas on April 14th. The first one tracked across Russell County producing a few brief tornado touchdowns. Then the most intense supercell moved into Rice County produced a long track tornado that caused EF4 damage south of Kanopolis Lake. It then briefly lifted before touching back down northeast of Salina producing EF1 damage.

Two other tornadoes touched down producing EF3 damage in south central Kansas including in the city of Wichita. Significant damage to homes, many of them had a number missing outer walls. A mobile home park in Wichita had seventy five percent of the homes uninhabitable. Significant damage was noted of the hangars at McConnell Air Force Base. Several apartments and businesses also had damage like roofs being torn off and windows blown out.

Figure 3.104. Photo of McConnell Air Force Base damage in Wichita, KS on April 14, 2012.

Source: Mike Hutmacher, Wichita Eagle.

FEMA-4010-DR: Severe Storms, Straight-line Winds, Tornadoes and Flooding – July 29, 2011 (May 19 to June 4, 2011)

Supercell thunderstorms developed in advance of a cold front and dry line during the late afternoon of Saturday May 21st. Several of the supercell thunderstorms produced tornadoes including at least 2 brief touchdowns in Topeka. The strongest tornado was rated an EF3 and hit the town of Reading Kansas. It claimed the life of one man when his mobile home was destroyed and injured 5 others in Reading. In all there were 8 tornadoes across Northeast Kansas that evening. There was one fatality which occurred in the town of Reading where a man was killed when his mobile home was destroyed. There were 5 injuries that required treatment in Reading.

FEMA-1932-DR: Severe Storms, Flooding and Tornadoes – August 10, 2010 (June 7 to July 21, 2010)

There were thunderstorms that developed tornadoes during this timeframe, but no widespread tornado damage. The majority of the declaration damage was from flooding to public roads and bridges.

FEMA-1849-DR: Severe Storms, Flooding, Straight-line Winds and Tornadoes – June 25, 2009 (April 25 to May 16, 2009)

On Aril 29th, severe thunderstorms produced very large hail and 5 tornadoes. One tornado started out moving southeast near Plymell in Finney County, but then curved back to the southwest. It unfortunately went through a cattle dairy and killed over 200 head as a tremendous amount of tin churned through the air. There were 8 pivot irrigation sprinklers damaged or destroyed, along with power poles, trees, and roof and window damage.

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

On October 22, 2008, Governor Kathleen Sebelius requested a major disaster declaration because of severe storms accompanied by tornadoes, lightning and torrential rains resulting in flooding and flash flooding during the period of September 11-18, 2008.

FEMA-1776-DR: Severe Storms, Flooding and Tornadoes- July 9, 2008 (May 22 to June 16, 2008)

A series of intense supercell thunderstorms moved north across northwest Kansas during the afternoon and early evening hours of May 23rd. Long-track tornadoes, flash flooding, large hail and damaging winds were reported. Eleven tornadoes were verified by storm chasers and damage surveys. One tornado in Sheridan County developed just south of highway 24 west of Hoxie, and moved north nine miles before dissipating. It produced EF2 damage at a home on highway 24, removing much of the roof of the home and destroying a large metal outbuilding. Significant tree damage also occurred. South of the highway, an irrigation pivot was overturned and a second home suffered minor damage and a small outbuilding was destroyed. Another tornado across southwest Decatur County developed a second tornado about 3 miles southwest of Oberlin. This tornado destroyed a number of irrigation pivots. Then a ¾ mile wide tornado produced EF3 damage and claimed the lives of two people in their car in Pratt County.

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

A 1.7 mile-wide EF5 tornado with wind estimated at 205 mph struck Greensburg in Kiowa County, destroying approximately 90 percent of the town and severely damaging the remaining 10 percent. Tornado sirens sounded in the City twenty minutes before the tornado struck, and a tornado emergency was issued, undoubtedly saving many lives in the town of 1,580. Nevertheless, the storm killed 12 people, 10 in Greensburg, one in Pratt, and one in Stafford, and hospitalized 13 others.

Initial assessment results indicated that Greensburg sustained extraordinary losses to housing, business, hospital, schools, and all other public facilities. Electric and water distribution systems were also seriously damaged. The town‘s entire population was displaced throughout surrounding counties. Farmsteads and farm properties throughout Kiowa County and surrounding areas were also impacted. According to the insurance commissioner, 1,900 insurance claims were filed as of August 14, 2007, totaling approximately $153 million dollars in estimated storm losses in Kiowa County.

Figure 3.105. Greenburg, Kansas in Kiowa County, after the devastating EF5 tornado in May of 2007

Source: Jaime Oppenheimer with the Wichita Eagle.

FEMA-1638-DR: Severe Storms, Tornadoes, and Straight-Line Winds—April 14, 2006 (March 12-13)

A significant tornado outbreak occurred over portions of eastern Kansas and western Missouri. Damage estimates in the Kansas City metropolitan area alone reached $6.58 million.

FEMA-1462-DR: Severe Storms, Tornadoes, and Flooding—May 6, 2003 (May 4–30)

In two separate storm events, May 4 and 15, tornadoes and flooding occurred across eastern Kansas. There was widespread property damage, seven fatalities, and more than 50 injuries. About a third of the town of Franklin in Crawford County was destroyed.

FEMA-1366-DR: Severe Storms and Tornado—April 27, 2001 (April 21)

On April 21, an F4 tornado touched down in Hoisington in Barton County, damaging many buildings, vehicles and power and telecommunications systems of the City. There was one fatality and 28 injuries. The storm destroyed 182 homes and caused major damage to 52 homes and minor damage to 180 more residences. A hospital, three schools and several businesses were damaged. Damage approximated $43 million.

FEMA-1327-DR: Severe Storms and Tornadoes—May 3, 2000 (April 19)

On April 19, damaging tornadoes struck communities in Crawford, Labette, Neosho and Montgomery Counties. Tornadoes caused extensive damage in Parsons and in Neosho County. An F3 destroyed an area of 30-square blocks, and 30-60-square blocks sustained moderate damage. More than 30 injuries were reported from all the tornadoes combined, most of them in Parsons.

FEMA-1273-DR: Tornadoes and Severe Storms—May 4, 1999 (May 3)

On May 3, severe thunderstorms and as many as four dozen tornadoes swept through south central Kansas, causing 6 deaths and 154 injuries in Haysville and Wichita. Damage exceeded $150 million. Damage summary for Sedgwick County: 8,480 buildings (all types) damaged or destroyed. Of these, 2,456 had at least 50 percent damage and 1,109 were totally destroyed. The number of customers that lost power was 52,000.

FEMA-903-DR: Severe Storm, Tornado—April 29, 1991 (April 26)

A tornado touched down in Harper County then skipped across Sedgwick and Butler Counties. In Sedgwick County it grew to F3 intensity and tore through parts of south and east Wichita, making a direct hit on McConnell Air Force Base. Four people were killed in Sedgwick County. The tornado then grew to F5 intensity and went through the community of Andover in Butler County. Major damage was incurred and 13 people were killed. At the same time, another tornado developed in Cowley County that grew to F4 intensity and killed one person east of Winfield and another near Howard in Elk County. Total property damage from these tornadoes was in excess of $272 million.

FEMA-219-DR: Tornadoes, Severe Storms—June 10, 1966 (June 8)

This F5 was the most destructive tornado in Topeka‘s history. It produced $100 million in damage, which made it the costliest tornado in American history at the time. Although 16 people were killed and 500 injured, excellent public warning and preparedness prevented a much larger number of deaths and injuries. About 820 homes were destroyed and 3,000 damaged as entire blocks were leveled to splinters in seconds. Every building on the Washburn University campus was damaged, many totally destroyed from the violent winds estimated at around 300 mph. The

Capitol Dome sustained damage from tremendous flying debris, as did many downtown Topeka buildings. Power and other utilities were out in much of the community for weeks.

Other tornadoes that day included one in Manhattan that caused 65 injuries, destroyed 11 homes, and damaged 328 others. Losses at Kansas State University alone totaled nearly $2 million. Two other tornadoes struck Leavenworth County, where two injuries and one death were reported.

FEMA-34-DR: Tornado—May 27, 1955 (May 25)

This F5 tornado killed five children in a home northeast of Oxford before moving on to Udall and completely devastating a large portion of the town. Seventy-five people were killed in Udall, and many of the 270 injuries were serious. Damage in this small town was listed at over $2.2 million. This remains Kansas' deadliest tornado.

Other Notable Tornadoes

- **February 28, 2012:** A line of thunderstorms moved eastward across northeast Kansas one of the strongest storms created a very strong tornado, which impacted the town of Harveyville, Wabaunsee County. The EF2 tornado struck after dark and was short-lived but was able to destroy a large portion of the town. Several houses were completely destroyed as was a church. At least a dozen injuries occurred with this storm, one of which became fatal after a day in the hospital.

Figure 3.106. Photo of Harveyville Tornado Damage

Source: National Weather Service, Topeka, KS taken on 2/28/2012, http://www.crh.noaa.gov/news/display_cmsstory.php?wfo=top&storyid=79764&source=2

- **June 15, 2009:** This tornado turned over four pivot irrigation sprinklers and destroyed two 80,000 bushel grain bins in Edwards County. In addition, a 500,000 bushel bin was heavily damaged. One of the 80k bins traveled nearly a mile. There was extensive rear flank downdraft damage in the vicinity of this tornado.

- **June 11, 2008:** Two long lived super cells wreaked havoc across portions of north central and northeast Kansas on the night of June 11th. Three significant tornadoes touched down, caused millions of dollars in damage, killed two, and critically injured three citizens. The town of Chapman saw the most extensive damage. Approximately three-quarters of the town was damaged by the tornado that passed through. Numerous homes were demolished, as were both the middle school and high school. One death occurred, as a result of a tree having fallen onto a young woman outside her car, who had just placed her daughter into her car seat. The most severe, but more localized damage occurred in the Miller Ranch neighborhood in Manhattan, where several homes were completely destroyed. A man was killed in his mobile home when it flipped several times and was found a few miles from its original location. The unoccupied home a few hundred feet from the mobile home went virtually untouched. Thousands of citizens turned up over the next few weeks to help with the clean-up effort in both Chapman and Manhattan.
- **May 29, 2008:** A significant severe weather outbreak occurred during the afternoon and evening of May 29th. Several tornadoes were reported from south of Palco in Rooks County to the community of Jewell in Jewell County. One tornado inflicted significant damage to the community of Jewell, including destroying the town‘s cafe and water tower. Several homes in rural areas of Mitchell and Jewell Counties were damaged or destroyed. The town of Woodston in eastern Rooks County also had a twister move through the community; luckily damage was not as severe. All together eight tornadoes occurred in this part of north central Kansas and no critical injuries were reported. Other areas of north central Kansas also saw hail and heavy rains from the storms.
- **May 5, 2007:** An EF2 tornado in Ottawa County heavily damaged or destroyed numerous homes, cabins, mobile homes, outbuildings and small cottages. There was one fatality. A second tornado, an EF1, crossed from Ottawa County to Cloud County, destroying a barn and damaging homes, trees and power poles. Another EF1 near Enosdale damaged a residence, its outbuildings, and several trees and power poles.
- **March 28, 2007:** Sixteen tornadoes tracked across northwest Kansas and southwest Nebraska. The strongest tornado, an EF2, moved from northeast Sherman County into eastern Cheyenne County, significantly damaging four homes. An EF1 tornado badly damaged three vacant mobile homes in Wallace County. The other storms caused little or no damage.
- **February 28, 2007:** An EF4 tornado in Linn County destroyed a home north of Blue Mound. Six more homes sustained minor damage, and about a dozen outbuildings were damaged or destroyed; trees and power lines were downed as well.
- **October 26, 2006:** Twenty-eight tornadoes were reported in southwest Kansas, specifically the counties of Ford, Grant, Clark, Gray, Comanche, and Meade. Only two of the storms caused damage, which was relatively minor.
- **April 6, 2006:** An F1 tornado in Labette County damaged two homes and destroyed a mobile home. It caused 12 injuries and an estimated $225,000 in damage. Six tornadoes were also reported in north central Kansas.
- **March 30, 2006:** A tornado in Montgomery County produced F2 damage, damaging and destroying homes and mobile homes along its 16-mile path. One man was seriously injured. Damage was estimated at $1 million.

- **January 28, 2006:** The first tornado to strike Kansas in January since reporting began in 1950; this event was also unique in that it was not associated with a thunderstorm. Fifty cars at a car lot were damaged by this F0 tornado.
- **November 27, 2005:** Occurring unusually late in the year, a number of F0 and F1 touched down across east-central and southeast Kansas. The strongest tornado, an F1 in Neosho County, caused an estimated $120,000 in damage to homes and outbuildings. There were no deaths or injuries. In terms of the number of reported tornadoes, this was the largest November outbreak in the Wichita forecast area since reporting began in 1950.
- **August 19, 2005:** A tornado caused estimated $500,000 damage to Great Bend Airport where hangars were unroofed and an unspecified number of aircraft were overturned. A second touchdown in the Great Bend area caused $250,000 in damage to two farmsteads.
- **June 4, 2005:** An F2 tornado damaged or destroyed 15 buildings in Brown County. An F1 damaged trees and four buildings and downed power lines in Pottawatomie County.
- **April 21, 2005:** An F3 tornado in Neosho County destroyed two mobile homes, two barns, two out-buildings, one garage, one shed; unroofed one home; and dislodged one home from its foundation, ultimately causing an estimated $200,000 in damage.
- **August 27, 2004:** Three tornadoes hit Sumner and Cowley Counties. The most significant of the three, an F2, damaged two homes and snapped four utility poles.
- **June 12, 2004:** Sumner and Cowley Counties experienced five tornadoes. An F3 caused $575,000 in damage to property and crops. Two people were injured.
- **May 29, 2004:** Five tornadoes were reported in Harper County. An F2 caused $375,000 in damage to property and crops. One F3 storm destroyed 15 farm buildings, 25 pieces of farm equipment, many miles of transmission line, and crops. Damage was estimated at nearly $2 million. A second F3 caused $1 million in damages at two homesteads.
- **May 12, 2004:** Sixteen tornadoes were reported in Harper County. An F4 storm destroyed a farm house, five barns, and five cars with damage to property and crops approximating $350,000. Three F2 tornadoes caused an additional $380,000 in damage.
- **May 8, 2003:** Nine tornadoes struck the Topeka National Weather Service County Warning Area. Four injuries were reported. In Anderson County, an F2 tornado injured three people, destroyed seven homes, and damaged several others. In Douglas County, three tornadoes were confirmed, an F0, F1 and F2. The F2 caused one injury and damaged 40 structures. Two tornadoes were confirmed in Osage County, an F1 and an F3. The F3 produced extensive damage. The same day in the Wichita area, an F3 in Woodson County destroyed several barns and a few houses. Trees were stripped bare or just blown away, and some cars were rolled. Another tornado did substantial damage in Anderson and Linn Counties.
- **September 2001:** Tornadoes hit in central Kansas, destroying at least two homes, damaging several others, and interrupting utilities in Saline County.
- **November 10, 1995:** Two different tornadoes affected portions of central and south-central Kansas on this day. The first one moved across Barton County, causing one million dollars in damage. One hundred and sixty homes were destroyed, and at least 1,000 sheep were killed. Debris was carried 85 miles and hundreds of dead ducks fell from the sky 25 miles northeast of the end of the tornado path. Another tornado moved across portions of Sumner and Sedgwick Counties, destroying at least 10 homes. The total number of deaths for these tornadoes was 15.
- **May 7, 1993:** A tornado killed one person in Russell County.

- **June 15, 1992:** This day set Kansas' record for the most tornadoes on one day: 39.
- **March 13, 1990:** This F5 tornado struck Hesston, killing two people, injuring 60, and damaging or destroying about 226 homes and 21 businesses in the western sections of town. It caused nearly $25 million in damages in Harvey County alone. In Burrton, a six-year-old boy was killed by a crumbling chimney as he huddled in a basement with his family.
- **June 17, 1978:** A tornado struck very near the Whippoorwill Showboat on Lake Pomona in Osage County causing it to capsize, resulting in 16 deaths and 3 injuries among the 58 passengers and crew. Although the deaths were due to drowning, they were attributed to the tornado. Damage was also reported to campers, trees and power lines, but these were relatively insignificant.
- **June 8, 1974:** This F4 tornado ripped through populated sections on the northwest side of Emporia killing 6 people and injuring 200. It caused massive damage and destruction to a shopping center, mobile home park, nursing home, apartment complex, and residential homes. Ten farmsteads were also damaged. Most of the deaths were in the mobile home park. Property damage in Lyon County was estimated at $25 million.
- **June 10, 1958:** A tornado passed through El Dorado, devastating a section of newer homes in the southwest part of El Dorado. About 200 homes were destroyed as a 45-block area was torn apart. This tornado took the lives of 15 people and injured 50.
- **May 7, 1927:** This tornado ranged from one-half to two miles wide and was on the ground for nearly 100 miles. It traveled from Barber County through Kingman and Reno Counties before dissipating in McPherson County. Ten people were killed and 300 injured.
- **May 25, 1917:** This tornado touched down near Cheney and moved through the southeastern parts of Andale, across the southern edge of Sedgwick to three miles northeast of Florence. Along the path, 118 farms, homes, and businesses were destroyed, many of them completely swept away. Twenty-three people were killed and 70 injured. Twelve of the deaths were in Andale, where half the town was damaged or destroyed. The funnel was reportedly over a mile wide.

Table 3.129. Kansas Tornado Statistics, 1993-2012

Total Number of Tornadoes	1,922
Total Number of Deaths	36
Total Number of Injuries	506
Yearly Average of Tornadoes	96
Yearly Average of Deaths	2
Yearly Averages of Injuries	25

Source: NCDC

Insured Crop Loss Data

According to the USDA Risk Management Agency, insured crop losses through the State of Kansas as a result of tornado damage for the ten year period of 2002-2011 totaled $950,048 as shown in **Table 3.130**. It shows the highest year of crop losses as 2007 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 3.131** in the State Vulnerability Analysis section.

Table 3.130. Crop Insurance Paid for Tornado Damages by Year, 2002-2011

Year	Crop Insurance Paid
2011	$244,835
2010	$66,179
2009	$106,397
2008	$150,173
2007	$293,346
2006	$16,229
2005	$15,482
2004	$24,784
2003	$23,504
2002	$9,120
Total	**$950,048**

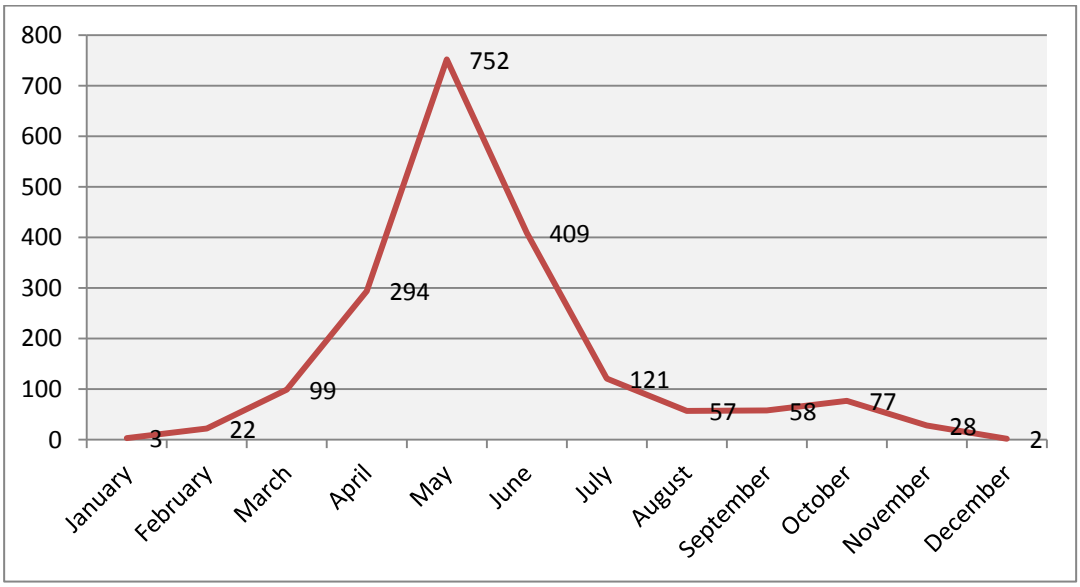
Source: USDA Risk Management Agency

Probability of Future Hazard Events

According to the National Climatic Data Center, there were 1,922 tornadoes in Kansas between 1993 and 2012 (20 years). Based on this information, the probability that at least one tornado will occur in Kansas in any given year is 100 percent. The estimated annualized loss for property losses is $50 million. This hazard's CPRI probability is "**Highly Likely**" within the calendar year.

Tornadoes in Kansas occur most often between May and July, which has come to be known as "tornado season" in Kansas and other areas. The chart in **Figure 3.107** is a breakdown of tornadoes in Kansas by month from 1993 to 2012. The month of May experiences the most tornadoes and the month of December has the least number of occurrences.

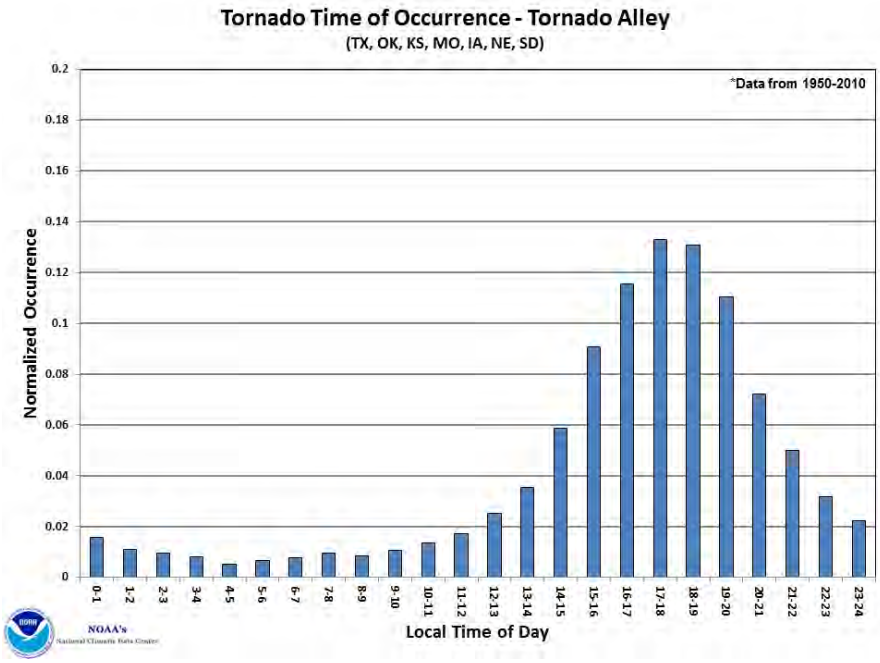
Figure 3.107. Kansas Tornado Occurrence by Month, 1993-2012



Source: National Climatic Data Center

Figure 3.108 shows the number of tornadoes by time of occurrence in Tornado Alley which consists of Texas, Oklahoma, Kansas, Missouri, Iowa, Nebraska, and South Dakota. The most occur between 6pm and 8pm local time.

Figure 3.108. Tornado Time of Occurrence, Tornado Alley, 1950-2010



Source: NOAA, National Climatic Data Center, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html#timing

State Vulnerability Analysis

All 105 counties in Kansas are vulnerable and highly susceptible to tornadoes. Kansas is located in the region called —Tornado Alley".

To refine and access the relative vulnerability of each of Kansas' counties to tornadoes, 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 crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the most vulnerable counties.

Tornados that touch-down can create a unique path of destruction unlike a wide-spread winter storm event that can affect entire regions of the State. So using the prior events as a factor can give the perception that a county has a higher overall vulnerability to tornadoes, but in factor the entire State is vulnerable.

The following are the data sources for the rating factors: Social Vulnerability Index for Kansas counties from the Hazards and Vulnerability Research Institute at the University of South Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010), USDA's Census of Agriculture (2007) and USDA Risk Management Agency (2002 – 2011). It was determined that for tornado, historical events and property damages are needed back to 1993 to adequately describe the tornado hazard in Kansas.

Table 3.131 below provides the factor's amounts per county that are considered for tornado vulnerability. The factors are based on available data from a variety of sources for each hazard. Please note that the property and crop damages from Kiowa County's May 4, 2007 Greensburg EF 5 tornado are omitted from this analysis as statistical outliers. Therefore, the NCDC property damages of $250,000,000 and the USDA Risk Management Agency's crop insurance losses of $88,916 were omitted from damages reported for Kiowa County.

Table 3.131. Vulnerability of Kansas Counties Factor Amounts for Tornadoes

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region A									
Cheyenne	5	20	$2,082,000	$104,100	$189,307	2.7	$52,458,000	$1,350	$135
Decatur	5	27	$3,806,000	$190,300	$232,035	3.3	$49,747,000	$0	$0
Gove	4	26	$3,450,000	$172,500	$224,662	2.5	$59,084,000	$45,499	$4,550
Logan	4	13	$0	$0	$223,349	2.6	$47,558,000	$0	$0
Rawlins	5	20	$349,500	$17,475	$205,462	2.4	$59,406,000	$814	$81
Sheridan	5	28	$2,140,000	$107,000	$200,661	2.9	$95,542,000	$6,259	$626
Sherman	4	39	$143,000	$7,150	$461,185	5.7	$108,370,000	$0	$0
Thomas	4	20	$1,128,500	$56,425	$599,973	7.4	$129,521,000	$704	$70
Wallace	3	16	$252,000	$12,600	$117,421	1.6	$47,203,000	$86,939	$8,694
Subtotal		**209**	**$13,351,000**	**$667,550**	**$2,454,055**		**$648,889,000**	**$141,565**	**$14,157**
Mitigation Planning Region B									
Ellis	2	20	$2,082,000	$104,100	$189,307	2.7	$52,458,000	$1,350	$135
Graham	4	27	$3,806,000	$190,300	$232,035	3.3	$49,747,000	$0	$0
Ness	5	26	$3,450,000	$172,500	$224,662	2.5	$59,084,000	$45,499	$4,550
Norton	5	13	$0	$0	$223,349	2.6	$47,558,000	$0	$0
Phillips	4	20	$349,500	$17,475	$205,462	2.4	$59,406,000	$814	$81
Rooks	4	28	$2,140,000	$107,000	$200,661	2.9	$95,542,000	$6,259	$626
Rush	5	39	$143,000	$7,150	$461,185	5.7	$108,370,000	$0	$0
Russell	4	20	$1,128,500	$56,425	$599,973	7.4	$129,521,000	$704	$70
Trego	5	16	$252,000	$12,600	$117,421	1.6	$47,203,000	$86,939	$8,694
Subtotal		**209**	**$13,351,000**	**$667,550**	**$2,454,055**		**$648,889,000**	**$117,512**	**$11,751**
Mitigation Planning Region C									
Grant	3	14	$680,000	$34,000	$469,849	13.6	$63,853,000	$0	$0
Greeley	4	24	$25,000	$1,250	$131,666	1.6	$64,552,000	$2,087	$209
Hamilton	4	10	$0	$0	$187,869	2.7	$51,817,000	$18,018	$1,802
Kearny	4	16	$400,000	$20,000	$228,723	4.6	$66,321,000	$10,022	$1,002

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Lane	4	19	$75,000	$3,750	$162,362	2.4	$31,082,000	$0	$0
Morton	4	7	$100,000	$5,000	$230,152	4.4	$42,645,000	$0	$0
Scott	2	19	$260,000	$13,000	$350,514	6.9	$71,718,000	$57,476	$5,748
Stanton	4	4	$0	$0	$151,658	3.3	$76,592,000	$26,619	$2,662
Stevens	2	16	$7,190,000	$359,500	$293,762	7.9	$124,066,000	$0	$0
Wichita	5	10	$300,000	$15,000	$175,679	3.1	$0	$0	$0
Subtotal		**139**	**$9,030,000**	**$451,500**	**$2,382,234**		**$592,646,000**	**$121,616**	**$12,162**
Mitigation Planning Region D									
Clark	5	28	$0	$0	$182,482	2.3	$15,466,000	$0	$0
Finney	2	33	$3,670,000	$183,500	$2,042,592	28.2	$140,746,000	$572	$57
Ford	2	49	$1,665,000	$83,250	$1,731,663	30.8	$87,004,000	$1,304	$130
Gray	2	20	$3,653,000	$182,650	$360,141	6.9	$109,340,000	$0	$0
Haskell	3	19	$450,500	$22,525	$252,803	7.4	$116,154,000	$0	$0
Hodgeman	3	20	$212,500	$10,625	$131,155	2.2	$41,068,000	$31,548	$3,155
Meade	4	21	$560,000	$28,000	$295,936	4.7	$91,206,000	$0	$0
Seward	2	19	$14,757,000	$737,850	$1,021,471	35.9	$81,688,000	$0	$0
Subtotal		**209**	**$24,968,000**	**$1,248,400**	**$6,018,243**		**$682,672,000**	**$33,424**	**$3,342**
Mitigation Planning Region E									
Barber	4	17	$10,000	$500	$388,136	4.3	$15,969,000	$0	$0
Barton	3	54	$47,349,000	$2,367,450	$1,772,118	30.9	$65,249,000	$33,762	$3,376
Comanche	5	23	$0	$0	$135,138	2.4	$13,395,000	$0	$0
Edwards	4	31	$3,480,000	$174,000	$232,382	4.9	$73,732,000	$17,423	$1,742
Kiowa*	4	38	$800,000	$40,000	$237,655	3.5	$34,681,000	$0	$0
Pawnee	5	17	$1,085,000	$54,250	$449,592	9.2	$67,357,000	$5,809	$581
Pratt	3	36	$20,573,500	$1,028,675	$689,239	13.1	$62,967,000	$7,789	$779
Stafford	4	39	$575,000	$28,750	$295,331	5.6	$74,613,000	$23,915	$2,391
Subtotal		**255**	**$73,872,500**	**$3,693,625**	**$4,199,591**		**$407,963,000**	**$88,698**	**$8,870**

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region F									
Clay	3	8	$135,000	$6,750	$599,823	13.2	$47,769,000	$374	$37
Cloud	5	11	$2,275,000	$113,750	$691,783	13.3	$55,096,000	$5,797	$580
Dickinson	4	10	$20,303,000	$1,015,150	$1,262,865	23.3	$50,121,000	$56,253	$5,625
Ellsworth	5	25	$73,250	$3,663	$459,624	9.1	$19,376,000	$0	$0
Jewell	5	13	$5,309,000	$265,450	$254,815	3.4	$61,168,000	$5,671	$567
Lincoln	4	19	$235,000	$11,750	$234,746	4.5	$32,667,000	$0	$0
Mitchell	4	14	$1,545,000	$77,250	$510,997	9.1	$61,762,000	$39	$4
Osborne	5	10	$990,000	$49,500	$343,004	4.3	$37,801,000	$0	$0
Ottawa	2	13	$90,000	$4,500	$418,316	8.5	$35,560,000	$0	$0
Republic	5	37	$4,939,000	$246,950	$417,216	6.9	$79,639,000	$7,789	$779
Saline	2	17	$2,995,000	$149,750	$3,591,872	77.2	$26,903,000	$30,617	$3,062
Smith	5	16	$1,245,000	$62,250	$278,296	4.3	$54,022,000	$0	$0
Subtotal		**193**	**$40,134,250**	**$2,006,713**	**$9,063,357**		**$561,884,000**	**$106,540**	**$10,654**
Mitigation Planning Region G									
Butler	1	24	$108,000	$5,400	$3,509,143	46.1	$41,249,000	$0	$0
Cowley	3	35	$2,360,000	$118,000	$2,180,637	32.3	$23,126,000	$0	$0
Harper	4	33	$2,500,000	$125,000	$455,272	7.5	$17,809,000	$137,369	$13,737
Harvey	2	11	$525,000	$26,250	$2,143,090	64.3	$49,189,000	$0	$0
Kingman	3	36	$80,000	$4,000	$606,598	9.1	$25,749,000	$7,756	$776
Marion	4	19	$945,000	$47,250	$762,377	13.4	$43,687,000	$0	$0
McPherson	2	16	$340,000	$17,000	$854,909	32.5	$57,227,000	$8,339	$834
Reno	3	41	$1,485,000	$74,250	$4,120,706	51.4	$69,497,000	$4,385	$439
Rice	4	14	$120,000	$6,000	$668,411	13.9	$53,225,000	$12,216	$1,222
Sedgwick	1	20	$381,035,000	$19,051,750	$31,528,899	499.6	$56,918,000	$0	$0
Sumner	2	40	$23,350,000	$1,167,500	$1,574,242	20.4	$50,711,000	$8,748	$875
Subtotal		**289**	**$412,848,000**	**$20,642,400**	**$48,404,284**		**$488,387,000**	**$178,813**	**$17,881**
Mitigation Planning Region H									
Allen	3	10	$150,000	$7,500	$983,778	26.7	$15,462,000	$0	$0

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Bourbon	4	4	$100,000	$5,000	$1,102,488	23.9	$9,918,000	$0	$0
Chautauqua	5	6	$0	$0	$285,438	5.7	$4,971,000	$0	$0
Cherokee	4	13	$2,935,000	$146,750	$1,293,753	36.8	$53,420,000	$0	$0
Crawford	3	9	$7,800,000	$390,000	$2,588,817	66.4	$34,463,000	$2,673	$267
Elk	5	5	$0	$0	$187,291	4.5	$0	$0	$0
Greenwood	5	14	$95,000	$4,750	$491,412	5.9	$8,087,000	$0	$0
Labette	4	20	$73,755,000	$3,687,750	$1,453,850	33.5	$22,765,000	$0	$0
Montgomery	4	11	$1,110,000	$55,500	$2,432,183	55.1	$16,616,000	$2,830	$283
Neosho	4	12	$2,175,000	$108,750	$1,174,150	28.9	$17,811,000	$0	$0
Wilson	4	5	$20,000	$1,000	$671,059	16.5	$26,882,000	$12,437	$1,244
Woodson	5	4	$2,500,000	$125,000	$207,905	6.6	$14,486,000	$268	$27
Subtotal		**113**	**$90,640,000**	**$4,532,000**	**$12,872,124**		**$224,881,000**	**$18,208**	**$1,821**
Mitigation Planning Region I									
Chase	3	12	$70,000	$3,500	$183,326	3.6	$6,222,000	$5,912	$591
Geary	2	9	$511,000	$25,550	$1,453,512	89.3	$11,039,000	$0	$0
Lyon	3	10	$120,000	$6,000	$2,366,508	39.8	$24,554,000	$0	$0
Morris	3	13	$27,762,000	$1,388,100	$421,954	8.5	$21,783,000	$0	$0
Pottawatomie	1	14	$1,250,000	$62,500	$1,157,180	25.7	$30,455,000	$2,445	$245
Riley	2	9	$885,000	$44,250	$3,814,017	116.6	$23,622,000	$0	$0
Wabaunsee	2	11	$515,000	$25,750	$439,179	8.9	$17,358,000	$0	$0
Subtotal		**78**	**$31,113,000**	**$1,555,650**	**$9,835,676**		**$135,033,000**	**$8,357**	**$836**
Mitigation Planning Region J									
Anderson	3	5	$1,500,000	$75,000	$518,401	14	$33,029,000	$0	$0
Coffey	3	5	$0	$0	$670,953	13.7	$25,497,000	$0	$0
Franklin	2	7	$105,000	$5,250	$1,598,004	45.5	$32,349,000	$0	$0
Linn	2	5	$535,000	$26,750	$659,126	16.3	$13,053,000	$34,879	$3,488
Miami	1	3	$500,000	$25,000	$2,106,266	57	$27,726,000	$0	$0
Osage	2	19	$2,011,000	$100,550	$977,110	23.1	$27,618,000	$11,207	$1,121
Shawnee	2	8	$212,000	$10,600	$11,828,241	327.1	$32,959,000	$0	$0

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Subtotal		**52**	**$4,863,000**	**$243,150**	**$18,358,101**		**$192,231,000**	**$46,086**	**$4,609**
Mitigation Planning Region K									
Atchison	3	6	$625,000	$31,250	$1,333,363	39.3	$42,536,000	$0	$0
Brown	5	18	$1,875,000	$93,750	$713,225	17.5	$86,532,000	$2,009	$201
Doniphan	3	5	$500,000	$25,000	$557,109	20.2	$67,800,000	$0	$0
Douglas	1	15	$7,815,000	$390,750	$6,614,269	243.1	$27,973,000	$0	$0
Jackson	3	13	$790,000	$39,500	$788,323	20.5	$21,169,000	$6,573	$657
Jefferson	1	12	$1,299,000	$64,950	$1,130,852	35.9	$33,429,000	$0	$0
Marshall	4	10	$1,706,000	$85,300	$2,054,603	11.2	$81,815,000	$2,803	$280
Nemaha	4	37	$12,780,000	$639,000	$711,896	14.2	$67,091,000	$7,465	$747
Washington	4	20	$1,298,000	$64,900	$396,656	6.5	$65,762,000	$0	$0
Subtotal		**136**	**$28,688,000**	**$1,434,400**	**$14,300,296**		**$494,107,000**	**$18,850**	**$1,885**
Mitigation Planning Region L									
Johnson	1	8	$518,000	$25,900	$43,871,468	1,149.60	$29,472,000	$0	$0
Leavenworth	1	15	$7,782,000	$389,100	$4,877,783	164.7	$20,983,000	$0	$0
Wyandotte	3	3	$15,500,000	$775,000	$12,066,666	1,039.00	$0	$0	$0
Subtotal		**26**	**$23,800,000**	**$1,190,000**	**$60,815,917**		**$50,455,000**	**$0**	**$0**
Statewide Totals			**$766,658,750**	**$38,332,938**	**$191,157,933**		**$5,128,037,000**	**$861,132**	**$86,113**

Note: The Census of Agriculture did not publish crop exposure in Elk, Wichita and Wyandotte Counties to avoid disclosure of individual operations. * Property and crop damages from Kiowa County's May 4, 2007 Greensburg EF 5 tornado were deemed to be statistical outliers. Therefore, the NCDC property damages of $250,000,000 and the USDA Risk Management Agency's crop insurance losses of $88,916 have been omitted from the data for Kiowa County.

Table 3.132 shows the 1 – 10 ranges for the tornado vulnerability factor ratings. These factor ranges are calculated based on that range of data not comparing the range to another factor‘s ratings range. Ranges may be different for each hazard. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.132. Ranges for Tornado Vulnerability Factor Ratings

Ratings	Social Vulnerability	Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss Insurance Paid
1		3 - 7	$500 - $500,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	$0 - $1,000
2	1	8 - 12	$500,001 - $1,000,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$1,001 - $2,000
3		13 - 17	$1,000,001 - $1,300,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$2,001 - $3,000
4	2	18 - 22	$1,300,001 - $2,000,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$3,001 - $4,000
5		23 - 27	$2,000,001 - $3,000,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$4,0001- $5,000
6	3	28 - 32	$3,000,001 - $4,000,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$5,001 - $6,000
7		33 - 37	$4,000,001 - $7,000,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$6,001 - $7,000
8	4	38 - 42	$8,000,001 - $11,000,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$7,001 - $8,000
9		43 - 47	$11,000,001 - $13,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$8,001 - $9,000
10	5	48 - 54	Above $13,000,001	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$9,001 and up

* Population density is the number of people per square mile.
Note: The assigned 1-10 range would be based on the range of dollar losses, not comparing the range of losses to another factor‘s range.

Table 3.133 provides the calculated ranges applied to determine the Medium, Medium-High and High vulnerable counties and **Table 3.134** provides the seven rating values assigned that were considered in determining overall vulnerability to tornadoes. The entire State is vulnerable to tornadoes so the overall ranges started with Medium and goes higher. **Figure 3.109** that follows provides the mapped results of this analysis by county.

Table 3.133. Ranges for Overall Tornado Vulnerability

Ranges	Medium	Medium-High	High
	9 - 19	20 – 29	30 - 40

Table 3.134. Vulnerability of Kansas Counties to Tornadoes

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Tornado Vulnerability
Mitigation Planning Region A									
Cheyenne	10	4	1	1	1	4	1	22	Medium-High
Decatur	10	5	1	1	1	4	1	23	Medium-High
Gove	8	5	1	1	1	4	5	25	Medium-High
Logan	8	3	0	1	1	4	1	18	Medium
Rawlins	10	4	1	1	1	5	1	23	Medium-High
Sheridan	10	6	1	1	1	7	1	27	Medium-High
Sherman	8	8	1	1	1	8	1	28	Medium-High
Thomas	8	4	1	1	1	10	1	26	Medium-High
Wallace	6	3	1	1	1	4	9	25	Medium-High
Mitigation Planning Region B									
Ellis	4	4	1	1	1	4	1	16	Medium
Graham	8	5	1	1	1	4	6	26	Medium-High
Ness	10	5	1	1	1	4	1	23	Medium-High
Norton	10	3	0	1	1	4	1	20	Medium-High
Phillips	8	4	1	1	1	5	1	21	Medium-High
Rooks	8	6	1	1	1	7	3	27	Medium-High
Rush	10	8	1	1	1	8	1	30	Medium-High
Russell	8	4	1	1	1	10	1	26	Medium-High
Trego	10	3	1	1	1	4	1	21	Medium-High
Mitigation Planning Region C									
Grant	6	3	1	1	1	5	1	18	Medium
Greeley	8	5	1	1	1	5	1	22	Medium-High
Hamilton	8	2	0	1	1	4	2	18	Medium
Kearny	8	3	1	1	1	5	2	21	Medium-High
Lane	8	4	1	1	1	2	1	18	Medium
Morton	8	1	1	1	1	3	1	16	Medium
Scott	4	4	1	1	1	5	6	22	Medium-High
Stanton	8	1	0	1	1	6	3	20	Medium-High
Stevens	4	3	1	1	1	9	1	20	Medium-High
Wichita	10	2	1	1	1	1	1	17	Medium
Mitigation Planning Region D									
Clark	10	6	0	1	1	1	1	20	Medium-High
Finney	4	7	1	1	1	10	1	25	Medium-High
Ford	4	10	1	1	1	7	1	25	Medium-High
Gray	4	4	1	1	1	8	1	20	Medium-High
Haskell	6	4	1	1	1	9	1	23	Medium-High
Hodgeman	6	4	1	1	1	3	4	20	Medium-High
Meade	8	4	1	1	1	7	1	23	Medium-High

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Tornado Vulnerability
Seward	4	4	2	1	1	6	1	19	Medium
Mitigation Planning Region E									
Barber	8	3	1	1	1	1	1	16	Medium
Barton	6	10	5	1	1	5	4	32	High
Comanche	10	5	0	1	1	1	1	19	Medium
Edwards	8	6	1	1	1	6	2	25	Medium-High
Kiowa	8	8	1	1	1	3	1	23	Medium-High
Pawnee	10	3	1	1	1	5	1	22	Medium-High
Pratt	6	7	3	1	1	5	1	24	Medium-High
Stafford	8	8	1	1	1	6	3	28	Medium-High
Mitigation Planning Region F									
Clay	6	2	1	1	1	4	1	16	Medium
Cloud	10	2	1	1	1	4	1	20	Medium-High
Dickinson	8	2	3	1	1	4	6	25	Medium-High
Ellsworth	10	5	1	1	1	2	1	21	Medium-High
Jewell	10	3	1	1	1	5	1	22	Medium-High
Lincoln	8	4	1	1	1	3	1	19	Medium
Mitchell	8	3	1	1	1	5	1	20	Medium-High
Osborne	10	2	1	1	1	3	1	19	Medium
Ottawa	4	3	1	1	1	3	1	14	Medium
Republic	10	7	1	1	1	6	1	27	Medium-High
Saline	4	3	1	1	1	2	4	16	Medium
Smith	10	3	1	1	1	4	1	21	Medium-High
Mitigation Planning Region G									
Butler	2	5	1	1	1	3	1	14	Medium
Cowley	6	7	1	1	1	2	1	19	Medium
Harper	8	7	1	1	1	1	10	29	Medium-High
Harvey	4	2	1	1	1	4	1	14	Medium
Kingman	6	7	1	1	1	2	1	19	Medium
Marion	8	4	1	1	1	3	1	19	Medium
McPherson	4	3	1	1	1	4	1	15	Medium
Reno	6	8	1	1	1	5	1	23	Medium-High
Rice	8	3	1	1	1	4	1	19	Medium
Sedgwick	2	4	10	8	5	4	1	34	High
Sumner	4	8	3	1	1	4	1	22	Medium-High
Mitigation Planning Region H									
Allen	6	2	1	1	1	1	1	13	Medium
Bourbon	8	1	1	1	1	1	1	14	Medium
Chautauqua	10	1	0	1	1	1	1	15	Medium
Cherokee	8	3	1	1	1	4	1	19	Medium

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Tornado Vulnerability
Crawford	6	2	1	1	1	3	1	15	Medium
Elk	10	1	0	1	1	1	1	15	Medium
Greenwood	10	3	1	1	1	1	1	18	Medium
Labette	8	4	6	1	1	2	1	23	Medium-High
Montgomery	8	2	1	1	1	1	1	15	Medium
Neosho	8	2	1	1	1	1	1	15	Medium
Wilson	8	1	1	1	1	2	2	16	Medium
Woodson	10	1	1	1	1	1	1	16	Medium
Mitigation Planning Region I									
Chase	6	2	1	1	1	1	1	13	Medium
Geary	4	2	1	1	1	1	1	11	Medium
Lyon	6	2	1	1	1	2	1	14	Medium
Morris	6	3	4	1	1	2	1	18	Medium
Pottawatomie	2	3	1	1	1	2	1	11	Medium
Riley	4	2	1	1	2	2	2	14	Medium
Wabaunsee	4	2	1	1	1	1	1	11	Medium
Mitigation Planning Region J									
Anderson	6	1	1	1	1	3	1	14	Medium
Coffey	6	1	0	1	1	2	1	12	Medium
Franklin	4	1	1	1	1	3	1	12	Medium
Linn	4	1	1	1	1	1	4	13	Medium
Miami	2	1	1	1	1	2	1	9	Medium
Osage	4	4	1	1	1	2	2	15	Medium
Shawnee	4	2	1	3	3	3	1	17	Medium
Mitigation Planning Region K									
Atchison	6	1	1	1	1	3	1	14	Medium
Brown	10	4	1	1	1	7	1	25	Medium-High
Doniphan	6	1	1	1	1	5	1	16	Medium
Douglas	2	3	1	2	3	2	1	14	Medium
Jackson	6	3	1	1	1	2	1	15	Medium
Jefferson	2	2	1	1	1	3	1	11	Medium
Marshall	8	2	1	1	1	6	1	20	Medium-High
Nemaha	8	7	2	1	1	5	1	25	Medium-High
Washington	8	4	1	1	1	5	1	21	Medium-High
Mitigation Planning Region L									
Johnson	2	2	1	10	10	2	1	28	Medium-High
Leavenworth	2	3	1	2	2	2	1	13	Medium
Wyandotte	6	1	2	3	10	1	1	24	Medium-High

Figure 3.109. Vulnerability Summary for Tornadoes

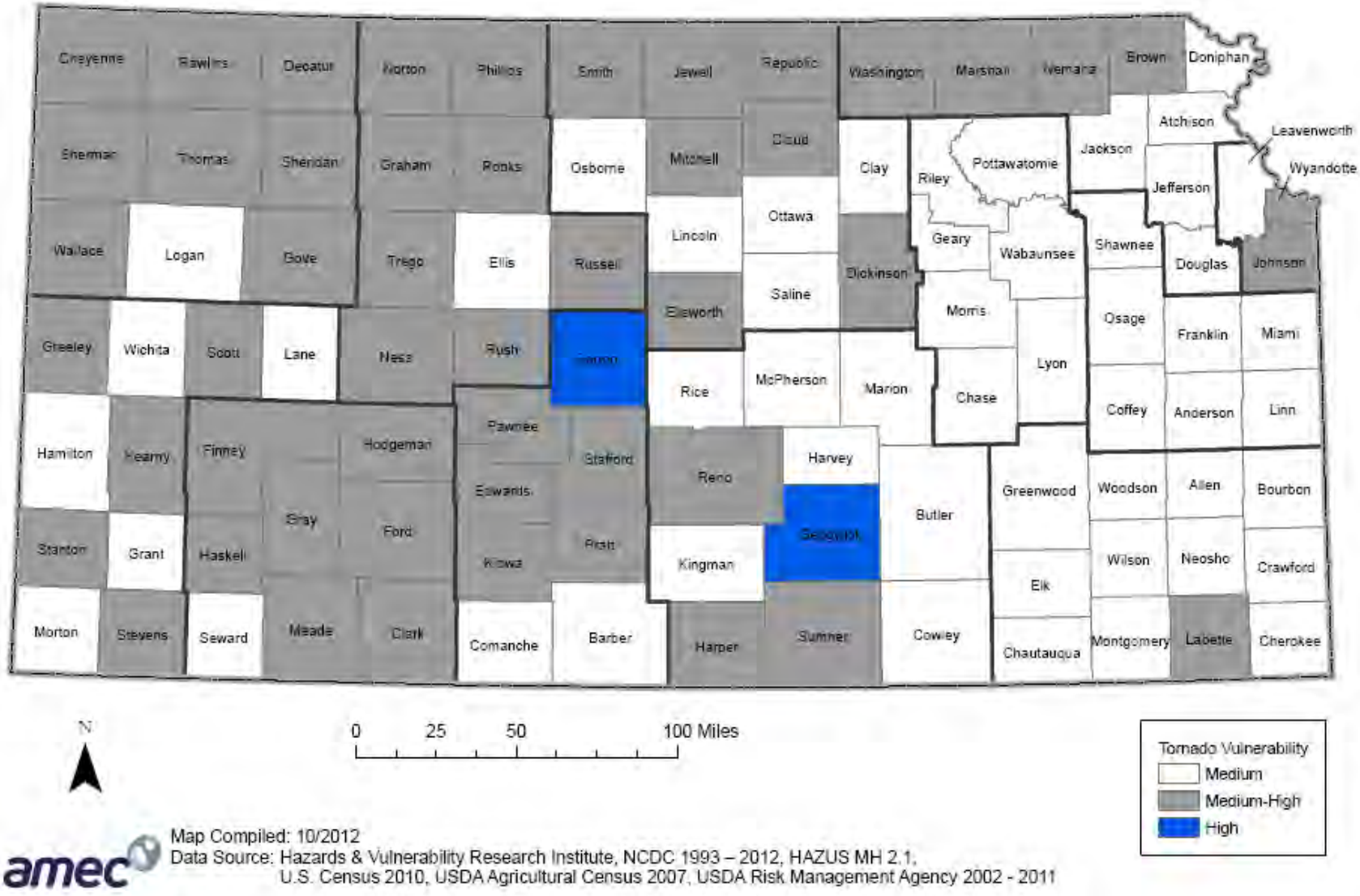


Table 3.135 below lists the top 10 vulnerable counties in Kansas relative to each other concerning tornadoes. The one EF5 destructive tornado in Greensburg, Kiowa County was deemed a statistical outlier and was not included in this analysis. Otherwise, Kiowa County would be the highest rated county.

Table 3.135. Top Counties: Vulnerable to Tornadoes

Mitigation Planning Region	County	Overall Vulnerability Rating	Winter Storm Vulnerability
G	Sedgwick	34	High
E	Barton	32	High
B	Rush	30	Medium-High
G	Harper	29	Medium-High
A	Sherman	28	Medium-High
E	Stafford	28	Medium-High
L	Johnson	28	Medium-High
A	Sheridan	27	Medium-High
B	Rooks	27	Medium-High
F	Republic	27	Medium-High

Mobile Home Vulnerability

Of the more than 560 people killed in the U.S between 2001 and 2010 by tornadoes, 51 percent were in mobile homes, according to the National Oceanic and Atmospheric Administration. According to the *2012 Kansas Severe Weather Awareness Week* packet, people living in mobile homes are killed because of tornadoes at a rate 20 times higher than people living in permanent homes. Only 33 percent of those who died were in permanent structures, and 16 percent were outside a home.

Yet mobile homes make up only about 7 percent of the nation's housing. They represent about 5.2 percent of homes in Kansas, which 65,184 units according to the U.S. Census Bureau.

Table 3.136 provides the number of mobile home units per county according to the U.S. Census Bureau American Community Survey 2005 – 2009.

Table 3.136. Number of Mobile Home Units per County

Mitigation Planning Region	County	Number of Mobile Homes
A	Cheyenne	81
A	Decatur	97
A	Gove	83
A	Logan	90
A	Rawlins	111
A	Sheridan	74
A	Sherman	164
A	Thomas	349
A	Wallace	89
B	Ellis	685
B	Graham	56
B	Ness	76
B	Norton	115
B	Phillips	218
B	Rooks	148
B	Rush	101
B	Russell	156
B	Trego	87
C	Grant	714
C	Greeley	66
C	Hamilton	174
C	Kearny	322
C	Lane	124
C	Morton	176
C	Scott	127
C	Stanton	181
C	Stevens	472
C	Wichita	145
D	Clark	23
D	Finney	1,879
D	Ford	1,678
D	Gray	384
D	Haskell	266
D	Hodgeman	81
D	Meade	95
D	Seward	1,318
E	Barber	256
E	Barton	1,014
E	Comanche	33
E	Edwards	97
E	Kiowa	81
E	Pawnee	150
E	Pratt	367
E	Stafford	180

Mitigation Planning Region	County	Number of Mobile Homes
G	Butler	2,155
G	Cowley	1,474
G	Harper	183
G	Harvey	777
G	Kingman	181
G	Marion	380
G	McPherson	740
G	Reno	1,268
G	Rice	203
G	Sedgwick	8,797
G	Sumner	777
H	Allen	694
H	Bourbon	571
H	Chautauqua	228
H	Cherokee	1,444
H	Crawford	1,370
H	Elk	167
H	Greenwood	427
H	Labette	658
H	Montgomery	1,442
H	Neosho	714
H	Wilson	582
H	Woodson	287
I	Chase	133
I	Geary	1,600
I	Lyon	1,372
I	Morris	364
I	Pottawatomie	1,060
I	Riley	1,988
I	Wabaunsee	274
J	Anderson	301
J	Coffey	445
J	Franklin	1,283
J	Linn	965
J	Miami	788
J	Osage	847
J	Shawnee	2,824
K	Atchison	466
K	Brown	178
K	Doniphan	475
K	Douglas	1,586
K	Jackson	505
K	Jefferson	895
K	Marshall	212

Mitigation Planning Region	County	Number of Mobile Homes
F	Clay	278
F	Cloud	279
F	Dickinson	656
F	Ellsworth	302
F	Jewell	133
F	Lincoln	70
F	Mitchell	122
F	Osborne	130
F	Ottawa	289
F	Republic	126
F	Saline	1,197
F	Smith	48
K	Nemaha	184
K	Washington	166
L	Johnson	1,392
L	Leavenworth	873
L	Wyandotte	1,676

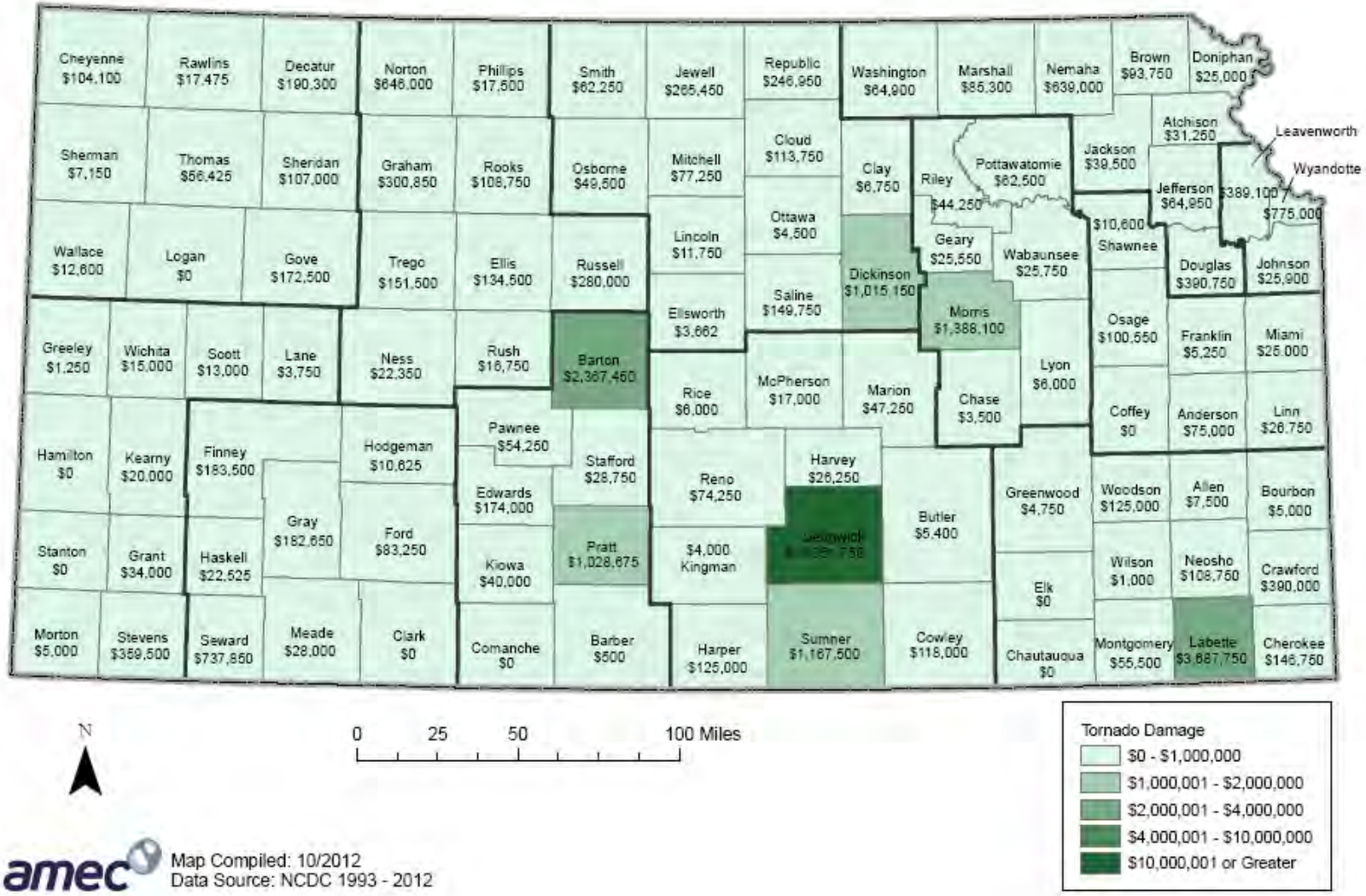
Source: U.S. Census Bureau American Community Survey 2005 – 2009.

State Estimates of Potential Losses

To determine potential financial loss estimates to tornadoes in Kansas, the available historical loss data was annualized to determine future potential losses. As discussed above in the vulnerability overview for tornado, the planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (1993 – 2012). According to this data, the annualized property loss for the State of Kansas from tornadoes is $38 million as can be viewed in **Table 3.131** (vulnerability overview section). The one EF5 destructive tornado in Greensburg, Kiowa County was deemed a statistical outlier and the property losses were not included in this analysis.

Figure 3.110 provided the annualized property loss damages per county. Sedgwick and Barton Counties have the highest annualized damage; which are located in south central and central Kansas. Overall, the pattern of greatest loss is in central counties of Kansas.

Figure 3.110. Annualized Property Loss from Tornadoes, by County, 1993 – 2012



Development in Hazard Prone Areas

New development anywhere in Kansas will be susceptible to tornado impacts. New manufactured housing development will be most susceptible to damage, particularly if not anchored properly. The extent of new manufactured housing development is not known.

Of the more than 560 people killed in the U.S between 2001 and 2010 by tornadoes, 51 percent were in mobile homes, according to the National Oceanic and Atmospheric Administration. Folks living in mobile homes die because of tornadoes at a rate 20 times higher than people living in permanent homes as stated in the *2012 Kansas Severe Weather Awareness Week* packet.

Only 33 percent of those who died were in permanent structures, and 16 percent were outside a home.

Yet mobile homes make up only about 7 percent of the nation's housing. They represent about 5.2 percent of homes in Kansas, according to the U.S. Census Bureau.

Consequence Analysis

A tornado scenario is analyzed in KDEM's THIRA. 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 3.137** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.137. EMAP Consequence Analysis: Tornado

Subject	Ranking	Impacts/Tornado
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe depending on whether individuals were able to seek shelter and get out of the trajectory of the tornado. Casualties are dependent on warning systems and warning times.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal to Severe	Temporary/Permanent relocation may be necessary if government facilities experience damage (minimal to severe).
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be severe in the trajectory path. Roads, buildings, and communications could be adversely affected. Damage could be severe.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained. Depending on the incident size the damage could be severe.
Environment	Minimal to Severe	Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the trajectory

Subject	Ranking	Impacts/Tornado
		of the tornado. If a jurisdiction takes a direct hit then the economic conditions will be severe. With an indirect hit the impact could still be anywhere from low to severe.
Public Confidence in Jurisdiction‘s Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Warning systems and warning time will also be questioned (minimal to severe)

3.3.19. Utility/Infrastructure Failure

Calculated Priority Risk Index	Planning Significance
1.75	Low

Description/Location

Critical infrastructure involves several different types of facilities and systems including: electric power, transportation routes, natural gas and oil pipelines, water and sewer systems, storage networks, and internet/telecommunications systems. Failure of utilities or other components of the infrastructure in Kansas can seriously impact public health, functioning of communities and the State's economy. Disruption of any of these services could result from the majority of the natural, technological, and manmade hazards described in this plan. In addition to a secondary or cascading impact from another primary hazard, utilities and infrastructure can fail as a result of faulty equipment, lack of maintenance, degradation over time, or accidental damage such as damage to buried lines or pipes during excavation.

Electric Power

Disruption of electric power supply can be a cascading impact of several other hazards. The most common hazards analyzed in this plan that disrupt power supply are: flood, tornado, windstorm, and winter weather as these hazards can cause major damage to power infrastructure. To a lesser extent, extreme temperatures, dam and levee failure, lightning, and terrorism can disrupt power. Extreme heat can disrupt power supply when air conditioning use spikes during heat waves which can cause brownouts. Dam and levee failure, are similar to flood in that infrastructure can be damaged or made inaccessible by water. Lightning strikes can damage substations and transformers, but is usually isolated to small areas of outage. Many forms of terrorism could impact power supply either by direct damage to infrastructure or through cyber-terrorism targeting power supply networks.

Electricity in Kansas is provided by three types of utilities: investor-owned utilities, municipal utilities, and rural electric cooperatives. Electric utilities in Kansas are regulated by both the Kansas Corporation Commission (KCC) and the Federal Energy Regulatory Commission (FERC). Investor-owned utilities in Kansas are operated by public corporations, and their stock is traded publicly and owned by shareholders. The Investor-owned Utilities (IOUs) operating in Kansas are Westar Energy, Kansas City Power & Light (KCP&L), and the Empire District Electric Company. Westar operates 12 power plants and owns over 33,000 miles of transmission and distribution lines. Its service territory covers about 10,130 square miles in east and east-central Kansas, and they provide electricity to more than 675,000 customers. KCP&L is based out of Kansas City, Missouri, and has a service territory of approximately 18,000 square miles in areas of northeastern Missouri and eastern Kansas. KCP&L operates nine power plants, supplying power to over 800,000 customers in Missouri and Kansas. The Empire District Electric Company is headquartered in Joplin, Missouri, and provides electric, natural gas, water, and fiber optics services throughout western Missouri. Outside Missouri, Empire serves part of Cherokee County in Kansas.

Kansas municipal utilities are customer-owned, not-for-profit, public power systems, operated by municipal governments. Their rates are set by the city council, commission, or a representative municipal board. There are 121 municipal electric utilities that provide electricity to nearly 20 percent of the State‘s consumers. The largest municipal utility is the Kansas City Board of Public Utilities, which serves approximately 69,000 customers in Kansas City, Kansas. Although roughly half of the State‘s municipal utilities own and operate generating units, most municipal generation is operated only to serve demand, and the majority of the energy delivered by municipal electric utilities (also known as public power systems) is purchased through long-term contracts or on the wholesale market. Many municipal electric utilities in the State also work through a joint action agency to coordinate energy purchases.

Rural electric cooperatives (RECs) are not-for-profit, member-owned electric utilities. Distribution cooperatives deliver electricity to consumers. Generation and transmission cooperatives (G&Ts) generate and transmit electricity to distribution co-ops. Kansas RECs are governed by a board of trustees elected from the membership. Most Kansas RECs were set up under the Kansas Electric Cooperative Act, which, together with the federal Rural Electrification Act of 1934, made electric power available to rural customers. Currently, Kansas has two G&Ts—Sunflower Electric Power Corporation, based in Hays, and Kansas Electric Power Cooperative, Inc. (KEPCo), headquartered in Topeka—and 29 distribution cooperatives.

Some municipal utilities and rural electric cooperatives receive an allocation of renewable energy from federal hydropower projects, the Western Area Power Administration (WAPA) and the Southwestern Power Administration (SWPA). Kansas utilities also receive some hydropower from the Grand River Dam Authority (GRDA).

Two nuclear power plants serve Kansas: Cooper Nuclear Station in Brownville, Nebraska, is owned and operated by Nebraska Public Power District. The Wolf Creek Generating Station in the Burlington, Kansas (Coffey County) is operated by the Wolf Creek Nuclear Operating Corporation and is a subsidiary of three owners: KCP&L, Westar, and Kansas Electric Power Cooperative.

Figure 3.111 shows the locations of electric transmission lines and power plants throughout Kansas. **Figure 3.112** that follows shows Kansas Electric Certified Areas.

Figure 3.111. Kansas Electric Transmission Lines and Power Plants

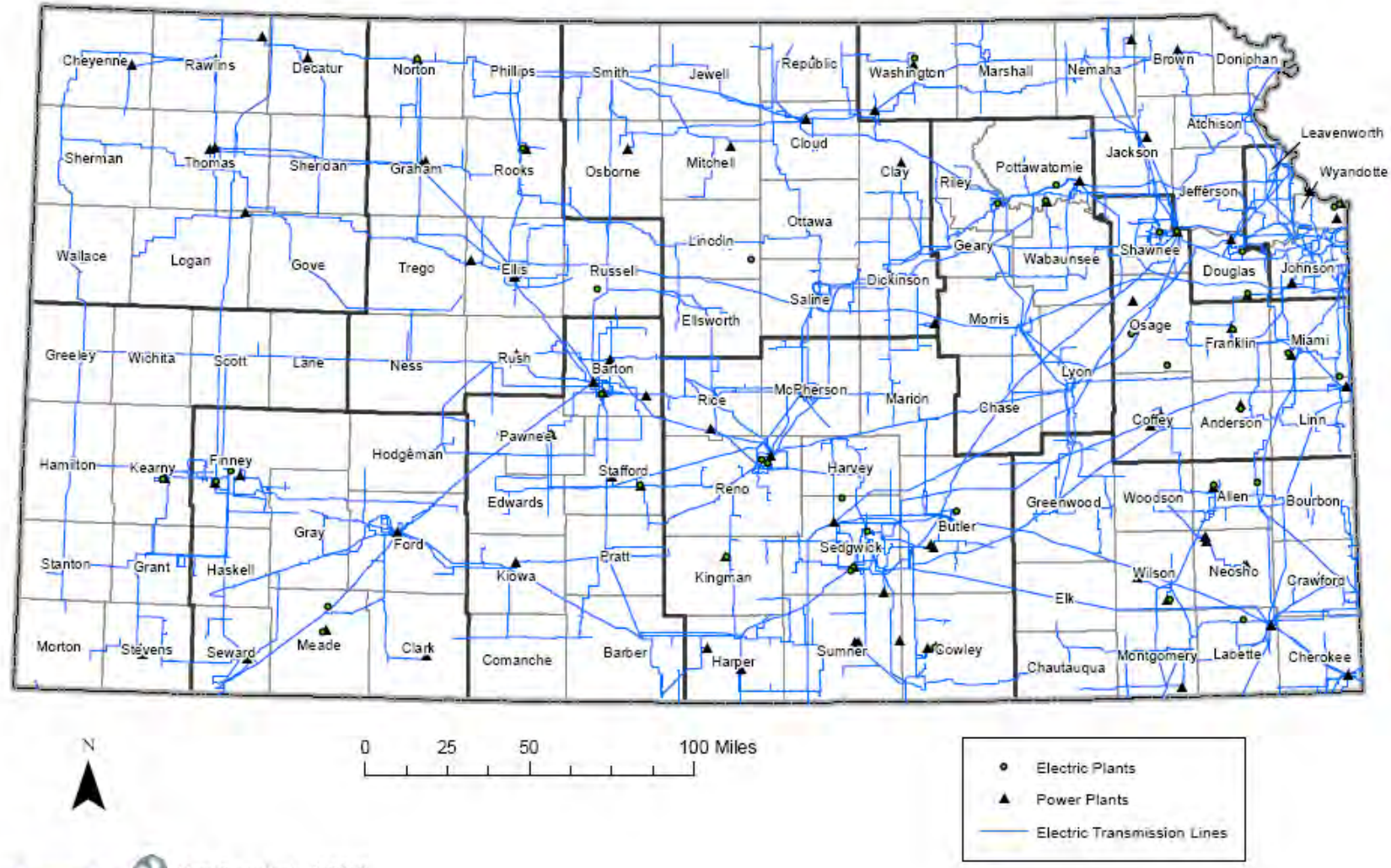
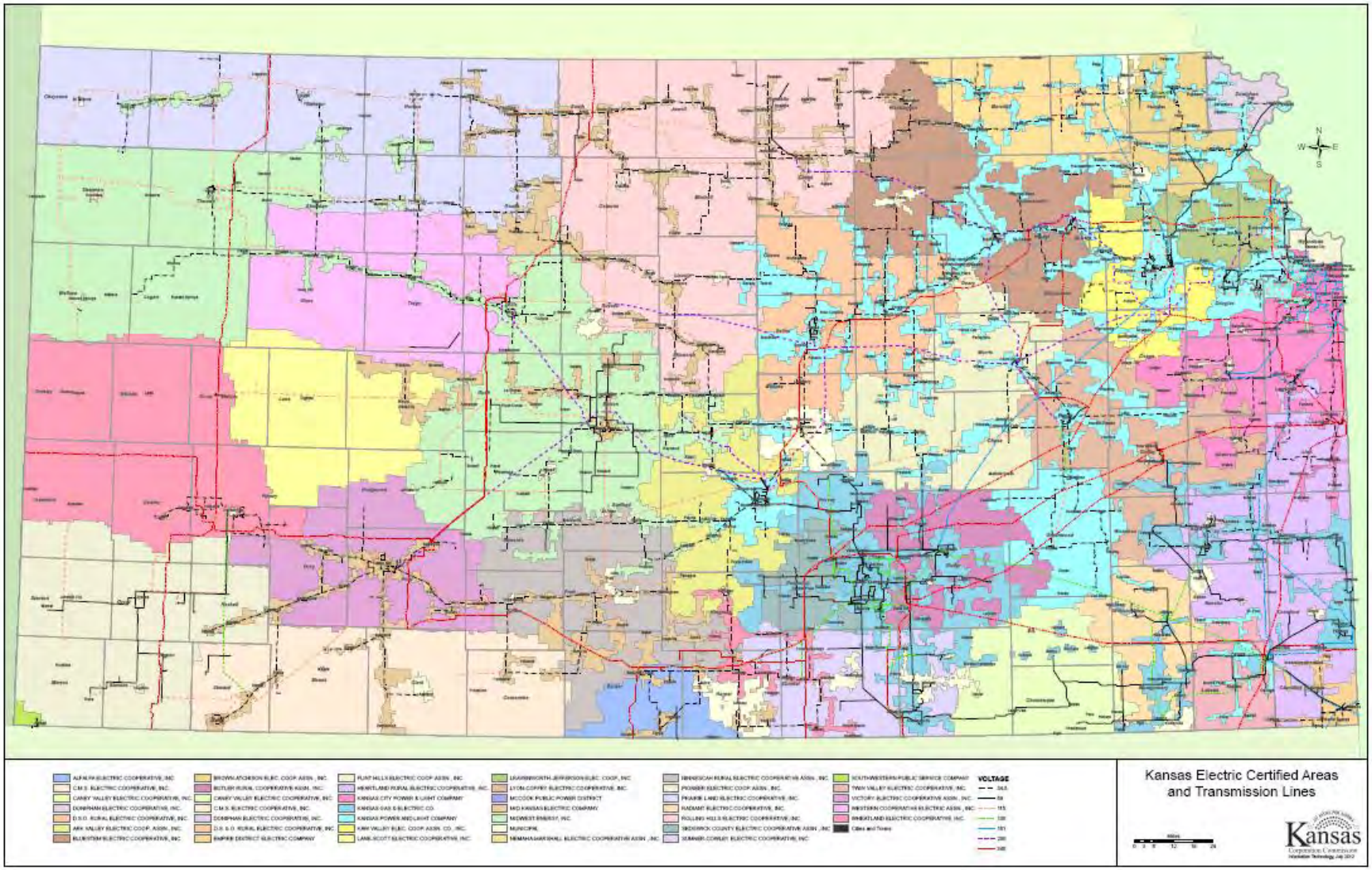


Figure 3.112. Kansas Electric Certified Areas



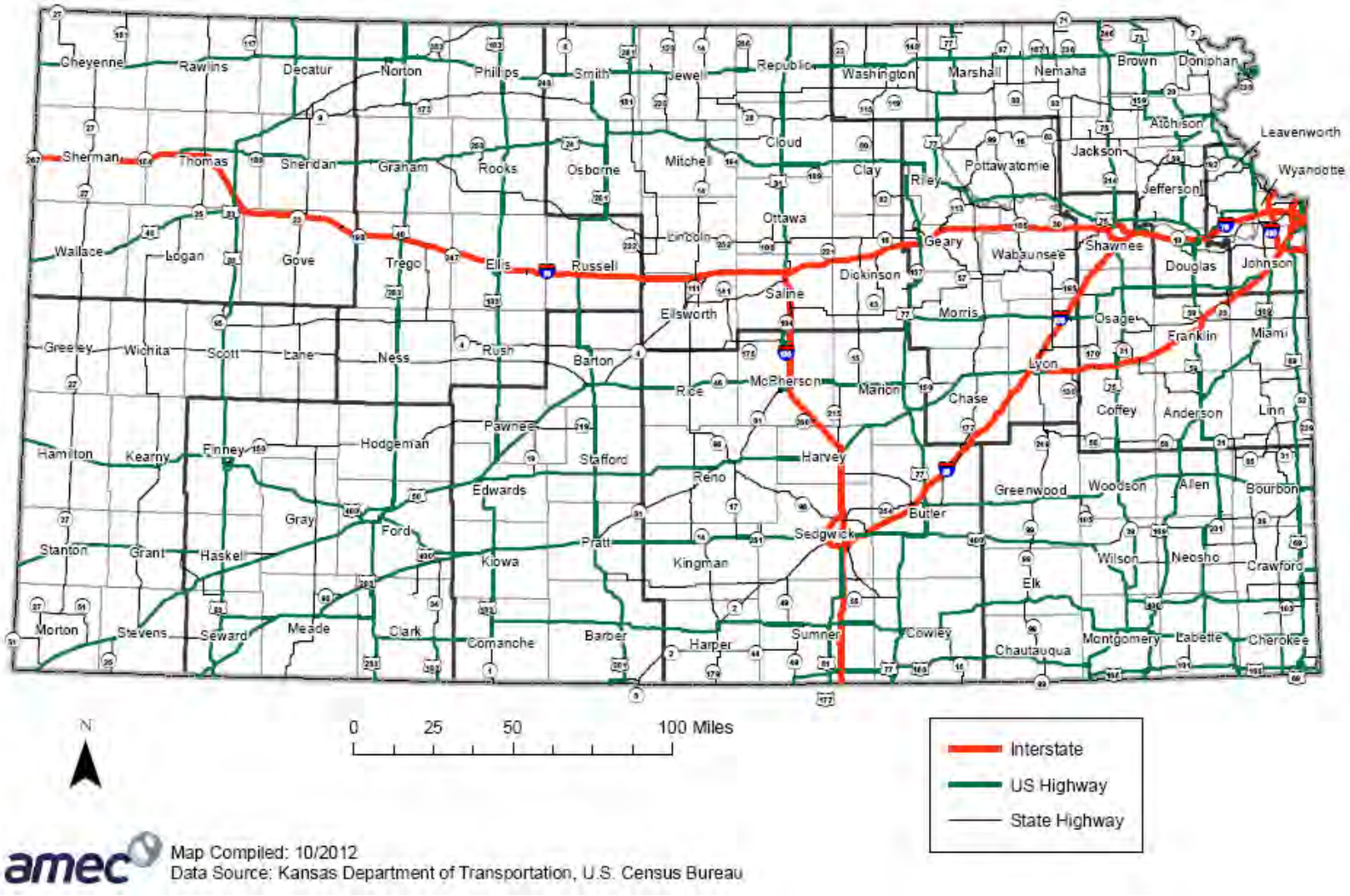
Source: Kansas Corporation Commission

Transportation Routes

Transportation routes can also be impacted by many of the hazards discussed in this plan. The primary hazards that impact transportation are: Flood, Hazardous Materials, and Winter Weather. Flood events, both riverine and flash flood can make roads and bridges impassible due to high water. Flood waters can also erode or scour road beds and bridge abutments. Highway and railroad accidents that involve hazardous materials can impact transportation routes as road and railroad closures, as well as evacuations may be necessary. Winter Weather frequently impacts transportation as roads become treacherous or impassible due to ice and snow. Secondary hazards that impact transportation routes include: dam and levee failure if routes are in inundation areas, extreme temperatures can cause damage to pavement (especially asphalt), land subsidence can damage roads/railroads if subsidence area is near the route, landslide can cause debris and rock falls onto roadways, terrorism can target routes, tornado can directly damage infrastructure or deposit debris in routes, wildfire can cause decreased visibility on transportation routes due to smoke, and windstorm can cause vehicle accidents or overturning (particularly cargo vans).

Figure 3.113 shows the interstates, U.S. highways, and state highway transportation routes in Kansas.

Figure 3.113. Major Highways in Kansas



Natural Gas and Oil Pipelines

Primary hazards that can impact natural gas and oil pipelines are earthquake, expansive soils, land subsidence, landslide, and terrorism.

Figure 3.114 shows the natural gas transmission lines in Kansas and **Figure 3.115** that follows shows the petroleum transmission lines.

Figure 3.114. Natural Gas Transmission Lines in Kansas

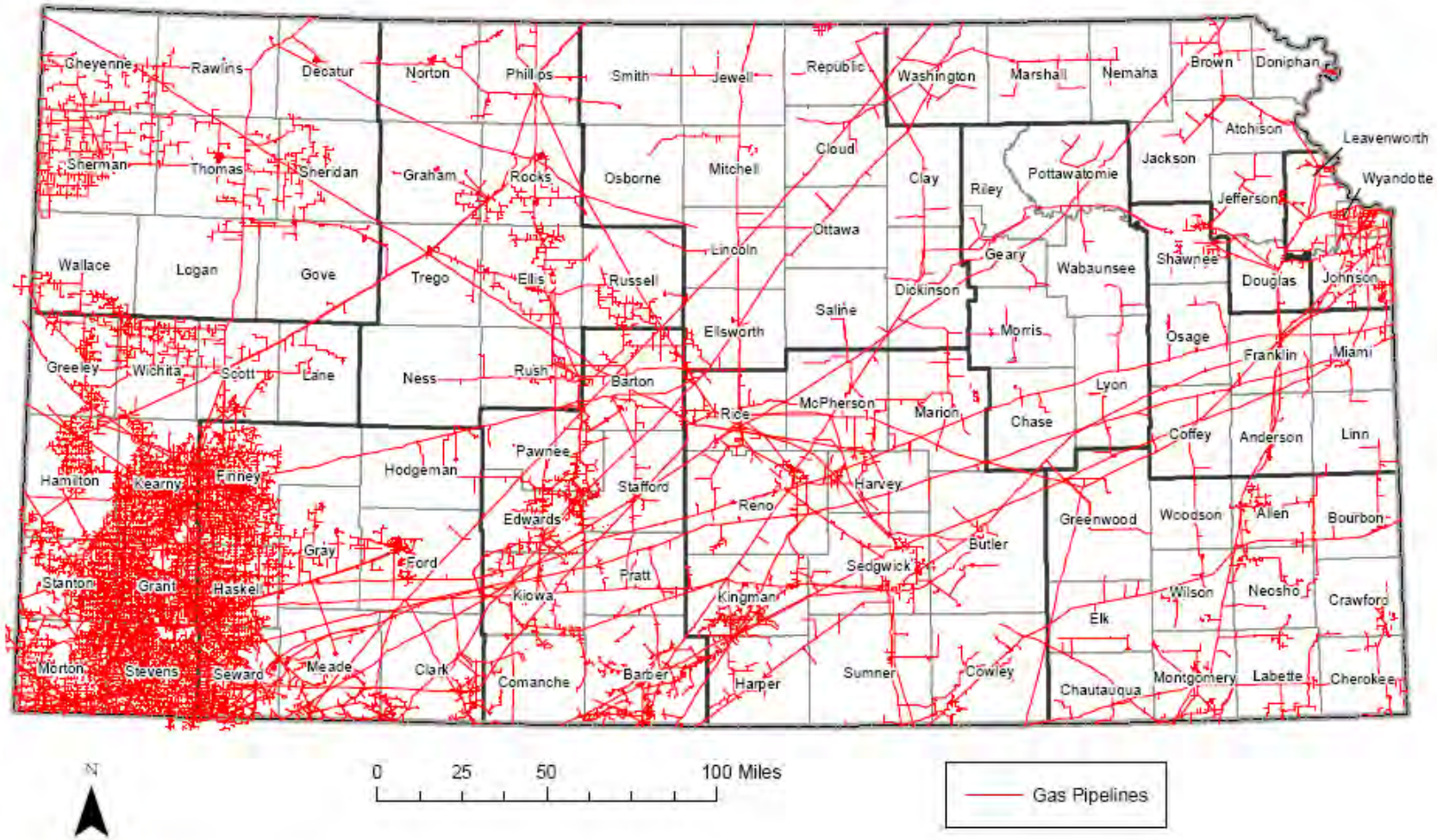
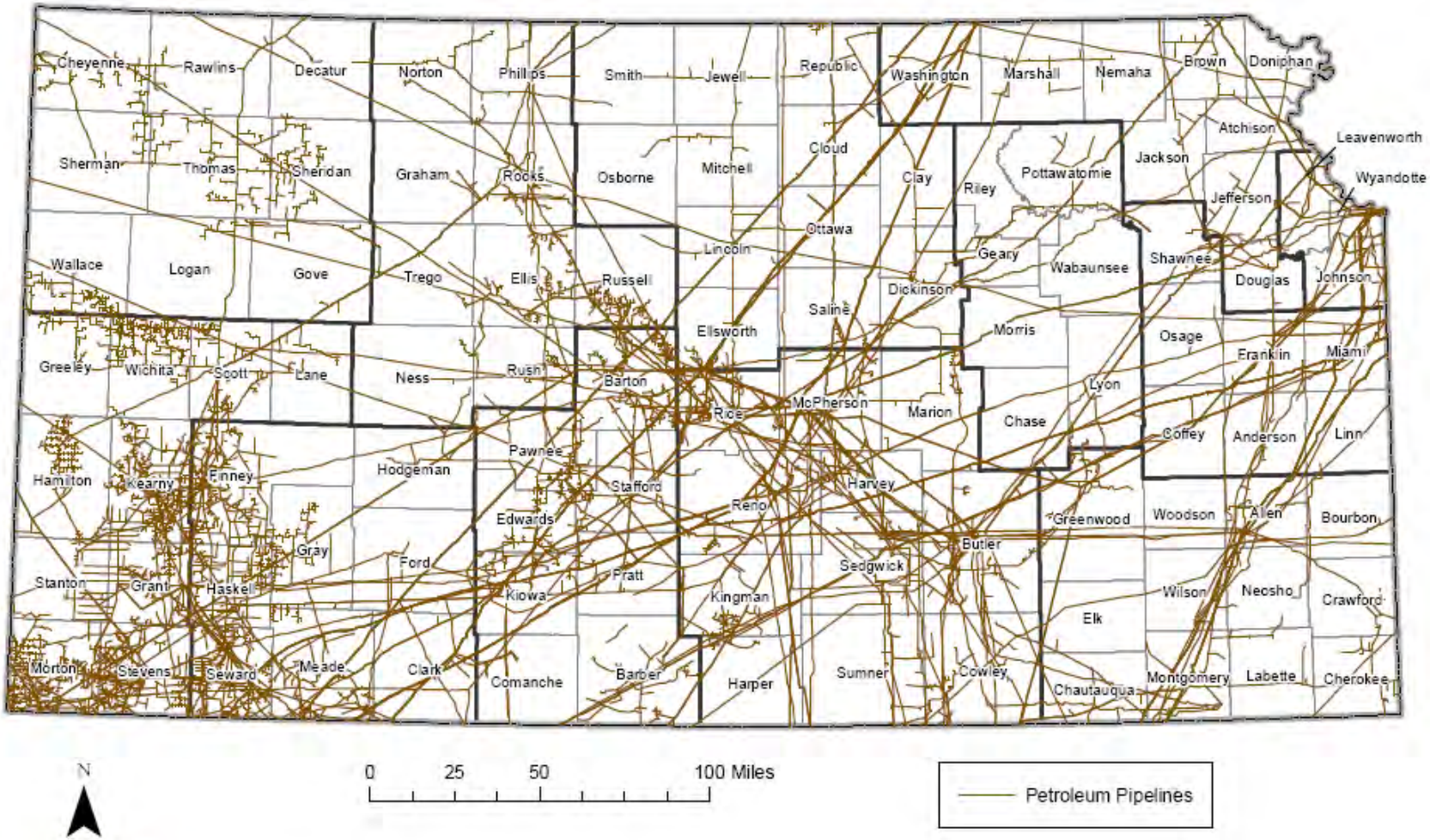


Figure 3.115. Petroleum Lines in Kansas



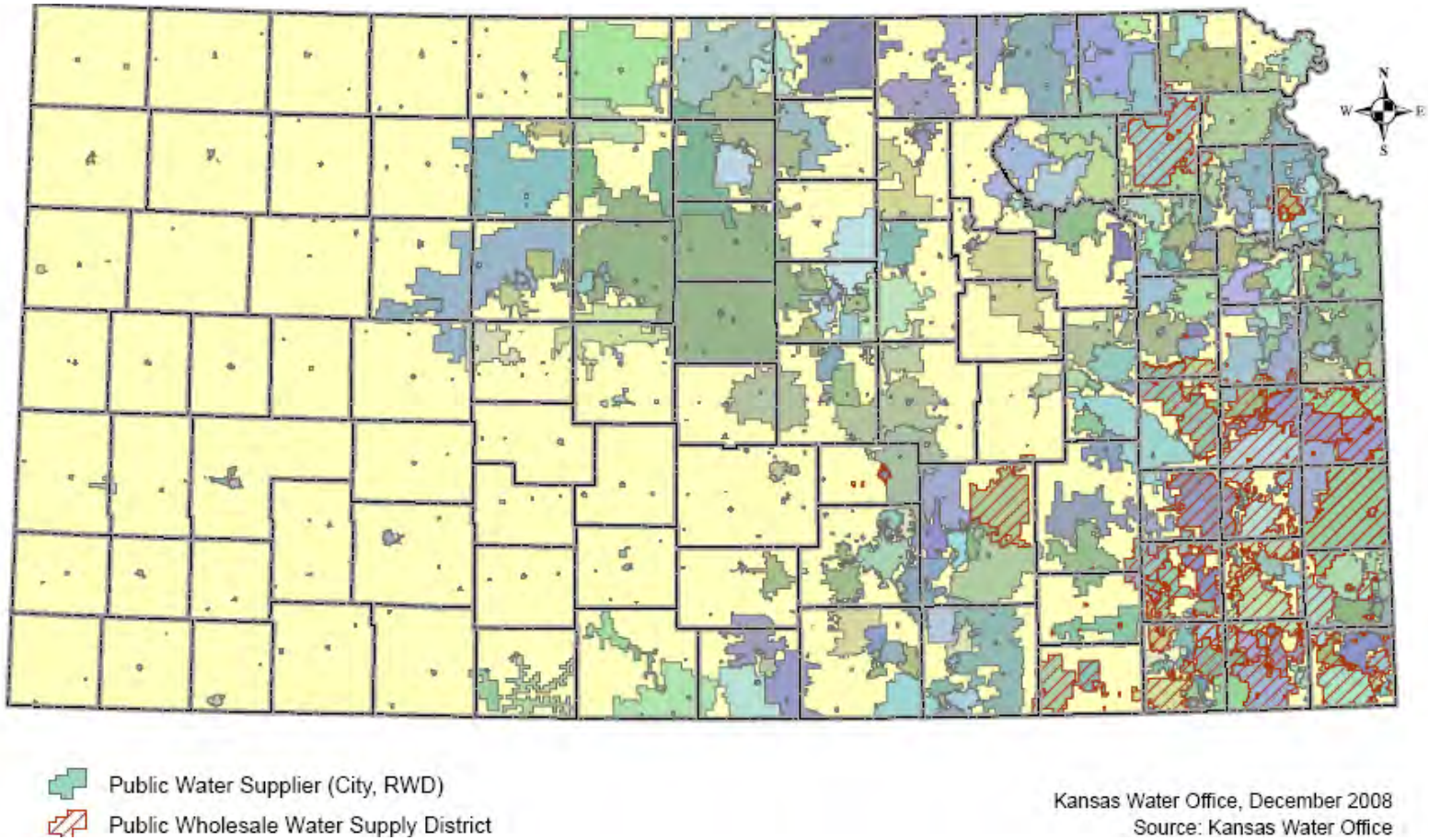
amec Map Compiled: 10/2012
Data Source: KCC, KDEM

Water and Sewer Systems

The primary hazards that can impact water supply systems are: drought, flood, hazardous materials, and terrorism. The primary hazard that impacts sewer systems is flood.

Figure 3.116 provides a map of public water suppliers in Kansas.

Figure 3.116. Public Water Suppliers in Kansas



Source: Kansas Water Office, http://www.kwo.org/Kansas_Water_Plan/KWP_Docs/VolumeIII/Statewide/map_statewide_KWP_PWS_090508_tr.pdf

Storage Networks

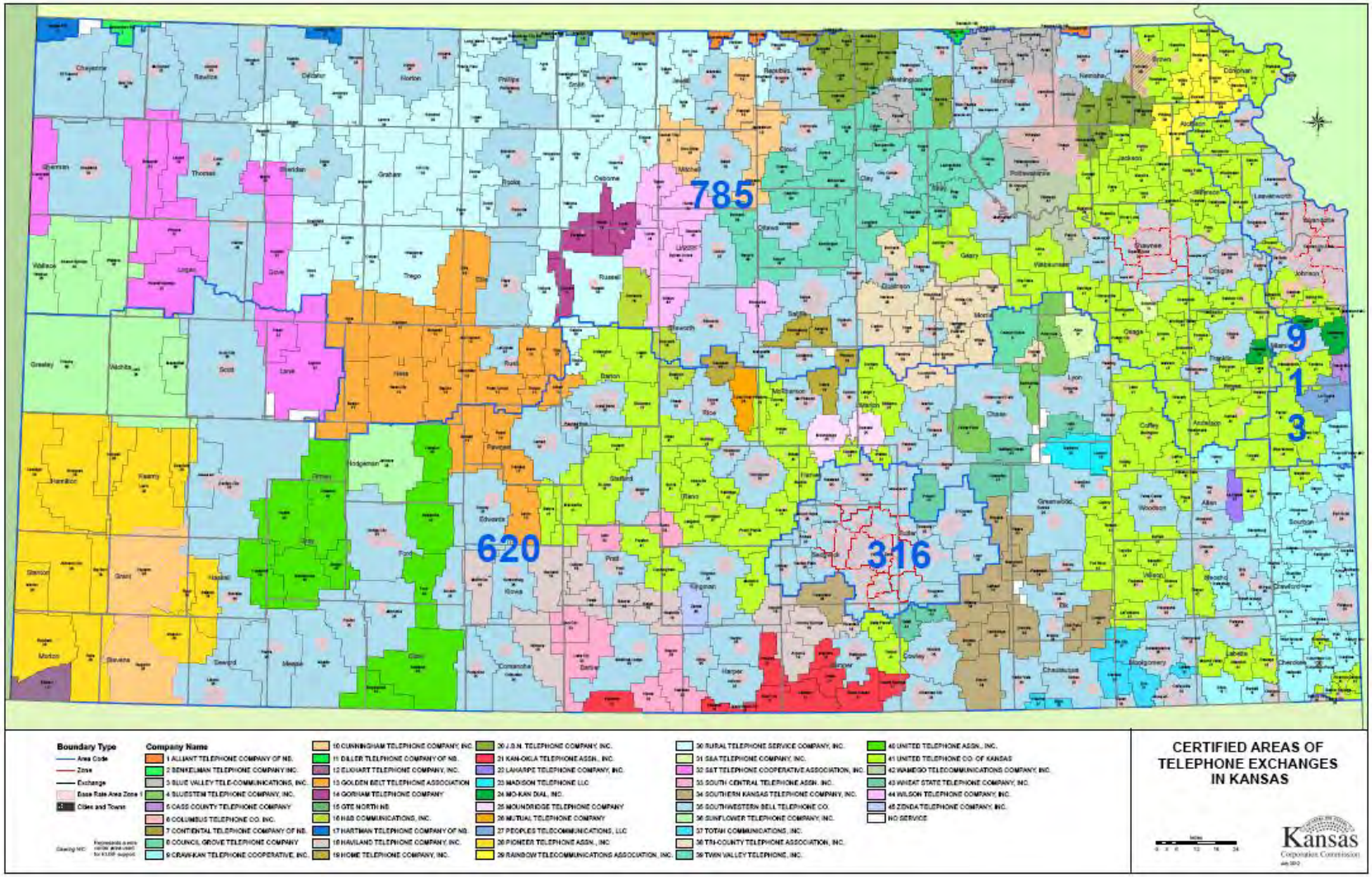
If damaged, storage networks and infrastructure can disrupt government and business functions. All state government and most local governments and businesses utilize redundant systems to decrease vulnerability to outages. All hazards that can disrupt electric power can also impact storage networks as electricity is required to power the infrastructure. In addition, the networks themselves can be damaged if the hazard impacts the facility where the network is located. The primary hazards that can cause direct damage are: flood, lightning, terrorism, and tornado.

Internet/Telecommunications

Internet and telecommunications infrastructure can be impacted by a number of hazards as well. The types of hazards and impacts to internet and telecommunications infrastructure are very similar to electric power supply. Land line phone lines often utilize the same poles as electric lines. So, when weather events such as windstorm or winter weather cause lines to break, both electricity and telephone services experience outages. With the increasing utilization of cellular phones, hazard events such as tornado that can damage cellular repeaters can cause outages. In addition, during any hazard event, internet and telecommunications systems can become overwhelmed due to the surge in call/usage volume.

Figure 3.117 provides certified areas of telephone exchanges in Kansas.

Figure 3.117. Certified Areas of Telephone Exchanges in Kansas



Source: Kansas Corporation Commission, http://www.kcc.state.ks.us/maps/ks_telephone_certified_areas.pdf

Previous Occurrences

Many of the events in previous occurrences of other hazards discuss impacts to utilities and infrastructure. This section highlights some of the more damaging events.

- **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. 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. The counties included are Atchison, Doniphan, Leavenworth, and Wyandotte. Damages as a result of this event were estimated to be nearly $7.4 billion and primarily involved damages to roads and bridges.
- **FEMA-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-1868-DR—December, 2009 (November 14-16, 2009):** This event resulted in extremely heavy snows that caused severe damage to electric infrastructure and disrupting power to several thousand customers. The majority of the snowfall occurred in the northern counties along the US-36 corridor. Northern Republic County reported eight inches of snow. Morrowville in Washington County reported a 12 inch accumulation. Marshall, Nemaha, and Brown Counties reported accumulations of five to seven inches. Damage estimates of 1.6 million dollars included damage to power poles across Washington, Marshall, Republic and Cloud Counties with the worst damage across Washington and Marshall Counties. FEMA‘s Public Assistance funds spent $43,217,690 on this disaster. Rolling Hills Electric Cooperative stated that around 750 power poles snapped in Republic, Washington, and Marshall Counties due to the weight on the lines.
- **FEMA-1741-DR—February, 2008 (December 6-19, 2007):** An ice storm caused numerous power outages and approximately 130,000 Kansas customers were without power. Specifically, Kansas Rural Electric Cooperatives reported 49,000 customers without power, Westar reported 76,000 customers, Kansas City Power & Light reported 4,300 customers, and Kansas City, Kansas Board of Public Utilities reported 800 customers without power. FEMA‘s Public Assistance costs were $355,651,857 for this disaster.
- **FEMA-1711-DR: Severe Storms and Flooding—July 2, 2007 (June 26–30):** This event was major flooding in southeast Kansas. Initially, Neodesha, in Wilson County 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 Montgomery County, the Coffeyville Resources refinery and nitrogen fertilizer plant, and many local businesses were flooded.

- **FEMA-1675-DR—January 7, 2007 (December 28–30, 2006):** This storm was one of Kansas' worst disasters on record. It began on December 28, 2006, and increased in intensity December 29 overnight into December 30. Snow depths ranged from four inches in Saline County to 30 inches in Wallace County. Numerous highways were closed for days in western Kansas, and there were major power outages because of icing. The ice was 1/4 inch thick on guide wires that brought several communication towers down. During the peak of the storm there were 46,300 meters off-line and 10,500 power poles down. Approximately 60,000 people were without power. FEMA's Public Assistance costs were $315,201,639 for this disaster.
- **Summer 2006:** During the summer of 2006, a heat wave caused two train derailments and rerouting of train traffic. The derailments were caused by —sunkinks" as 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 were compromised.
- **FEMA-1626-DR—January 26, 2006 (November 27-28, 2005):** Much of the State was affected by this storm. Winds of 40 to 60 mph combined with two to seven inches of snow resulted in a blizzard, which raged across parts of north central Kansas. The wind whipped the snow into drifts 10 to 15 feet high in some places. Interstate 70 was closed west of Russell, and numerous other highways were impassable during the storm. There were several reports of auto accidents, including a 25-car pileup, and sporadic power outages. At least three auto-related deaths were attributed to the storm. FEMA's Public Assistance costs were $50,281,517 for this disaster.
- **FEMA-1579-DR—February 8, 2005 (January 4-6):** Although freezing rain was the primary culprit, sleet also played a vital role in coating nearly the entire region with one-two inches of ice, which caused incredible damage to trees, power lines, and power poles. Many areas were without power for more than a week. The storm caused an estimated $30 million in damages. Particularly hard hit were Butler and Sedgwick Counties, which sustained an estimated $8.5 million and $15 million damage, respectively. FEMA's Public Assistance costs were $106,873,672 for this disaster.
- **FEMA-1402-DR: Ice Storm—February 6, 2002 (January 29–February 15):** Beginning on January 29, a three-day severe winter storm hit 35 Kansas counties in the southeast corner of the State with freezing rain, drizzle, sleet, and snow. With one to two inches of ice accumulation, utility poles and power lines snapped, transportation was treacherous, and fallen trees damaged many structures. The resulting power outages affected nearly the entire region and lasted nearly a week in some areas. Loss of power was particularly problematic for many nursing homes. There were seven casualties, and property damage approximated $32 million. FEMA's Public Assistance costs were $45,020,240 for this disaster.
- **January 2001:** A 143 million cubic feet of compressed natural gas leaked from a nearby storage field occurred. The natural gas migrated underground, and then rose to the surface through old brine wells creating about 15 gas blowholes. An explosion in downtown Hutchinson destroyed two businesses and damaged many others. Another explosion

occurred the next day at a mobile home park three miles away from the first explosion. Two residents died of injuries from the explosion and hundreds of people were evacuated as gas geysers began erupting in the area. Some geysers reached as high as 30 feet in the air.

- **Sumer of 1993:** The 1993 flood is an extreme example of disruption of Kansas' Infrastructure. Not only were roads and rivers un-navigable for weeks and months following the flood, but power lines were swept away causing disruption of communications and power services.

Probability of Future Hazard Events

Based on historical records, utility failures occur annually across the State. For ranking purposes, the mitigation planning team elected to only factor significant failures for the probability ranking. A significant failure was considered to be failure where 10 percent of the population of an affected jurisdiction is impacted by the utility/infrastructure failure for 3 days. This hazard's CPRI probability for significant events is —Likely" within the next three years.

State Vulnerability Analysis

While every community in the State is at risk to utility/infrastructure failure, the vulnerability is somewhat elevated in the northeast area of the State due to the higher population density, development, and economic activities of the Kansas City Metropolitan Area that would be disrupted by a major infrastructure failure event. The south-central portion of the State is also has an increased vulnerability due to the population density, development, and economic activity in the Wichita area. Agricultural areas of the State are also vulnerable to prolonged outage events as modern agricultural practices are reliant on energy; such as electric milking machines, and irrigation pivots.

In addition, generally the smaller utility suppliers such as small electrical suppliers have limited resources for mitigation. Thus, the large number of small electric providers could mean greater vulnerability in the event of a major, widespread disaster, such as a major flood, severe winter storm or ice storm. The majority of the municipal utilities purchase power on the wholesale market for resale to their customers. This may make them more vulnerable to regional shortages of power as well. Such vulnerability was demonstrated in the power outages in the Great Lakes and New York area in 2003.

In recent years, regional electric power grid system failures in the western and northeastern United States have demonstrated that similar failures could happen in Kansas. This vulnerability is most appropriately addressed on a multi-state regional or national basis.

State Estimates of Potential Losses

Since utility/infrastructure failure is generally a secondary or cascading impact of other hazards, it is not possible to quantify estimated potential losses specific to this hazard due to the variables associated with affected population, duration of outages, etc...

Although the limitless variables make it difficult to estimate future losses on a statewide basis, FEMA has developed standard loss of use estimates in conjunction with their Benefit-Cost

Analysis methodologies to estimate the cost of lost utilities on a per-person, per-use basis (See **Table 3.138**).

Table 3.138. FEMA Standard Values for Loss of Service for Utilities and Roads/Bridges

Loss of Electric Power	Cost of Complete Loss of Service
Total Economic Impact	$126 per person per day
Loss of Potable Water Service	**Cost of Complete Loss of Service**
Total Economic Impact	$93 per person per day
Loss of Wastewater Service	**Cost of Complete Loss of Service**
Total Economic Impact	$41 per person per day
Loss of Road/Bridge Service	**Cost of Complete Loss of Service**
Vehicle Delay Detour Time	$38.15 per vehicle per hour
Vehicle Delay Mileage	$0.55 per mile (or current federal mileage rate)

Source: FEMA BCA Reference Guide, June 2009, Appendix C

Development in Hazard Prone Areas

Increases in development and population growth increase the demand for utilities as well as the level of impacts when the utilities fail.

Consequence Analysis

The information in **Table 3.139** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.139. EMAP Consequence Analysis: Utility/Infrastructure Failure

Subject	Ranking	Impacts/Utility/Infrastructure Failure
Health and Safety of Persons in the Area of the Incident	Moderate to Severe	Localized impact will be moderate to severe for persons with functional and access needs, and the elderly, depending on length of failure and time of year.
Responders	Minimal	Impact to responders will be minimal if properly trained and equipped.
Continuity of Operations	Minimal	Due to the nature of the hazard, the COOP plan is not expected to be activated, however, if the recovery time is excessive than temporary relocation may become necessary (minimal).
Property, Facilities, and Infrastructure	Minimal	Impact is dependent on the nature of the incident, e.g., electric, water, sewage, gas, communication disruptions). (Minimal)
Delivery of Services	Minimal	Delivery of services could be affected within and around the affected area (minimal).
Environment	Minimal	Impact, depending on the nature of the incident, should be minimal.
Economic Conditions	Minimal	Economic conditions could be adversely affected depending on damages suffered, extent of damages, etc. (minimal)
Public Confidence in Jurisdiction‘s Governance	Minimal	Impact will be dependent on whether or not the government or non-government entities response, recovery, and planning were not timely and effective (minimal).

3.3.20. Wildfire

Calculated Priority Risk Index	Planning Significance
3.2	High

Description/Location

Wildfires have always been a part of the Kansas landscape. Wildfires in Kansas typically originate in pasture or prairie areas following the ignition of dry grasses (by natural or human sources). Ranchers and farmers intentionally ignite vegetation to restore soil nutrients or alter the existing vegetation growth. These fires have the potential to get out of control and erupt into wildfires. Wildfires are also associated with lightning and drought conditions, as dry conditions make vegetation more flammable. Wildfires may also originate, or spread to forested areas, or other areas with concentrations of woody fuel that can cause wildfires to increase in intensity and spread. The Eastern Red Cedar is of particular concern in Kansas. This invasive evergreen species can take over fence rows and un-planted fields, adding to wildfire fuel and risk. Additionally, this type of fuel, as well as other tree plantings near structures can cause structures to be consumed by wildfires, putting inhabitants at risk.

The State experiences most of its wildfires in March and April when people are conducting controlled burns in grassland and fields; such as the annual burning of the Flint Hills to control invasive plants and restore natural tallgrass prairies. When conditions green up later in the summer and the humidity is higher, the risk of wildfires is generally lower. This trend, however, does not continue in years of extreme drought when hot and dry weather prevail.

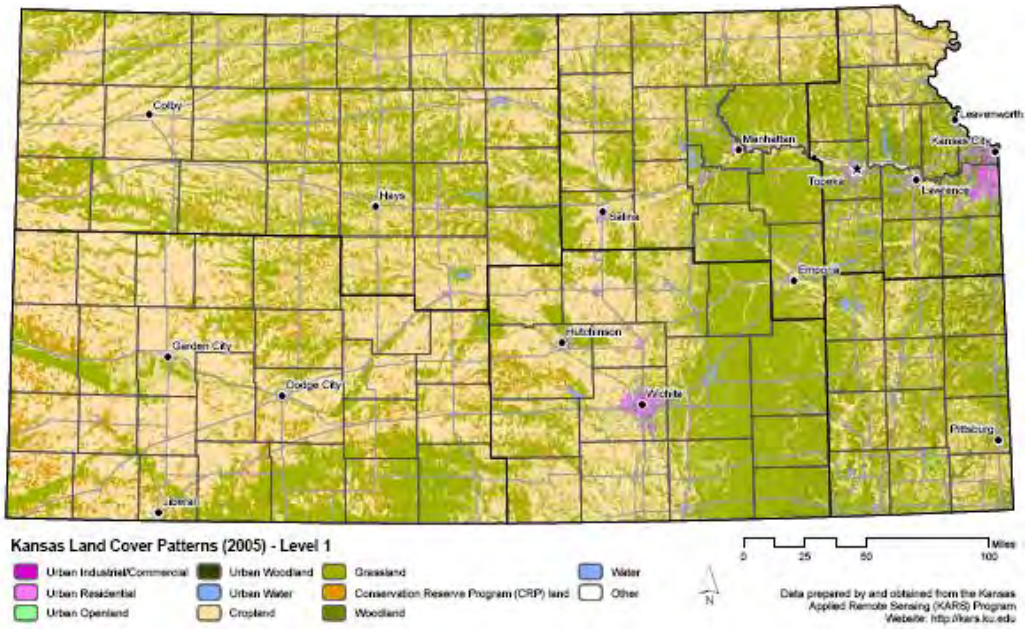
The wildland/urban interface is the area where human improvements such as homes, ranches and farms come in contact with the wildlands. Urban expansion has driven the increased building of homes in wildland areas. Wherever people are living in or adjacent to wildland areas, the threat of wildfire exists. As the rural population increases, so does the risk to life and property from wildfire.

Due to the primarily rural, agricultural characteristics of the State, as well as the existence of wildland and grassland areas even in more urban counties, the entire State is susceptible to wildfires. The wildfire risk is generally moderate in the eastern part of the State and somewhat less in the western part. This is largely because of the population growth in the eastern part of the State resulting in increasing encroachment into the wildland-urban interface. Additionally, the effects of smoke emissions from wildfires are more of a concern in the more urban eastern counties due to higher populations in those areas.

According to the 2011 *Kansas Forest Action Plan*, with the exception of Eastern Redcedar/hardwood, most forest types in Kansas do not pose significant fire management issues for the State. However, grasslands are a different story. Range and pasture lands make up more than 18 million acres, or about 35 percent of the land area in Kansas with about 14 percent of that area comprising Conservation Reserve Program lands. These areas and the wildland-urban interface where development has occurred are the focus of wildland fire

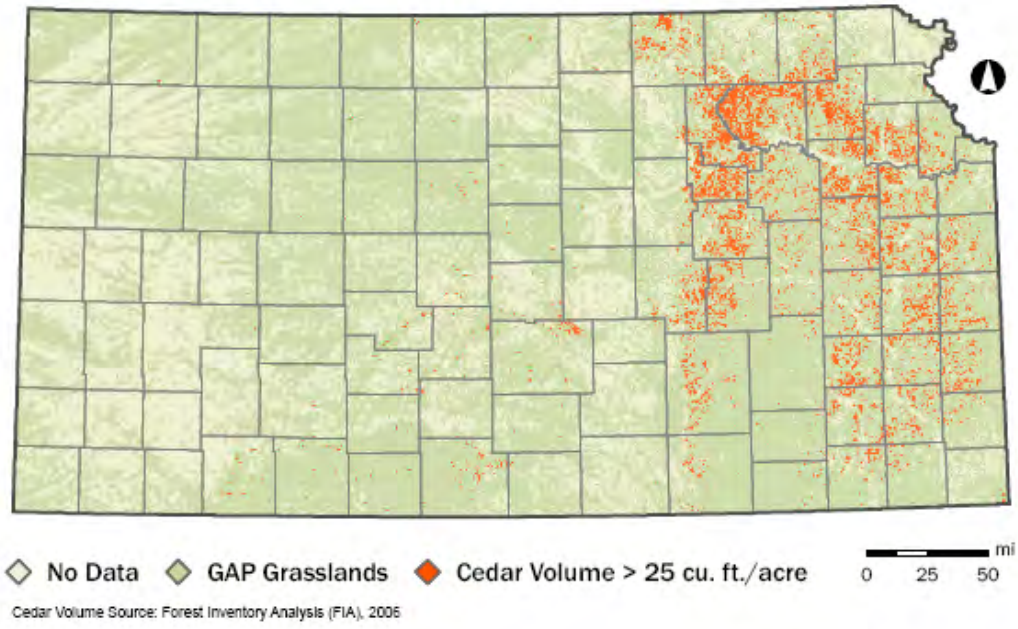
management issues in Kansas. **Figure 3.118** and **Figure 3.119** show the land cover in Kansas and the occurrence of Eastern Redcedar by volume respectively.

Figure 3.118. Kansas Land Cover



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

Figure 3.119. Occurrence of Eastern Redcedar by Volume



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

Previous Occurrences

Wildfires and grass fires are a fairly common occurrence in Kansas. This section reports those events which have resulted in FEMA Fire Management Assistance Declarations (see **Table 3.140**) as well as other notable wildfire events.

Table 3.140. Fire Management Assistance Declarations in Kansas

Declaration Number	Declaration Date	Event	Counties Involved
2878	4/3/2011	Haskell County Fire	Haskell and Stevens Counties
2632	3/30/2006	Obee Fire	Reno County

- **2012**: More than 41,000 acres and 26 structures burned across the State of Kansas from April through September due to extreme drought conditions. This places 2012 as one of the worst years for wildfires in Kansas on record. The week of August 19th alone had seven fires scorching more than 8,000 acres. http://cjonline.com/news/2012-09-02/wildfire-activity-unique-extreme-dry-kansas-summer

Figure 3.120. Kansas Grass Fire

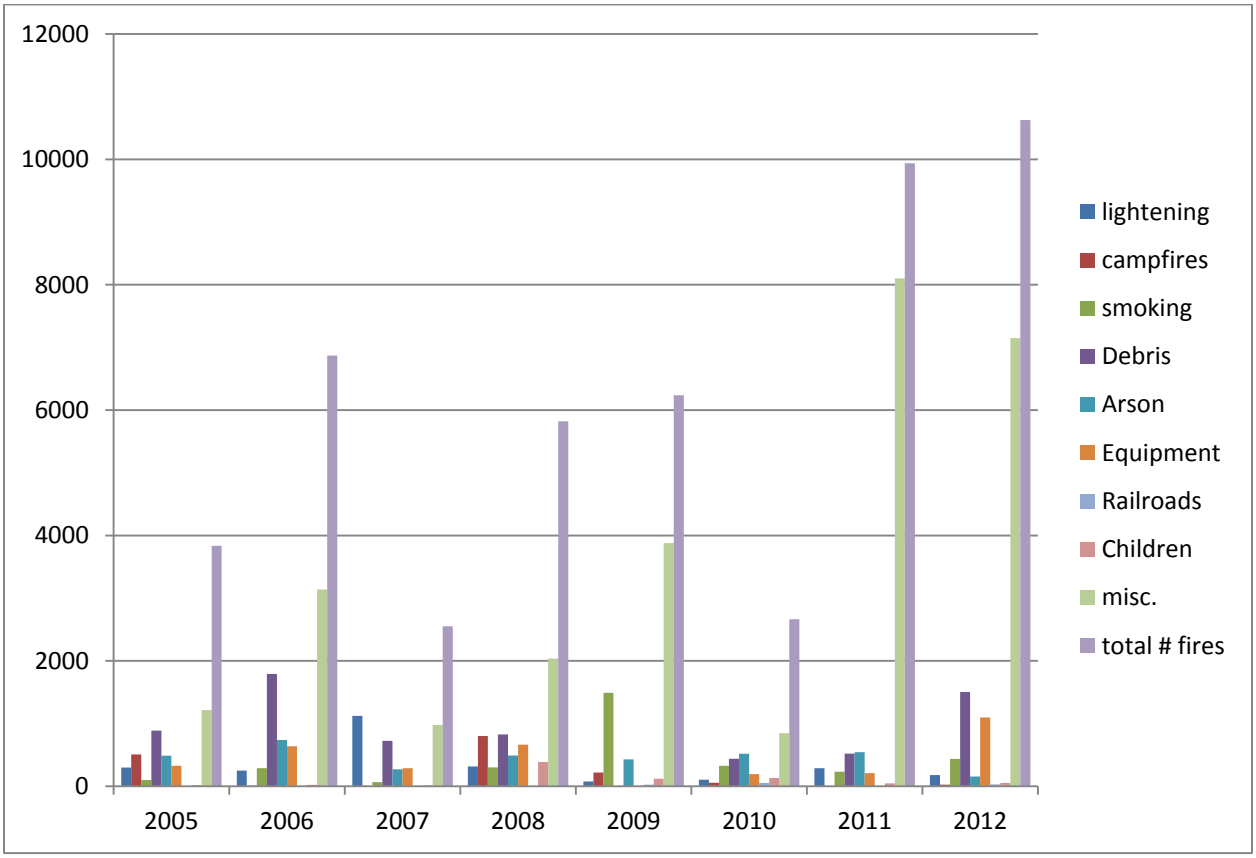
Source: Kansas Division of Emergency Management

- **2011 (FEMA- 2878-FMA: Haskell County Fire)**: On April 3, 2011 a large grass fire prompted authorities in Satanta, Kansas to briefly evacuate the town‘s 1,200 residents, including the town‘s long-term care facility. The fire that burned about 9,600 acres in both Haskell and Stevens Counties destroyed one home, two unoccupied trailers and 12 outbuildings. In addition, the Cimarron Valley Railroad bridge located west of Satanta just north of Highway 56 was destroyed by the fire. The fire caused two confirmed injuries from smoke inhalation.
- **April 12, 2010** – A firefighter was killed while fighting a rural brush fire just to the west of Peru, Kansas.
- **March 15, 2010** - A Fredonia woman was found dead after a field fire trapped her in rural Labette County. When deputies arrived, they found that numerous people had been conducting a controlled burn on a grassy field and that a woman had become trapped by the fire and died.
- **July 30, 2006:** Two large wildfires burned out of control for several hours across portions of Ellsworth and Lincoln Counties, consuming 1,000 acres of grassland. Utility poles, trees, and fence lines were destroyed, but no major structures were lost. Damage was estimated at $10,000.
- **March 30, 2006 (FEMA-2632-FMA: Obee Fire):** A wildfire burned 5,400 acres east of the Hutchinson Airport. It was likely started by a lightning strike from thunderstorms early that afternoon. Three hundred to four hundred people were evacuated from a 21 square-mile area. The fire destroyed five houses and 20 outbuildings. Numerous campers, automobiles, and farm implements were damaged or destroyed. Scattered power outages were reported. Damage was estimated at $1.1 million. This incident marked the State‘s first request for federal fire management assistance.
- **March 8, 2006:** This large fire started just east of Towanda and, fed by drought conditions and very strong southwesterly winds, spread quickly. The fire started as an accident involving sparks from a trailer on K-254. The fire caused thick smoke across the Kansas Turnpike, which resulted in a two-car accident and eventually shut the roadway down for 45 minutes. The fire charred 10,700 acres of grassland, damaged or destroyed 10 outbuildings, caused minor damage to two homes, set three oil wells ablaze, and caused the evacuation of Oil Hill Elementary School.
- **February 9, 2006:** A large grass fire along the Reno/Harvey County line erupted just north of Burrton and spread quickly, fed by drought conditions and sustained winds of 25 to 35 mph. The fire was believed to be extinguished that evening but around noon on February 10 the fire reignited as strong winds once again swept across the area. The fire was eventually extinguished late in the day on February 10. The fire burned 8,800 acres and caused approximately $30,000 in damage to ranch and farmland.
- **May 14, 2003:** There was a large grass fire in Kanopolis State Park in Ellsworth County that required evacuation of campers, threatened several structures, and necessitated deployment of a Kansas National Guard helicopter to extinguish the blaze.
- **April 18, 2000:** The western United States was experiencing increased wildfires, and many areas were severely affected. Kansas experienced increased grassland fires during this period of extra risk, which can be attributed primarily to the severe drought occurring at the time.

- **April 1, 1998:** Over 100 acres of grass burned and two cabins were destroyed in a wildfire in Scott County that caused approximately $150,000 in damage.
- **February 24, 1996:** A fast moving grass fire in northeast Kansas consumed 25 square miles (25,000 acres) of grass and timber and required the evacuation of part of the town of Auburn. The fire was stopped about a half mile from the town, preventing any significant property damage. Three firefighters were injured and two homes and several other buildings were destroyed. Property damages were estimated at $250,000.

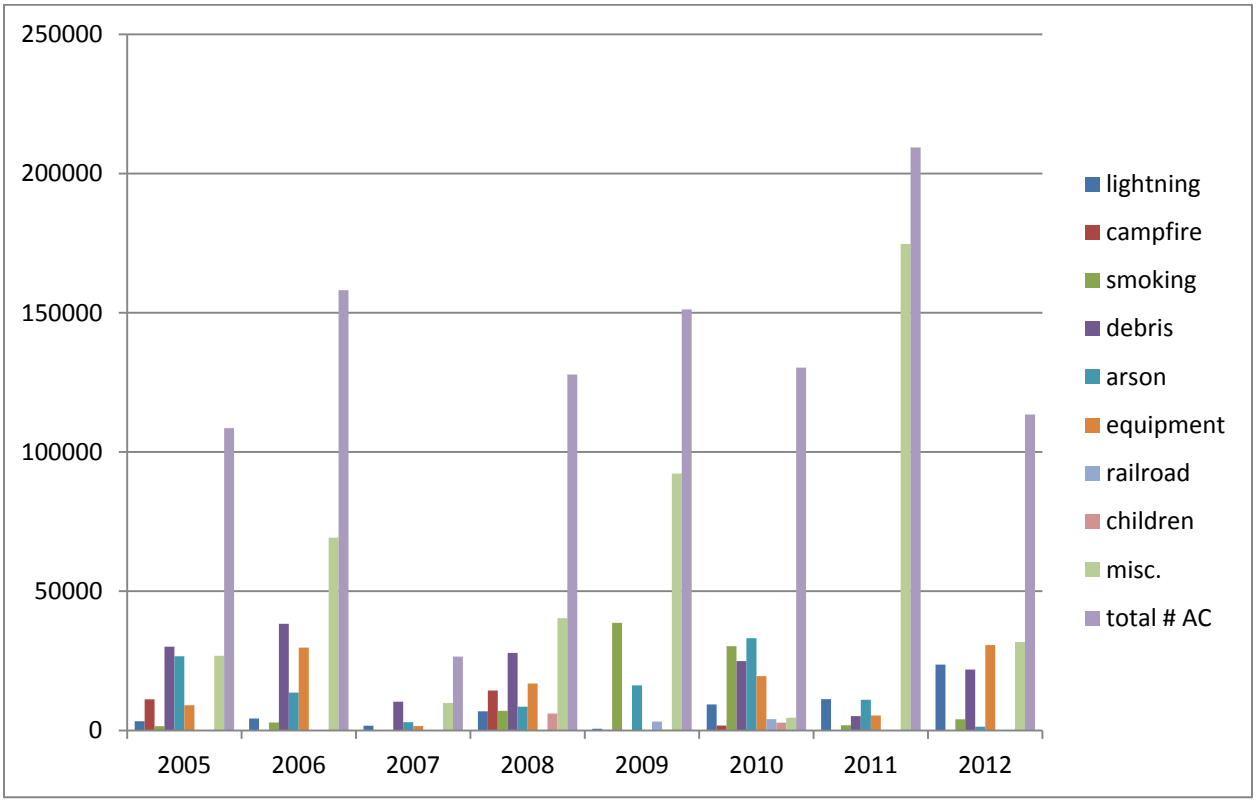
The Kansas Forest Service provided the following charts based on statistics from the National Fire Incident Reporting System regarding occurrence of wildfires in Kansas from 2005-2012. **Figure 3.121** provides the total number of wildland fires in Kansas by cause/origin and **Figure 3.122** provides the number of acres burned in Kansas each year by cause/origin. According to this data from 2005 to 2012, there were approximately 1.2 million acres burned by wildfires.

Figure 3.121. Number of Kansas Wildland Fires by Cause/Origin, 2005-2012



Source: Kansas Forest Service

Figure 3.122. Number of Kansas Acres Burned by Cause/Origin, 2005-2012



Source: Kansas Forest Service

Table 3.141 provides data from USDA's Risk Management Agency on Crop insurance payments for loss of crops due to wildfire. According to the data for the available reporting period, 2011 had the most crop insurance payments for wildfire by far. Data for 2012 was not yet available during development of this plan. However, it is anticipated that crop insurance claims due to wildfire were even higher in 2012 due to the extreme drought conditions.

Table 3.141. USDA Crop Insurance Payments as a Result of Wildfire

Crop Year	Mitigation Planning Region	County Name	Crop Name	Cause of Loss	Crop Insurance Paid
2011	D	Ford	WHEAT	Fire	$17,267
2011	D	Gray	GRAIN SORGHUM	Fire	$108,572
2011	G	Kingman	WHEAT	Fire	$37,291
2011	F	Lincoln	GRAIN SORGHUM	Fire	$1,966
2011	A	Logan	CORN	Fire	$24,245
2011	A	Thomas	CORN	Fire	$135,974
2011 Total					$325,315
2010	G	Rice	WHEAT	Fire	$122
2010	C	Stevens	WHEAT	Fire	$6,143
2010	G	Sumner	WHEAT	Fire	$1,982

Crop Year	Mitigation Planning Region	County Name	Crop Name	Cause of Loss	Crop Insurance Paid
2010 Total					$8,247
2008	E	Barton	WHEAT	Fire	$1,592
2008	G	Rice	WHEAT	Fire	$3,793
2008	D	Seward	CORN	Fire	$9,260
2008	G	Sumner	GRAIN SORGHUM	Fire	$2,065
2008 Total					$16,710
2007	J	Franklin	SOYBEANS	Fire	$808
2007	B	Graham	WHEAT	Fire	$2,170
2007	G	Reno	WHEAT	Fire	$5,147
2007 Total					$8,125
2006	C	Wichita	WHEAT	Fire	$7,915
2006 Total					$7,915
2005	H	Cherokee	SOYBEANS	Fire	$1,084
2005	G	Harper	WHEAT	Fire	$1,691
2005	G	Sumner	SOYBEANS	Fire	$299
2005 Total					$3,074
2004	H	Cherokee	WHEAT	Fire	$193
2004	C	Grant	WHEAT	Fire	$5,133
2004	F	Ottawa	WHEAT	Fire	$7,913
2004 Total					$13,239
2003	F	Mitchell	GRAIN SORGHUM	Fire	$54
2003	G	Reno	WHEAT	Fire	$312
2003	G	Rice	GRAIN SORGHUM	Fire	$966
2003	F	Smith	SUNFLOWERS	Fire	$6,121
2003 Total					$7,453
2002	C	Stanton	WHEAT	Fire	$1,263
2002	B	Trego	WHEAT	Fire	$4,689
2002 Total					$5,952
Grand Total					**$396,029**

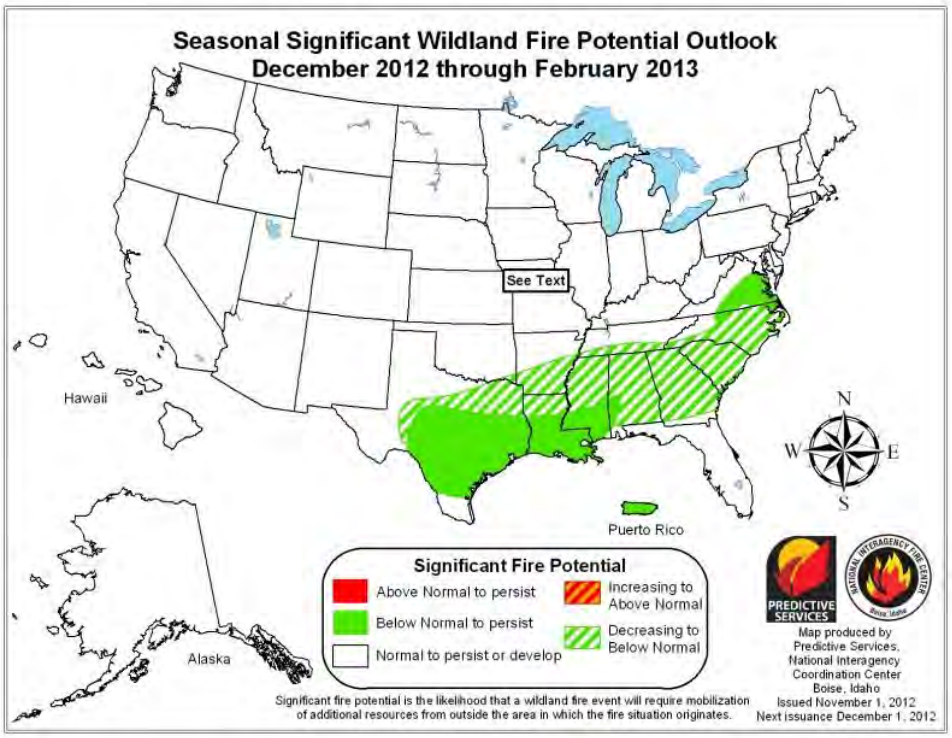
Source: USDA Risk Management Agency, 2012

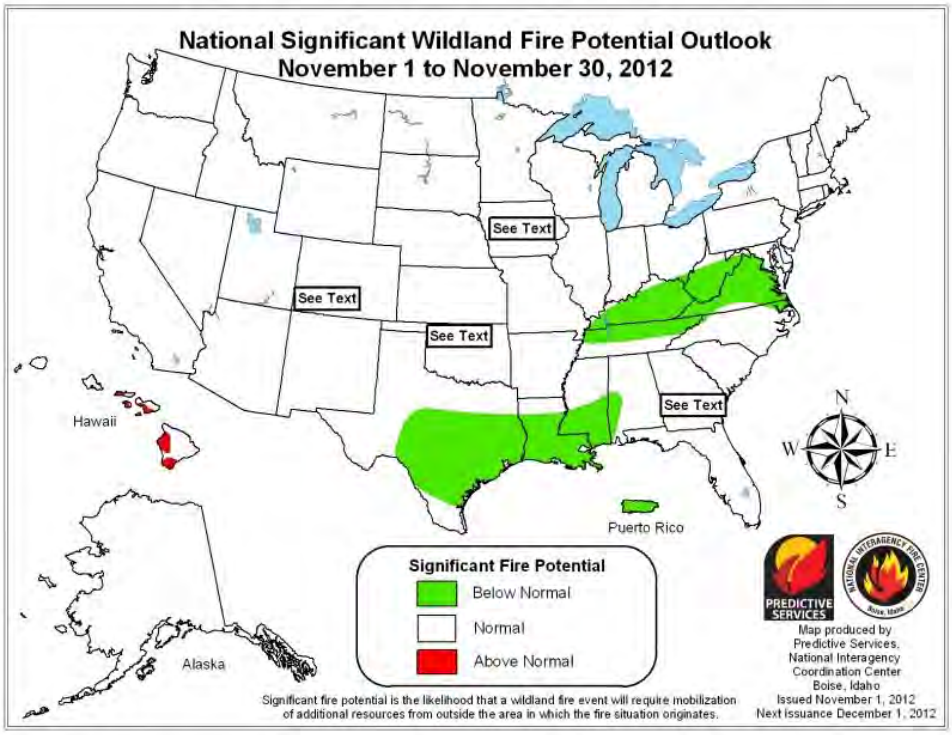
Probability of Future Hazard Events

Since wildfires occur on an annual basis, this hazard's probability is ―**Highly Likely"** within the calendar year.

Although wildfires occur every year, the outlook for November 2012 to February 2013 from the National Interagency Fire Center Predictive Services for a wildfire event in Kansas that will require mobilization of additional resources from outside the area in which the fire situation originated is considered to be in the ―normal" range see **Figure 3.123**.

Figure 3.123. National Significant Wildland Fire Potential Outlook, November 2012 to February 2013





Source: National Interagency Fire Center Predictive Services, http://www.predictiveservices.nifc.gov/outlooks/monthly_seasonal_outlook.pdf

State Vulnerability Analysis

Although some data is available from the National Fire Incident Reporting System (NFIRS) in terms of previous events, this data has limitations in providing useful statistical data for an overview statewide vulnerability analysis. The most problematic issues are that not all fire departments report to NFIRS and of those that report, not all incidents are reported. This current lack of local level, (i.e. fire district or county), requirements and a past lack of enforcement of state statutes has led to a lack of fire occurrence data for both prescribed burns and wildfires being available in Kansas. Changes in enforcement of wildfire reporting requirements at the state level, as well as prescribed fire reporting requirements that are part of the EPA-mandated Kansas Flint Hills Smoke Management Plan (approved in 2011), will give the Kansas Forest Service a much greater opportunity to begin using real-time fire occurrence data to assist in making the best fire management decisions.

In light of the data limitations associated with available statistics, and with the publication of the 2011 *Kansas Forest Action Plan*, the KHMT determined that the best available data for the overview statewide vulnerability analysis for the Wildfire Hazard is the ‗Weighted Sum' analysis that was completed and utilized to develop a ‗Wildfire Risk' composite layer as part of the Forest Action Plan.

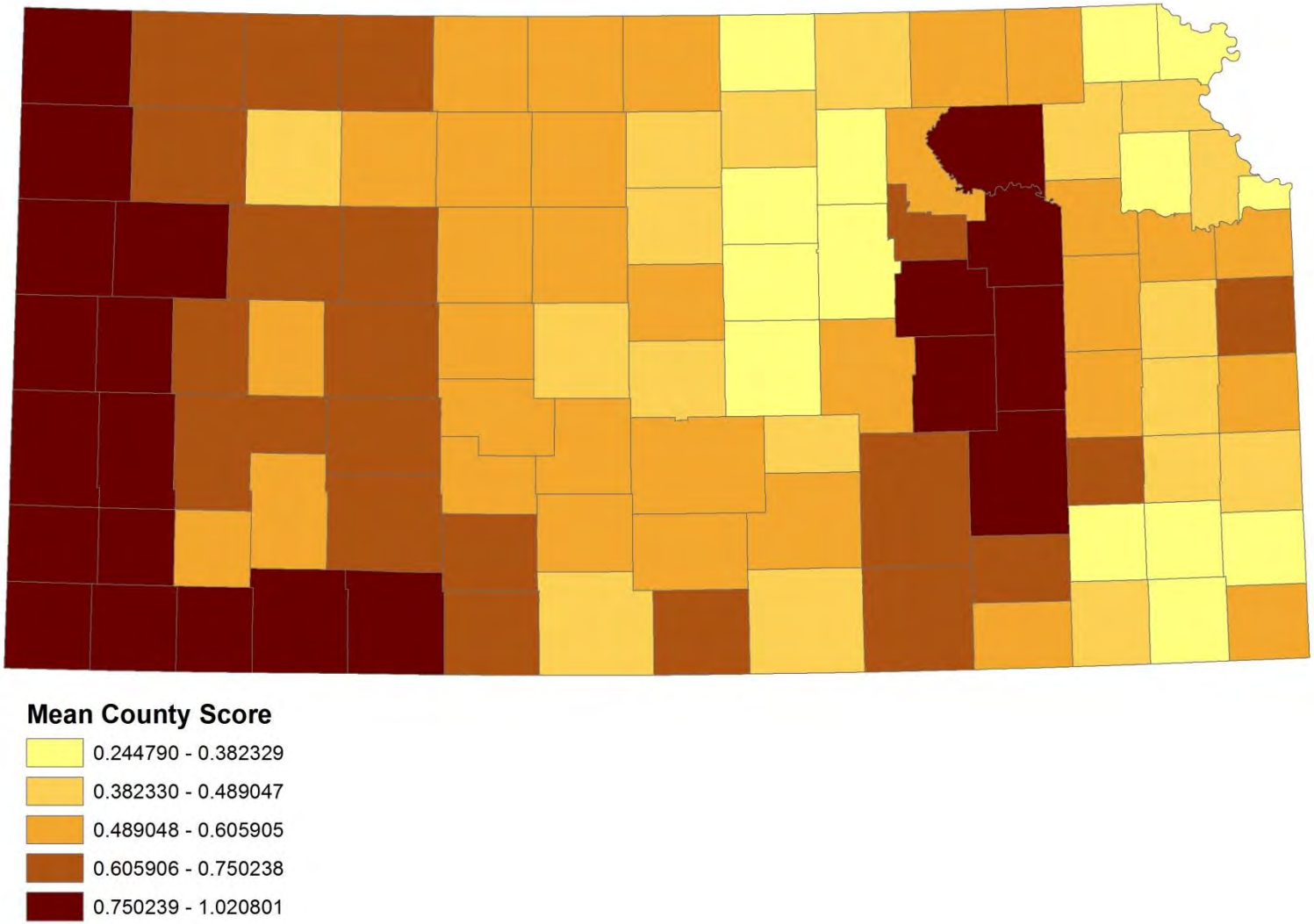
The ‗Wildfire Risk' composite layer was developed using a ‗Weighted Sum' analysis to combine six data layers produced from a combination of eight separate datasets. In close consultation with the Kansas Forest Service's Fire Management Coordinator and other Fire Management staff six data inputs were developed to represent Wildfire Risk in Kansas. These data inputs and their corresponding analysis weight are listed below:

1) Wildland Urban Interface—from 3 data sets (.85)
2) ISO Fire Station Coverage Gaps (.75);
3) Conservation Reserve Program Lands (.60);
4) Eastern Redcedar in Grasslands (.75);
5) ‗Moderate' Fire Potential risk and (.53);
6) ‗High' Fire Potential risk (.80).

For more detailed descriptions of these six data layers, see pages 27-28 of the *Kansas Forest Action Plan*, http://www.kansasforests.org/assessment.shtml. The six data layer inputs were combined using the ‗Weighted sum' analysis. The resulting raster contains values ranging from 0 to 3.48. **Figure 3.124** provides a map indicating the mean score for each county. The higher the numbers (darker shading) indicate higher wildfire risk. **Table 3.142** provides the mean score for each county, organized by Mitigation Planning Region.

According to this analysis, Mitigation Planning Region C has the highest regional average wildfire risk score, followed by Region I, A, and D.

Figure 3.124. Wildfire Risk (by Mean County Score)



Source: Kansas Forest Service

Table 3.142. Mean Wildfire Risk Score for Kansas Counties by Mitigation Planning Region

County	Mean Wildfire Risk Score
Mitigation Planning Region A	
Cheyenne	0.83202922344
Decatur	0.63617873192
Gove	0.68196290731
Logan	0.87758433819
Rawlins	0.67689388990
Sheridan	0.41293302178
Sherman	0.80699771643
Thomas	0.64878171682
Wallace	0.85376489162
Planning Region Average	**0.71412515971**
Mitigation Planning Region B	
Ellis	0.53203177452
Graham	0.58315795660
Ness	0.62485492230
Norton	0.62233209610
Phillips	0.54657953978
Rooks	0.54870098829
Rush	0.49393326044
Russell	0.50755840540
Trego	0.71779179573
Planning Region Average	**0.57521563768**
Mitigation Planning Region C	
Grant	0.81166213751
Greeley	0.89731788635
Hamilton	1.00021004677
Kearny	0.79696023464
Lane	0.53289169073
Morton	1.02080094814
Scott	0.75023835897
Stanton	0.81276172400
Stevens	0.83445894718
Wichita	0.81508344412
Planning Region Average	0.82723854184
Mitigation Planning Region D	
Clark	0.81596451998
Finney	0.63259768486
Ford	0.62894970179
Gray	0.60590511560
Haskell	0.58026349545
Hodgeman	0.74772334099
Meade	0.89620631933
Seward	0.76877677441
Planning Region Average	0.70954836905

County	Mean Wildfire Risk Score
Mitigation Planning Region E	
Barber	0.48301097751
Barton	0.48904693127
Comanche	0.71569627523
Edwards	0.54626333714
Kiowa	0.72480762005
Pawnee	0.57326853275
Pratt	0.50816005468
Stafford	0.56549882889
Planning Region Average	0.57571906969
Mitigation Planning Region F	
Clay	0.30874466896
Cloud	0.45788627863
Dickinson	0.35430383682
Ellsworth	0.57244682312
Jewell	0.52142769098
Lincoln	0.45221167803
Mitchell	0.39919689298
Osborne	0.54113310576
Ottawa	0.38232901692
Republic	0.29488581419
Saline	0.35529443622
Smith	0.56137561798
Planning Region Average	0.43343632172
Mitigation Planning Region G	
Butler	0.68625336886
Cowley	0.68642038107
Harper	0.62990236282
Harvey	0.44664919376
Kingman	0.56784808636
Marion	0.50497281551
McPherson	0.34183818102
Reno	0.53886169195
Rice	0.43372270465
Sedgwick	0.50146812201
Sumner	0.43694227934
Planning Region Average	0.52498901703
Mitigation Planning Region H	
Allen	0.40892705321
Bourbon	0.46224874258
Chautauqua	0.58948814869
Cherokee	0.50862157345
Crawford	0.31517902017
Elk	0.66811245680
Greenwood	0.84238952398
Labette	0.34831532836
Montgomery	0.41717612743
Neosho	0.37931758165
Wilson	0.24478954077
Woodson	0.69705641270
Planning Region Average	0.49013512582

County	Mean Wildfire Risk Score
Mitigation Planning Region I	
Chase	0.98686426878
Geary	0.65034091473
Lyon	0.82670283318
Morris	0.81822949648
Pottawatomie	0.77291822434
Riley	0.54725021124
Wabaunsee	0.78287732601
Planning Region Average	0.76931189639
Mitigation Planning Region J	
Anderson	0.40381976962
Coffey	0.58299744129
Franklin	0.48104989529
Linn	0.54418075085
Miami	0.62391990423
Osage	0.53426063061
Shawnee	0.52085530758
Planning Region Average	0.52729767135
Mitigation Planning Region K	
Atchison	0.43419876695
Brown	0.33541154862
Doniphan	0.35770264268
Douglas	0.53378498554
Jackson	0.43833905459
Jefferson	0.34613996744
Marshall	0.55832988024
Nemaha	0.51145887375
Washington	0.48299509287
Planning Region Average	0.44426231252
Mitigation Planning Region L	
Johnson	0.52408075333
Leavenworth	0.41779085994
Wyandotte	0.28411415219
Planning Region Average	0.40866192182
Statewide	
Statewide Average	**0.58397087824**

Source: Kansas Forest Service

Table 3.143 provides the top 10 counties by mean wildfire risk score.

Table 3.143. Top 10 Counties by Mean Wildfire Risk Score

Mitigation Planning Region	County	Mean Wildfire Risk Score
C	Morton	1.02080094814
C	Hamilton	1.00021004677
I	Chase	0.98686426878
C	Greeley	0.89731788635
D	Meade	0.89620631933
A	Logan	0.87758433819
A	Wallace	0.85376489162
H	Greenwood	0.84238952398
C	Stevens	0.83445894718
A	Cheyenne	0.83202922344

According to the 2011 *Kansas Forest Action Plan*, an estimated 40 percent of Kansans are protected by volunteer rural firefighters. Changes in fuel characteristics and continued development and fragmentation of rural areas suggest increased hazards and expense associated with wildland fire suppression. With the expansion of Eastern Redcedar into grasslands (**Figure 3.119**) there is a need for additional training on new suppression techniques and tremendous potential and need to promote prescribed fire throughout the State. There is a need to create a system that tracks endemic areas of fire origin from a historical prospective and geographically identify large fires. Such information would foster strategic placement of suppression resources

Community Wildfire Protection Plans

One way for communities at risk to wildfire to reduce their overall vulnerability is development of Community Wildfire Protection Plans (CWPP) to identify specific areas at risk and actions that can be taken to reduce risk. The Healthy Forests Restoration Act (HFRA) provided communities with an opportunity to influence where and how federal agencies implement fuel reduction projects on federal lands. A CWPP is the most effective way to take advantage of this opportunity. Additionally, communities with Community Wildfire Protection Plans in place are given priority for funding of HFRA hazardous fuels reduction projects.

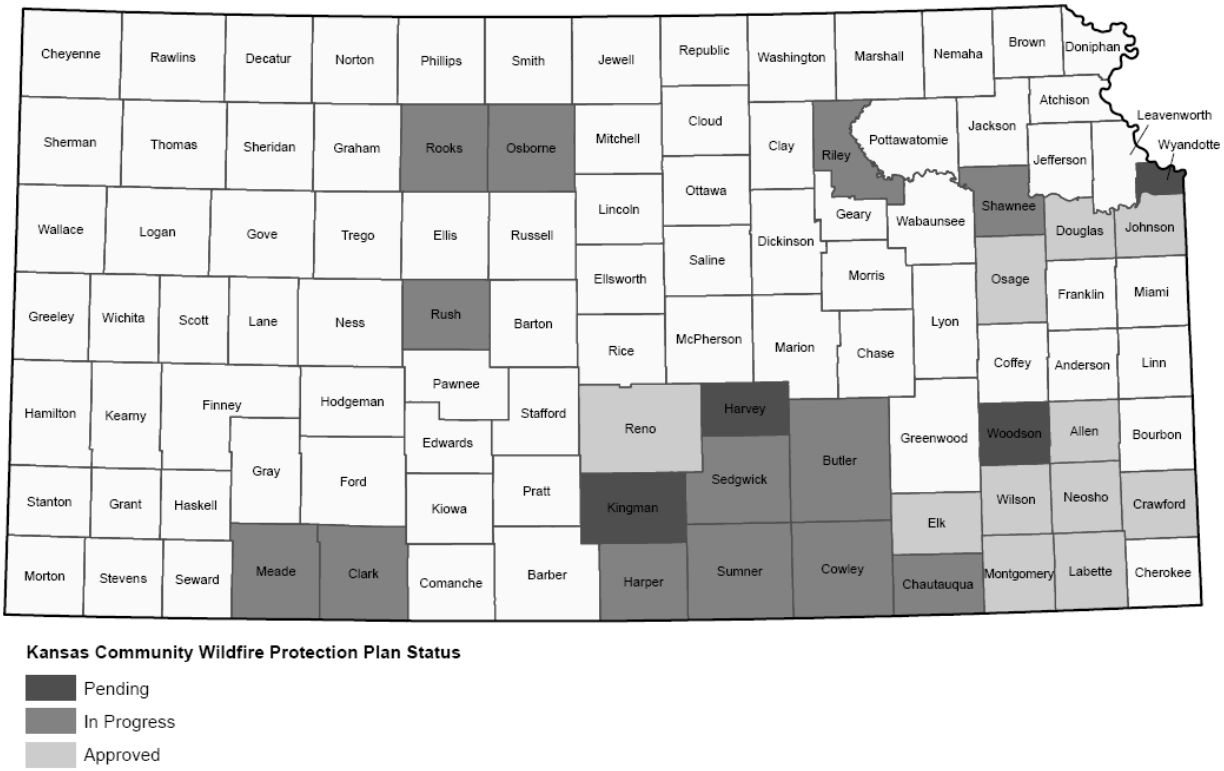
CWPPs can take a variety of forms, based on the needs of the people involved in their development. They may address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection—or all of the above. The three main components of a CWPP are:

1) Collaboration between all affected or potentially affected jurisdictions,
2) Assessment of the wildfire hazards in an area that leads to recommendation for prioritized fuel reduction, and
3) A section on recommendations towards reducing structural ignitability.

In Kansas, the Kansas Forest Service coordinated with several Local Hazard Mitigation Planning efforts to integrate a Community Wildfire Hazard Assessment into Local Hazard Mitigation Plans. By doing so, the requirements of the main components of the CWPP have been met. The language in the HFRA provides maximum flexibility for communities to determine the substance and detail of their plans and the procedures they use to develop them. Because the legislation is general in nature, some communities may benefit from assistance on how to prepare such a plan. Any communities desiring additional and/or more information can contact the Kansas Forest Service.

Figure 3.125 shows the status of CWPPs in Kansas Counties.

Figure 3.125. Kansas Counties with a Community Wildfire Protection Plan



Source: Kansas Forest Service, *Kansas Forest Action Plan*, 2011

Firewise Communities

Taking steps to become a Firewise Community is another way communities with wildfire risk can reduce their wildfire vulnerability. The five steps of Firewise recognition http://www.firewise.org/communities/usa-recognition-program/program-criteria.aspx

- Obtain a wildfire risk assessment as a written document from your state forestry agency or fire department.

- Form a board or committee, and create an action plan based on the assessment.
- Conduct a —Firewise Day" event.
- Invest a minimum of $2 per capita in local Firewise actions for the year.
- Submit an application to your state Firewise liaison

Kansas Currently has one Firewise Community:

- University Park, Manhattan, 2006

Whether or not communities have a CWPP or have taken steps to become a Firewise Community, many have adopted burn ban ordinances or place specific bans on burning during conditions favorable to wildfire, such as drought.

State Estimates of Potential Losses

According to the available information from USDA Risk Management agency, the annual average of crop insurance payments due to wildfire was $39,603 for the reporting period from 2002 to 2011.

In addition, according to the Kansas Forest Service from the period from 2005 to 2012, wildfires burned approximately 1.2 million acres. This translates to over 150,000 acres per year for this eight-year period. The State estimates similar levels of average loss will continue in the future.

Development in Hazard Prone Areas

Of the top 10 counties for wildfire risk, none are in the top 10 for increase in population or housing units. The areas with higher wildfire risk are generally rural, more agricultural counties. Although these areas are not seeing development in terms of populations or building, any additional agricultural development would be vulnerable to the wildfire hazard that is elevated in these areas.

Consequence Analysis

The information in **Table 3.144** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.144. EMAP Consequence Analysis: Wildfire

Subject	Ranking	Impacts/Wildfire
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas.
Responders	Minimal to Severe	Impact to responders is could be severe depending on the size and scope of the fire, especially for fire fighters. Impact will be low to moderate for support responders with the main threat being smoke inhalation.
Continuity of Operations	Minimal to Severe	Temporary relocation may be necessary if government facilities experience damage (minimal to severe).
Property, Facilities, and Infrastructure	Severe	Localized impact could be severe to facilities and infrastructure in the incident area. Property, Facilities, and infrastructure are all vulnerable to destruction by wildfire.
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained (minimal to severe).
Environment	Severe	Impact will be severe for the immediate impacted area with regards to trees, bushes, animals, crops, etc. Impact will lessen as distance increases from the immediate incident area.
Economic Conditions	Minimal to Moderate	Impacts to the economy could be moderate in the immediate area.
Public Confidence in Jurisdiction‘s Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Evacuation orders, shelters availability could be called in to question (minimal to severe).

3.3.21. Windstorm

Calculated Priority Risk Index	Planning Significance
3.35	High

Description/Location

Relatively frequent strong winds are a weather characteristic of Kansas. **Figure 3.102** in the Tornado Section shows the wind zones of the United States based on maximum wind speeds; Kansas is located within wind zones III and IV, the highest inland categories. High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety and have adverse economic impacts from business closures and power loss.

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

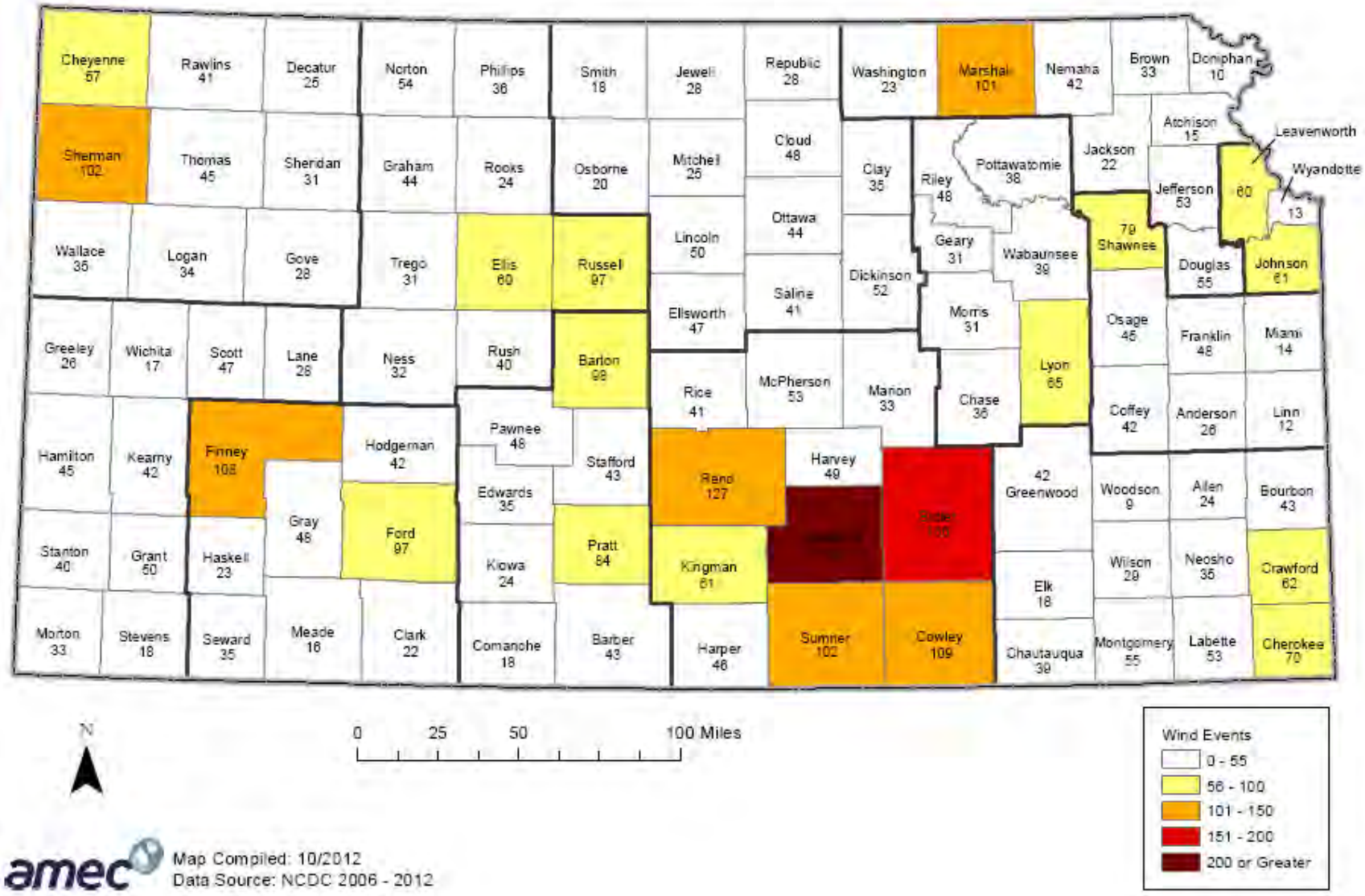
Thunderstorms over Kansas typically happen between late April and early September, but, given the right conditions, they can develop as early as March. They are usually produced by supercell thunderstorms or a line of thunderstorms that typically develop on hot and humid days.

All of Kansas is susceptible to high wind events. Most of Kansas is in Zone IV, which is susceptible to winds up to 250 mph. The western third of the State is in Zone III, which is susceptible to winds up to 200 mph.

Previous Occurrences

According to the National Climatic Data Center Storm Events database, there were 4,922 high wind, strong wind and thunderstorm wind events in Kansas between 2006 and 2012 (non-winter storm-related events that occurred between March and the end of October). There were two deaths and 61 injuries in this time period. Total property damage for events between 2006 and 2010 is estimated at $331,245 million. This suggests that Kansas could experience 703 wind events, $47,320 million in wind losses, and approximately nine 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 wind events represent wind reports, not necessarily individual storms, and thus likely over count the actual number of windstorms.) See the section on State Vulnerability Analysis for more information about how wind affects individual counties.

Figure 3.126. Kansas Wind Events by County, 2006 – 2010



Notable Windstorm Events:

- **August 8, 2012:** A significant downburst occurred near Forbes Field in south Topeka causing damage and power outages. Also two tractor-trailers overturned due to the high winds.
- **February 28, 2012:** A powerful storm system produced widespread severe weather across portions of central, south central and southeast Kansas during the evening hours. A center pivot irrigation system was overturned in the 70 mph winds in Kingman County. Cherryvale in Montgomery County was hard hit as well as a large portion of Labette County. Straight-line winds of 100 to 120 mph occurred near Pittsburg. Numerous tree damage, power pole damage or snapped off and building damage reports were recorded.
- **May 24, 2011:** Severe thunderstorms moved into western Kansas with winds of 70 to 80 mph producing damage to trees and utility poles in Logan County.
- **August 9, 2011:** Winds estimated at 70 to 80 mph moved across central and south central Kansas causing wide-spread damages to buildings in the area.
- **August 13, 2010:** Wind was measured at 93 mph gusts at the Air Traffic Control tower at Manhattan Regional Airport. In the town of Ogden, the windows of a residence were cracked by the force of the wind. Kansas State University sustained some significant roof damage to their buildings and throughout the city of Manhattan. Widespread power line and tree damage was also noted across the city.
- **July 14, 2010:** Damaging winds knocked down 23 power poles along Kansas Highway 4 in Barton County. This knocked out power to six small towns in the area and they remained without power for almost 12 hours. It also closed Kansas Highway 4 for a short time because of the damage.
- **July 8, 2009:** Several power poles, permanent structures, outbuildings, and trees were heavily damaged when a strong thunderstorm went through the area. The heaviest damage occurred at Ottawa Airport where a hangar filled with a collection of small aircraft collapsed. The hangar and aircraft all sustained heavy damage. The NWS survey crew could not get an exact number of power poles that were snapped, but can estimate over 100 destroyed power poles.
- **May 8, 2009:** A large swatch of damaging winds moved across the area from Benton to Rosalia including the city of El Dorado with winds measured at 80 mph at the Jefferson Elementary School in El Dorado. Numerous large trees were knocked down in Benton, with a mobile home trailer rolled over east of town. The damaging winds destroyed the historic stone silo bearing the name of the town of Towanda. The damaging winds estimated at 70 to 80 mph moved into El Dorado damaging roofs to numerous businesses in downtown and knocking down numerous large trees. Two or three schools in El Dorado had their roofs partially peeled off. The refinery in El Dorado had some large storage tanks dented. The damaging winds continued to move east downing almost every one of the large transmission lines along US 54 highway from El Dorado to Rosalia.
- **October 21, 2008:** Thunderstorm winds were estimated to be from 90 to 100 mph in Kearny County near Lakin. A mobile home was destroyed and another was heavily damaged. Two occupants of the destroyed trailer were injured, none seriously. There were also 16 pivot irrigation sprinklers overturned in a four-mile radius of this location. In addition, 20 power

poles were snapped and a large grain bin was destroyed. Large hay bales were blown around and all windows in the machinery and vehicles were blown out.

- **June 5, 2008:** Upper level and surface low pressure systems, shifting east into the Central Plains, brought a round of strong to severe thunderstorms to north central Kansas during the afternoon and early evening hours. These thunderstorms were aided by a surface front draped across the region, along with boundaries left from previous convection. Hail the size of golf balls and wind gusts near 60 mph were reported. There was one report of winds gusting to around 100 mph near Stockton in Rooks County.
- **September 6, 2007:** Thunderstorm outflow winds estimated at close to 90 mph in McDonald resulted in damage to grain bins, a trailer home, and a large storage building. Four power poles were snapped, resulting in a power outage lasting several hours in McDonald and Bird City.
- **May 5, 2007:** Straight-line winds in Clay County estimated at 80 to 90 mph damaged numerous farm buildings, grain bins, homes, trees, outbuildings, and power poles. Wind damage from straight-line winds estimated at 70 to 80 mph was found across Washington County.
- **August 25, 2006:** Straight-line winds up around 80 mph produced significant damage in northwest Morris County. Train cars were derailed, an old theater was damaged, and farm outbuildings and implements were damaged.
- **August 2006:** Pulse thunderstorms impacted the area on August 9 and 26. Power lines were downed from microburst winds in Crawford and Cherokee Counties. Power pole damage was estimated at $17,000.
- **July 26, 2006:** A microburst that produced up to 120 mph winds destroyed a house just north of Spearville. Wind speeds as high as 120 mph also destroyed a grain bin and cattle shed in the area and damaged trees and tombstones in a cemetery. One injury was reported.
- **June 16, 2006:** Severe thunderstorms produced straight line winds of 60 to 75 mph across Morris, Dickinson, Lyon, Wabaunsee, and Shawnee Counties. Damage to trees and structures was reported. Straight-line winds between 60 and 80 mph also did damage in Kingman, Sedgwick, and Marion Counties.
- **May 18, 2005:** Downburst winds estimated around 80 mph in southern Osage County damaged train cars, knocking 24 cars off the tracks.
- **April 23, 2006:** Large hail and straight-line winds were reported in northeast Kansas. Straight-line winds of 70 mph blew roofs off two boat houses on Perry Lake Marina.
- **March 12, 2006:** A severe thunderstorm produced straight-line winds of up to 90 mph and damage throughout Lawrence. Seventy buildings on the University of Kansas campus were damaged, semi-trailers were overturned, 60-foot silos fell, and homes and trees were damaged. Damage was estimated at $8 million. Severe straight-line winds in Frontenac caused structure damage estimated at $20,000.
- **August 19, 2005:** The severe thunderstorms that brought a tornado to Great Bend were also packed with 75-80 mph winds, which caused an estimated $5 million in damage in and around the City. Many buildings sustained major roof and structural damage. Numerous vehicles sustained smashed or shattered windows. Twelve people were injured. Wind damage in McPherson County was estimated at $150,000.

- **July 3, 2005:** Severe thunderstorms struck central and south-central Kansas. Winds between 70 and 100 mph caused extensive damage at Cheney Lake State Park, where the marina, around 125 boats, and 35 campers and mobile homes were either heavily damaged or destroyed. One person was killed when his boat overturned; six others were injured. Estimated damage from these storms was $2 million to property and $12.5 million to agriculture. The governor issued a state of disaster emergency for Reno County. In Harper County, a few buildings were unroofed in Bluff City by winds estimated around 85 mph.
- **June 30, 2005:** In Neosho County, severe thunderstorms unleashed 90 mph winds that blew roofs off many homes and businesses in Chanute. In Erie and St. Paul, large trees were uprooted and fell onto other homes, destroying one. Many barns and sheds were also destroyed. Total damage in all three towns was $2 million.
- **July 7, 2004:** Reports of 75 to 90 mph winds in the area around Beloit caused some structural and tree damage. Strong winds also caused damage in Rooks County, especially in the community of Plainville.
- **July 4, 2004:** A damaging wind storm known as a derecho tracked across extreme southeast Kansas. The most significant damage was in Cherokee County where several homes were destroyed or severely damaged.
- **June 15, 2004:** Thunderstorm downburst winds between 70 and 90 mph brought down power poles in Wallace and Thomas Counties and damaged a storage complex and a city well building in Colby. Decatur County winds near 100 mph west and southwest of Oberlin brought down trees and power lines and damaged outbuildings.
- **May 29, 2004:** Strong thunderstorm downdrafts of 60 to 90 mph developed and produced widespread damage to trees, power lines, roofs, and fences in western Kansas. As the downdrafts gained momentum, strong winds raced out well ahead of the thunderstorm rain cores. The strong winds collected a huge volume of dirt, sending it many hundreds of feet into the air, which produced a literal wall of dirt and resulted in instant blackout conditions similar to the 1930s Dust Bowl. Visibilities were reduced to tens of feet in some instances. Traffic on I-70 was adversely affected. Several pileups occurred. Two lives were lost.
- **April 23, 2004:** Strong winds in excess of 60 mph caused significant damage over Harper County. Three people were injured when the Historic Fairground Barn collapsed.
- **August 11, 2003:** A pair of severe thunderstorms struck south-central Kansas. The first left thousands of residents without power in the Wichita area after 70-80 mph winds snapped power poles. The area hardest hit by the second storm was El Dorado Lake, where winds estimated at 70-80 mph caused two minor injuries at the campgrounds along with wind damage to the marina docks. The storm continued to produce straight-line wind damage as it tracked across Cowley County.
- **July 10, 2003:** Straight-line winds from a downburst occurred near the Wichita Greyhound Park north of Wichita. Portions of the roof were peeled off, numerous vehicles were damaged, and power lines were blown down. Significant wind damage also occurred around El Dorado, where trees and power lines were blown down and shingles were blown off a Pizza Hut. Another long swath of wind damage started near Douglass and continued through Atlanta and on into southeast Kansas. A hangar was blown over at the airport in Eureka, and considerable tree damage was observed around Independence.
- **July 5, 2003:** A heat burst (an intense thunderstorm downdraft accompanied by pronounced warming) that developed over Wallace and Logan Counties and moved into

Sherman and Thomas Counties damaged barns, trees, and power poles and resulted in numerous traffic accidents as winds gusted over 70 mph, stirred up dirt, and lowered visibility.

- **August 13, 2002:** Winds up to 100 mph impacted northern Reno County. In Nickerson, many trees were knocked down, some sheds were damaged or destroyed, and power was lost in the city. In South Hutchinson, 25 train box cars were blown over, three mobile homes were destroyed, several homes lost their roofs, and several large trees were snapped or uprooted.
- **August 2002:** An intense microburst wind event in St. Francis caused a swath of damage approximately five blocks wide and a mile long. Automobiles at a car dealership were damaged and numerous structures sustained roof damage.
- **August 2002:** A storm had wind speeds from 70-87 knots, causing widespread tree and power line damage. Two single-family and three mobile homes were destroyed. Fifty other structures were damaged. A state of disaster emergency was declared by the governor.
- **May 2002:** Winds in excess of 80 mph near Ports and Harlan blew over empty train cars and caused an estimated $3 million in crop damage.
- **April 2002:** Winds measured at 82 mph damaged many buildings and businesses in Riley County. Power was knocked out, and a Wal-Mart suffered extensive roof damage, forcing store closure for several days. Total damages from Riley County were estimated at $5 million. During the same episode, winds in Shawnee County exceeded 60 mph, and many homes and businesses were damaged. Shawnee County damages totaled approximately $2 million.
- **March 9, 2002:** Winds in south-central Kansas gusted up to 87 mph in Cowley County. Large power poles were knocked down and a semi was overturned on the Kansas Turnpike in Butler County. Significant wind damage occurred in Coffeyville in Montgomery County. A large section of roof was blown off a church onto an adjacent building, and part of a stadium was damaged. A few downtown buildings also had windows broken as a result of the strong wind gusts.
- **March 2002:** A storm caused property damage in several areas of the State. Seventy mile per hour winds significantly damaged a junior high school in Paxico. In Topeka, downburst winds damaged 40 cars at an automobile dealership. Several farm structures were damaged near Altamont.
- **September 7, 2001:** Winds estimated from 70 to 100 mph tore across east-central Kansas damaging numerous trees and several structures. Damage was especially significant in and around the Lawrence, Baldwin City, Ottawa, and Garnett communities.
- **July 10, 2001:** Microburst winds of 100 mph produced widespread damage throughout Gaylord in Smith County. Damage was estimated at $400,000.
- **June 14, 2001:** A line of damaging winds, estimated between 70 and 80 mph caused considerable damage and injured two people near Yates Center on June 14. These winds lifted a couple into the air and blown debris knocked them unconscious.

Insured Crop Loss Data

According to the USDA Risk Management Agency, insured crop losses through the State of Kansas as a result of wind and excessive wind damage for the ten year period of 2002-2011

totaled $35,238,040 as shown in **Table 3.145**. It shows the highest year of crop losses as 2008 in this 10- year period, then the years of 2011 and 2009. This information is also reported and annualized by county in **Figure 3.128** in the State Estimates of Potential Losses Section. Also 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.

Table 3.145. Crop Insurance Paid for Wind and Excessive Wind Damages by Year, 2002-2011

Year	Crop Insurance Paid
2011	$7,444,018
2010	$1,949,745
2009	$5,065,382
2008	$12,708,899
2007	$1,605,246
2006	$488,835
2005	$515,696
2004	$1,979,505
2003	$768,761
2002	$2,711,953
Total	$35,238,040

Source: USDA Risk Management Agency

Probability of Future Hazard Events

According to the National Climatic Data Center, there were 4,922 wind events in Kansas between 2006 and 2012 (7 years). Based on this information, the probability that at least one wind event will occur in Kansas in any given year is 100 percent. Annualized losses are estimated at $47,320 million based on NCDC data. This hazard‘s CPRI probability is ―**Highly Likely**” within a calendar year.

State Vulnerability Analysis

All 105 counties in Kansas are vulnerable to windstorms. The statistical analysis method was used to refine and assess the relative vulnerability of each of Kansas‘ counties to wind. 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 crop loss. Then a rating value of 1-10 was assigned to the data obtained for each factor and then weighted equally and factored together to obtain overall vulnerability scores for comparison and to determine the greatest vulnerable counties.

The following are the data sources of the factors: Social Vulnerability Index for Kansas counties from the Hazards and Vulnerability Research Institute at the University of South Carolina, National Climatic Data Center (NCDC) storm events (2006 – 2012), U.S. Census Bureau (2010), USDA‘s Census of Agriculture (2007) and USDA Risk Management Agency (2002 – 2011). It was determined that since wind is a common occurrence in Kansas, that using

historical events and property damages from 2006 forward provides adequate events to describe the wind problem in Kansas.

Table 3.146 below provides the factor‘s amount per county that are considered for wind vulnerability.

Table 3.146. Vulnerability of Kansas Counties Factor Amounts for Wind

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Mitigation Planning Region A									
Cheyenne	5	57	$11,758,350	$1,679,764	$189,307	2.7	$52,458,000	$535,500	$53,550
Decatur	5	25	$143,300	$20,471	$232,035	3.3	$49,747,000	$77,208	$7,721
Gove	4	28	$143,500	$20,500	$224,662	2.5	$59,084,000	$281,030	$28,103
Logan	4	34	$252,050	$36,007	$223,349	2.6	$47,558,000	$346,332	$34,633
Rawlins	5	41	$267,800	$38,257	$205,462	2.4	$59,406,000	$337,334	$33,733
Sheridan	5	31	$857,000	$122,429	$200,661	2.9	$95,542,000	$526,613	$52,661
Sherman	4	102	$34,692,500	$4,956,071	$461,185	5.7	$108,370,000	$1,272,383	$127,238
Thomas	4	45	$325,200	$46,457	$599,973	7.4	$129,521,000	$451,565	$45,157
Wallace	3	35	$205,488	$29,355	$117,421	1.6	$47,203,000	$439,814	$43,981
Subtotal		**398**	**$48,645,188**	**$6,949,313**	**$2,454,055**		**$648,889,000**	**$4,267,780**	**$426,778**
Mitigation Planning Region B									
Ellis	2	60	$14,250	$2,036	$1,735,474	31.6	$27,729,000	$91,142	$9,114
Graham	4	44	$162,200	$23,171	$201,852	2.9	$42,105,000	$104,435	$10,444
Ness	5	32	$15,000	$2,143	$241,794	2.9	$37,636,000	$100,746	$10,075
Norton	5	54	$11,762,400	$1,680,343	$371,491	6.5	$42,614,000	$37,911	$3,791
Phillips	4	36	$364,000	$52,000	$439,444	6.4	$41,104,000	$56,919	$5,692
Rooks	4	24	$511,000	$73,000	$601,846	5.8	$46,688,000	$157,344	$15,734
Rush	5	40	$260,000	$37,143	$202,357	4.6	$33,863,000	$405,129	$40,513
Russell	4	97	$499,850	$71,407	$488,994	7.9	$23,659,000	$61,159	$6,116
Trego	5	31	$1,500	$214	$215,776	3.4	$30,057,000	$99,058	$9,906
Subtotal		**418**	**$13,590,200**	**$1,941,457**	**$4,499,028**		**$325,455,000**	**$1,113,842**	**$111,384**

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Mitigation Planning Region C									
Grant	3	50	$14,700	$2,100	$469,849	13.6	$63,853,000	$2,554,106	$255,411
Greeley	4	26	$6,554,000	$936,286	$131,666	1.6	$64,552,000	$851,736	$85,174
Hamilton	4	45	$11,500	$1,643	$187,869	2.7	$51,817,000	$689,173	$68,917
Kearny	4	42	$3,591,500	$513,071	$228,723	4.6	$66,321,000	$409,771	$40,977
Lane	4	28	$85,000	$12,143	$162,362	2.4	$31,082,000	$177,955	$17,795
Morton	4	33	$1,500	$214	$230,152	4.4	$42,645,000	$4,077,837	$407,784
Scott	2	47	$1,500	$214	$350,514	6.9	$71,718,000	$68,530	$6,853
Stanton	4	40	$1,500	$214	$151,658	3.3	$76,592,000	$4,024,449	$402,445
Stevens	2	18	$20,000	$2,857	$293,762	7.9	$124,066,000	$2,712,584	$271,258
Wichita	5	17	$115,000	$16,429	$175,679	3.1	$0	$224,337	$22,434
Subtotal		**346**	**$10,396,200**	**$1,485,171**	**$2,382,234**		**$592,646,000**	**$15,790,478**	**$1,579,048**
Mitigation Planning Region D									
Clark	5	22	$5,000	$714	$182,482	2.3	$15,466,000	$19,459	$1,946
Finney	2	108	$2,709,000	$387,000	$2,042,592	28.2	$140,746,000	$981,241	$98,124
Ford	2	97	$565,500	$80,786	$1,731,663	30.8	$87,004,000	$388,085	$38,809
Gray	2	48	$821,500	$117,357	$360,141	6.9	$109,340,000	$486,013	$48,601
Haskell	3	23	$200,000	$28,571	$252,803	7.4	$116,154,000	$2,142,614	$214,261
Hodgeman	3	42	$62,500	$8,929	$131,155	2.2	$41,068,000	$147,396	$14,740
Meade	4	16	$4,500	$643	$295,936	4.7	$91,206,000	$418,926	$41,893
Seward	2	35	$120,000	$17,143	$1,021,471	35.9	$81,688,000	$1,397,187	$139,719
Subtotal		**391**	**$4,488,000**	**$641,143**	**$6,018,243**		**$682,672,000**	**$5,980,922**	**$598,092**

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Mitigation Planning Region E									
Barber	4	43	$360,000	$51,429	$388,136	4.3	$15,969,000	$334,641	$33,464
Barton	3	98	$581,200	$83,029	$1,772,118	30.9	$65,249,000	$234,400	$23,440
Comanche	5	18	$0	$0	$135,138	2.4	$13,395,000	$460	$46
Edwards	4	35	$152,000	$21,714	$232,382	4.9	$73,732,000	$935,127	$93,513
Kiowa	4	24	$60,000	$8,571	$237,655	3.5	$34,681,000	$202,977	$20,298
Pawnee	5	48	$123,000	$17,571	$449,592	9.2	$67,357,000	$432,880	$43,288
Pratt	3	84	$136,500	$19,500	$689,239	13.1	$62,967,000	$578,853	$57,885
Stafford	4	43	$140,500	$20,071	$295,331	5.6	$74,613,000	$212,145	$21,214
Subtotal		**393**	**$1,553,200**	**$221,886**	**$4,199,591**		**$407,963,000**	**$2,931,482**	**$293,148**
Mitigation Planning Region F									
Clay	3	35	$21,000	$3,000	$599,823	13.2	$47,769,000	$38,858	$3,886
Cloud	5	48	$43,000	$6,143	$691,783	13.3	$55,096,000	$242,452	$24,245
Dickinson	4	52	$285,000	$40,714	$1,262,865	23.3	$50,121,000	$16,763	$1,676
Ellsworth	5	47	$391,000	$55,857	$459,624	9.1	$19,376,000	$6,699	$670
Jewell	5	28	$217,000	$31,000	$254,815	3.4	$61,168,000	$227,830	$22,783
Lincoln	4	50	$345,000	$49,286	$234,746	4.5	$32,667,000	$8,539	$854
Mitchell	4	25	$199,000	$28,429	$510,997	9.1	$61,762,000	$102,970	$10,297
Osborne	5	20	$335,200	$47,886	$343,004	4.3	$37,801,000	$109,743	$10,974
Ottawa	2	44	$106,500	$15,214	$418,316	8.5	$35,560,000	$12,385	$1,239
Republic	5	28	$5,000	$714	$417,216	6.9	$79,639,000	$85,441	$8,544
Saline	2	41	$584,000	$83,429	$3,591,872	77.2	$26,903,000	$3,464	$346
Smith	5	18	$445,000	$63,571	$278,296	4.3	$54,022,000	$138,831	$13,883
Subtotal		**436**	**$2,976,700**	**$425,243**	**$9,063,357**		**$561,884,000**	**$993,974**	**$99,397**

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Mitigation Planning Region G									
Butler	1	166	$32,371,150	$4,624,450	$3,509,143	46.1	$41,249,000	$28,018	$2,802
Cowley	3	109	$4,047,200	$578,171	$2,180,637	32.3	$23,126,000	$128,144	$12,814
Harper	4	46	$395,000	$56,429	$455,272	7.5	$17,809,000	$430,682	$43,068
Harvey	2	49	$178,223,000	$25,460,429	$2,143,090	64.3	$49,189,000	$72,750	$7,275
Kingman	3	61	$521,500	$74,500	$606,598	9.1	$25,749,000	$31,964	$3,196
McPherson	4	53	$682,400	$97,486	$762,377	13.4	$43,687,000	$95,831	$9,583
Marion	2	101	$2,175,950	$310,850	$854,909	32.5	$57,227,000	$16,386	$1,639
Reno	3	127	$2,438,000	$348,286	$4,120,706	51.4	$69,497,000	$200,499	$20,050
Rice	4	41	$483,650	$69,093	$668,411	13.9	$53,225,000	$166,607	$16,661
Sedgwick	1	232	$695,250	$99,321	$31,528,899	499.6	$56,918,000	$155,726	$15,573
Sumner	2	102	$913,750	$130,536	$1,574,242	20.4	$50,711,000	$554,782	$55,478
Subtotal		**1,087**	**$222,946,850**	**$31,849,550**	**$48,404,284**		**$488,387,000**	**$1,881,389**	**$188,139**
Mitigation Planning Region H									
Allen	3	24	$199,250	$28,464	$983,778	26.7	$15,462,000	$5,428	$543
Bourbon	4	43	$1,169,000	$167,000	$1,102,488	23.9	$9,918,000	$21,587	$2,159
Chautauqua	5	39	$120,600	$17,229	$285,438	5.7	$4,971,000	$0	$0
Cherokee	4	70	$5,567,200	$795,314	$1,293,753	36.8	$53,420,000	$555	$56
Crawford	3	62	$3,326,500	$475,214	$2,588,817	66.4	$34,463,000	$21,656	$2,166
Elk	5	18	$454,750	$64,964	$187,291	4.5	$0	$0	$0
Greenwood	5	42	$222,500	$31,786	$491,412	5.9	$8,087,000	$14,411	$1,441
Labette	4	53	$467,000	$66,714	$1,453,850	33.5	$22,765,000	$2,921	$292
Montgomery	4	55	$771,150	$110,164	$2,432,183	55.1	$16,616,000	$21,185	$2,119
Neosho	4	35	$395,000	$56,429	$1,174,150	28.9	$17,811,000	$1,841	$184
Wilson	4	29	$3,350,500	$478,643	$671,059	16.5	$26,882,000	$6,528	$653
Woodson	5	9	$3,500	$500	$207,905	6.6	$14,486,000	$0	$0

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Subtotal		**479**	**$16,046,950**	**$2,292,421**	**$12,872,124**		**$224,881,000**	**$96,112**	**$9,611**
Mitigation Planning Region I									
Chase	3	36	$216,500	$30,929	$183,326	3.6	$6,222,000	$845	$84
Geary	3	31	$82,000	$11,714	$1,453,512	89.3	$11,039,000	$6,151	$615
Lyon	2	65	$148,000	$21,143	$2,366,508	39.8	$24,554,000	$6,822	$682
Morris	2	31	$155,000	$22,143	$421,954	8.5	$21,783,000	$2,906	$291
Pottawatomie	1	38	$17,000	$2,429	$1,157,180	25.7	$30,455,000	$9,291	$929
Riley	2	48	$202,400	$28,914	$3,814,017	116.6	$23,622,000	$189	$19
Wabaunsee	2	39	$99,000	$14,143	$439,179	8.9	$17,358,000	$36,376	$3,638
Subtotal		**288**	**$919,900**	**$131,414**	**$9,835,676**		**$135,033,000**	**$62,580**	**$6,258**
Mitigation Planning Region J									
Anderson	3	26	$78,000	$11,143	$518,401	14	$33,029,000	$35,046	$3,505
Coffey	3	42	$323,000	$46,143	$670,953	13.7	$25,497,000	$8,374	$837
Franklin	2	48	$107,500	$15,357	$1,598,004	45.5	$32,349,000	$64,523	$6,452
Linn	2	12	$17,000	$2,429	$659,126	16.3	$13,053,000	$668	$67
Miami	1	14	$63,500	$9,071	$2,106,266	57	$27,726,000	$92,213	$9,221
Osage	2	45	$88,000	$12,571	$977,110	23.1	$27,618,000	$118,292	$11,829
Shawnee	2	79	$32,000	$4,571	$11,828,241	327.1	$32,959,000	$24,519	$2,452
Subtotal		**266**	**$709,000**	**$101,286**	**$18,358,101**		**$192,231,000**	**$343,636**	**$34,364**
Mitigation Planning Region K									
Atchison	3	15	$17,500	$2,500	$1,333,363	39.3	$42,536,000	$9,182	$918
Brown	5	33	$26,000	$3,714	$713,225	17.5	$86,532,000	$123,514	$12,351
Doniphan	3	10	$30,200	$4,314	$557,109	20.2	$67,800,000	$591,792	$59,179

County	SoVI Rating (1-5)	Prior Events 2006-2012	Property Damages	Annualized Property Damages	Total Building Exposure ($000)	Population Density	Crop Exposure (2007 Census of Agriculture)	Crop Insurance Paid for Wind	Annualized Crop Insurance Paid
Douglas	1	55	$8,029,000	$1,147,000	$6,614,269	243.1	$27,973,000	$123,445	$12,345
Jackson	3	22	$48,000	$6,857	$788,323	20.5	$21,169,000	$5,300	$530
Jefferson	1	53	$16,000	$2,286	$1,130,852	35.9	$33,429,000	$40,572	$4,057
Marshall	4	33	$24,500	$3,500	$2,054,603	11.2	$81,815,000	$261,272	$26,127
Nemaha	4	42	$33,000	$4,714	$711,896	14.2	$67,091,000	$87,997	$8,800
Washington	4	23	$5,000	$714	$396,656	6.5	$65,762,000	$423,085	$42,309
Subtotal		**286**	**$8,229,200**	**$1,175,600**	**$14,300,296**		**$494,107,000**	**$1,666,159**	**$166,616**
Mitigation Planning Region L									
Johnson	1	61	$81,000	$11,571	$43,871,468	1,149.60	$29,472,000	$109,685	$10,969
Leavenworth	1	60	$513,500	$73,357	$4,877,783	164.7	$20,983,000	$0	$0
Wyandotte	3	13	$150,000	$21,429	$12,066,666	1,039.00	$0	$0	$0
Subtotal		**134**	**$744,500**	**$106,357**	**$60,815,917**		**$50,455,000**	**$109,685**	**$10,969**
Statewide Totals		**4,922**	**$331,245,888**	**$47,320,841**	**$193,202,906**		**$4,804,603,000**	**$35,238,040**	**$3,523,804**

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

Table 3.147 shows the 1 – 10 ranges for the wind vulnerability factor ratings. These factor ranges are calculated based on that range of data not comparing the range to another factor‘s ratings range. Ranges may be different for each hazard. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.147. Ranges for Wind Vulnerability Factor Ratings

Ratings	Social Vulnerability	NCDC Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss
1		9 - 34	$0 - $200,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	19 - $40,800
2	1	35 - 56	$200,001 - $400,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$40,801 - $81,576
3		57 - 78	$400,001 - $600,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$81,577 - $122,352
4	2	79 - 100	$600,001 - $800,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$122,353 - $163,128
5		101 - 122	$800,001 - $1,000,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$163,129 - $203,904
6	3	123 - 144	$1,000,001 - $3,000,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$203,905 - $244,680
7		145 - 165	$3,000,001 - $5,000,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$244,681 - $285,456
8	4	166 - 187	$5,00,001 - $7,000,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$285,457 - $326,232
9		188 - 209	$7,000,001 - $9,000,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$326,233 - $367,008
10	5	210 - 232	$9,000,001 - $25,460,428	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$367,009 - $407,783

* Population density is the number of people per square mile.
Note: The assigned 1-10 range would be based on the range of dollar losses, not comparing the range of losses to another factor‘s range

Table 3.148 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and Table 3.149 provides the seven rating values assigned that were considered in determining overall vulnerability to wind. **Figure 3.127** that follows provides the mapped results of this analysis by county.

Table 3.148. Ranges for Overall Wind Vulnerability

Ranges	Low	Medium-Low	Medium	Medium-High	High
	9 - 14	15 - 19	20 - 24	25 – 29	30 - 34

Table 3.149. Vulnerability of Kansas Counties to Wind

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Wind Vulnerability
Mitigation Planning Region A									
Cheyenne	10	3	6	1	1	4	2	27	Medium-High
Decatur	10	1	1	1	1	4	1	19	Medium-Low
Gove	8	1	1	1	1	4	1	17	Medium-Low
Logan	8	1	1	1	1	4	1	17	Medium-Low
Rawlins	10	2	1	1	1	5	1	21	Medium
Sheridan	10	1	1	1	1	7	2	23	Medium
Sherman	8	5	7	1	1	8	4	34	High
Thomas	8	2	1	1	1	10	2	25	Medium-High
Wallace	6	2	1	1	1	4	2	17	Medium-Low
Mitigation Planning Region B									
Ellis	4	3	1	1	1	2	1	13	Low
Graham	8	2	1	1	1	3	1	17	Medium-Low
Ness	10	1	1	1	1	3	1	18	Medium-Low
Norton	10	2	6	1	1	3	1	24	Medium
Phillips	8	2	1	1	1	3	1	17	Medium-Low
Rooks	8	1	1	1	1	4	1	17	Medium-Low
Rush	10	2	1	1	1	3	1	19	Medium-Low
Russell	8	4	1	1	1	2	1	18	Medium-Low
Trego	10	1	1	1	1	2	1	17	Medium-Low
Mitigation Planning Region C									
Grant	6	2	1	1	1	5	7	23	Medium
Greeley	8	1	5	1	1	5	3	24	Medium
Hamilton	8	2	1	1	1	4	2	19	Medium-Low
Kearny	8	2	3	1	1	5	2	22	Medium
Lane	8	1	1	1	1	2	1	15	Medium-Low
Morton	8	1	1	1	1	3	10	25	Medium-High
Scott	4	2	1	1	1	5	1	15	Medium-Low
Stanton	8	2	1	1	1	6	10	29	Medium-High
Stevens	4	1	1	1	1	9	7	24	Medium
Wichita	10	1	1	1	1	1	1	16	Medium-Low
Mitigation Planning Region D									
Clark	10	1	1	1	1	1	1	16	Medium-Low
Finney	4	5	2	1	1	10	3	26	Medium-High
Ford	4	4	1	1	1	7	1	19	Medium-Low
Gray	4	2	1	1	1	8	2	19	Medium-Low
Haskell	6	1	1	1	1	9	6	25	Medium-High
Hodgeman	6	2	1	1	1	3	1	15	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Wind Vulnerability
Meade	8	1	1	1	1	7	2	21	Medium
Seward	4	2	1	1	1	6	4	19	Medium-Low
Mitigation Planning Region E									
Barber	8	2	1	1	1	1	1	15	Medium-Low
Barton	6	4	1	1	1	5	1	19	Medium-Low
Comanche	10	1	1	1	1	1	1	16	Medium-Low
Edwards	8	2	1	1	1	6	3	22	Medium
Kiowa	8	1	1	1	1	3	1	16	Medium-Low
Pawnee	10	2	1	1	1	5	2	22	Medium
Pratt	6	4	1	1	1	5	2	20	Medium
Stafford	8	2	1	1	1	6	1	20	Medium
Mitigation Planning Region F									
Clay	6	2	1	1	1	4	1	16	Medium-Low
Cloud	10	2	1	1	1	4	1	20	Medium
Dickinson	8	2	1	1	1	4	1	18	Medium-Low
Ellsworth	10	2	1	1	1	2	1	18	Medium-Low
Jewell	10	1	1	1	1	5	1	20	Medium
Lincoln	8	2	1	1	1	3	1	17	Medium-Low
Mitchell	8	1	1	1	1	5	1	18	Medium-Low
Osborne	10	1	1	1	1	3	1	18	Medium-Low
Ottawa	4	2	1	1	1	3	1	13	Low
Republic	10	1	1	1	1	6	1	21	Medium
Saline	4	2	1	1	1	2	1	12	Low
Smith	10	1	1	1	1	4	1	19	Medium-Low
Mitigation Planning Region G									
Butler	2	8	7	1	1	3	1	23	Medium
Cowley	6	5	3	1	1	2	1	19	Medium-Low
Harper	8	2	1	1	1	1	2	16	Medium-Low
Harvey	4	2	10	1	1	4	1	23	Medium
Kingman	6	3	1	1	1	2	1	15	Medium-Low
McPherson	8	2	1	1	1	3	1	17	Medium-Low
Marion	4	5	2	1	1	4	1	18	Medium-Low
Reno	6	6	2	1	1	5	1	22	Medium
Rice	8	2	1	1	1	4	1	18	Medium-Low
Sedgwick	2	10	1	8	5	4	1	31	High
Sumner	4	5	1	1	1	4	2	18	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Wind Vulnerability
Mitigation Planning Region H									
Allen	6	1	1	1	1	1	1	12	Low
Bourbon	8	2	1	1	1	1	1	15	Medium-Low
Chautauqua	10	2	1	1	1	1	0	16	Medium-Low
Cherokee	8	3	4	1	1	4	1	22	Medium
Crawford	6	3	3	1	1	3	1	18	Medium-Low
Elk	10	1	1	1	1	1	0	15	Medium-Low
Greenwood	10	2	1	1	1	1	1	17	Medium-Low
Labette	8	2	1	1	1	2	1	16	Medium-Low
Montgomery	8	2	1	1	1	1	1	15	Medium-Low
Neosho	8	2	1	1	1	1	1	15	Medium-Low
Wilson	8	1	3	1	1	2	1	17	Medium-Low
Woodson	10	1	1	1	1	1	0	15	Medium-Low
Mitigation Planning Region I									
Chase	6	2	1	1	1	1	1	13	Low
Geary	4	1	1	1	1	1	1	10	Low
Lyon	6	3	1	1	1	2	1	15	Medium-Low
Morris	6	1	1	1	1	2	1	13	Low
Pottawatomie	2	2	1	1	1	2	1	10	Low
Riley	4	2	1	1	2	2	1	13	Low
Wabaunsee	4	2	1	1	1	1	1	11	Low
Mitigation Planning Region J									
Anderson	6	1	1	1	1	3	1	14	Low
Coffey	6	2	1	1	1	2	1	14	Low
Franklin	4	2	1	1	1	3	1	13	Low
Linn	4	1	1	1	1	1	1	10	Low
Miami	2	1	1	1	1	2	1	9	Low
Osage	4	2	1	1	1	2	1	12	Low
Shawnee	4	4	1	3	3	3	1	19	Medium-Low
Mitigation Planning Region K									
Atchison	6	1	1	1	1	3	1	14	Low
Brown	10	1	1	1	1	7	1	22	Medium
Doniphan	6	1	1	1	1	5	2	17	Medium-Low
Douglas	2	2	6	2	3	2	1	18	Medium-Low
Jackson	6	1	1	1	1	2	1	13	Low
Jefferson	2	2	1	1	1	3	1	11	Low
Marshall	8	1	1	1	1	6	1	19	Medium-Low
Nemaha	8	2	1	1	1	5	1	19	Medium-Low
Washington	8	1	1	1	1	5	2	19	Medium-Low

County	SoVi Rating	NCDC Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Loss Rating	Overall Vulnerability Rating	Wind Vulnerability
Mitigation Planning Region L									
Johnson	2	3	1	10	10	2	1	29	Medium-High
Leavenworth	2	3	1	2	2	2	0	12	Low
Wyandotte	6	1	1	3	10	1	0	22	Medium

Figure 3.127. Vulnerability Summary for Wind

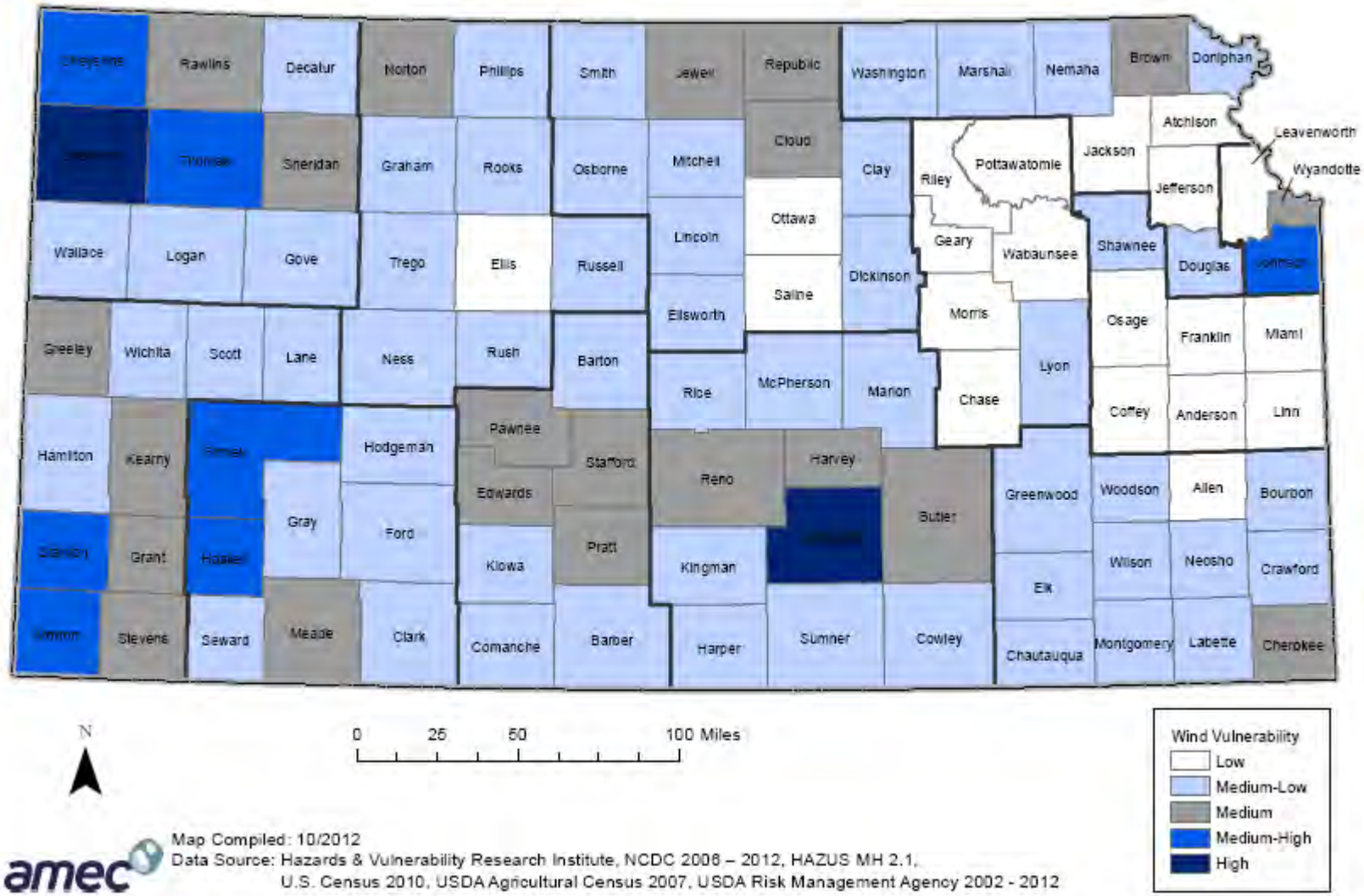


Table 3.150 below lists the top vulnerable counties in Kansas relative to each other concerning wind events.

Table 3.150. Top Counties: Vulnerable to Wind

Mitigation Planning Region	County	Overall Vulnerability Rating	Wind Vulnerability
A	Sherman	34	High
G	Sedgwick	31	High
C	Stanton	29	Medium-High
L	Johnson	29	Medium-High
A	Cheyenne	27	Medium-High
D	Finney	26	Medium-High
A	Thomas	25	Medium-High
C	Morton	25	Medium-High
D	Haskell	25	Medium-High
B	Norton	24	Medium
C	Greeley	24	Medium
C	Stevens	24	Medium

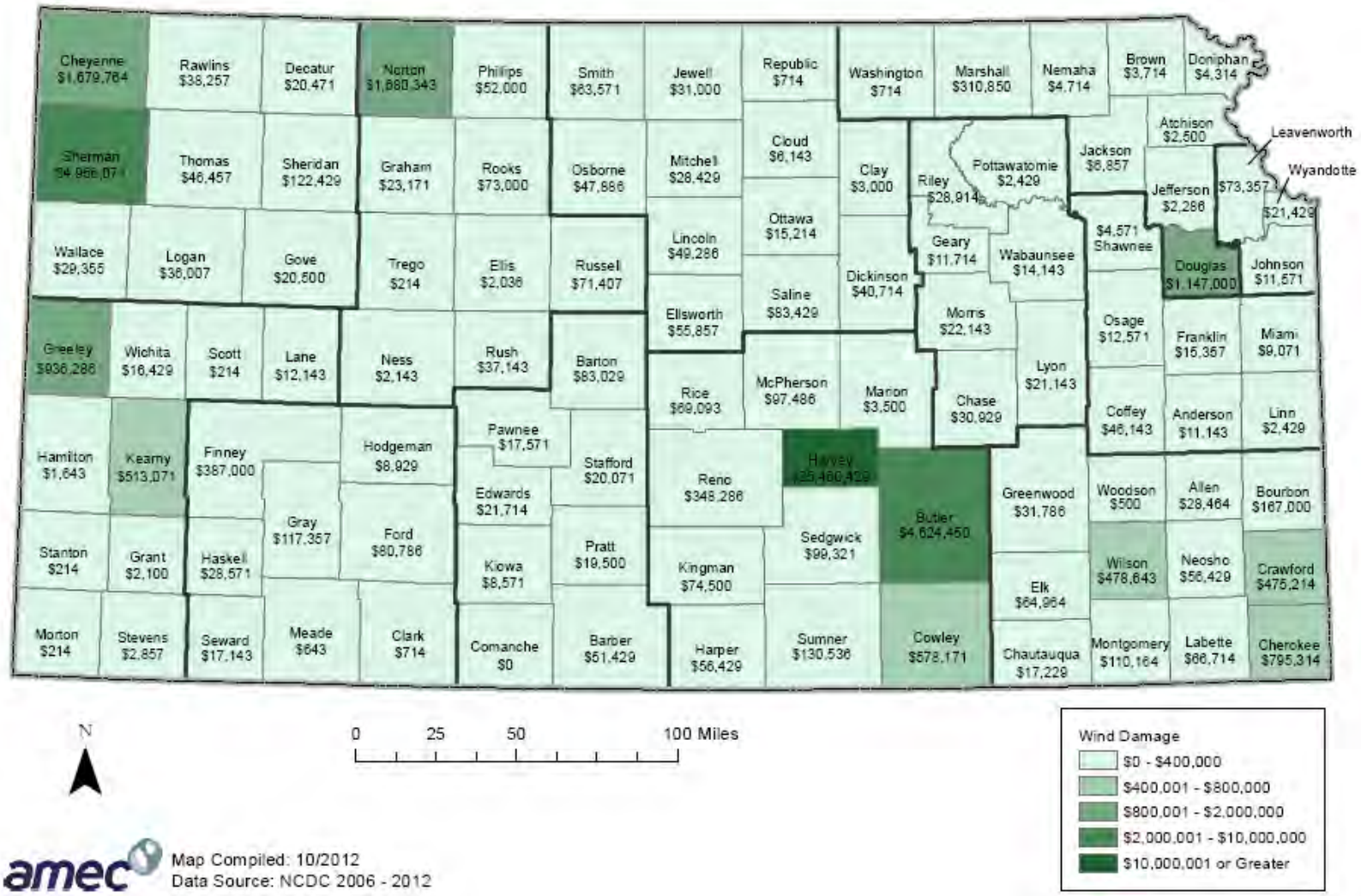
State Estimates of Potential Losses

Severe thunderstorms and the associated hail events will continue to cause damage to anything and everything exposed to the weather elements. Historically NCDC has reported 61 injuries in Kansas from 2006 through 2012 which calculates to an annualized occurrence of nine injuries.

To determine potential financial loss estimates to wind in Kansas, the available historical loss data was annualized. In the case of frequently occurring weather-related hazards such as wind, annualized historical loss data is considered to be the best resource for determining future potential losses. As discussed above in the vulnerability overview for wind, the planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (2006 – 2012) and the USDA Risk Management Agency insured crop loss payments (2002 – 2011) since agriculture plays such as important role in the Kansas economy. According to this data, the combined annualized property loss for the State of Kansas from wind is $50,844,645 ($47,320,841 property and $3,523,804 crop damages) as can be viewed in **Table 3.146** (vulnerability overview section).

Figure 3.128 provided the potential annualized property loss estimates per county. There is no distinct pattern of loss that can be inferred for property loss other than its random distribution and its impacts are statewide.

Figure 3.128. Annualized Property Losses from Wind, by County, 2006 - 2012



Development in Hazard Prone Areas

Future development projects should consider windstorm hazard at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Consequence Analysis

The information in **Table 3.151** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.151. EMAP Consequence Analysis: Windstorm

Subject	Ranking	Impacts/Windstorm
Health and Safety of Persons in the Area of the Incident	Minimal to Moderate	Impact of the immediate area could be minimal to moderate for affected areas.
Responders	Minimal	Impact to responders is expected to be minimal unless responders live within the affected area.
Continuity of Operations	Minimal	Temporary relocation may be necessary if government facilities experience damage (minimal).
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact could be minimal to moderate to facilities and infrastructure in the incident area. Utility lines most affected and could be severe.
Delivery of Services	Minimal	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained (minimal).
Environment	Minimal to Severe	Impact may be severe for the immediate impacted area with regards to trees, bushes, crops, etc. Impact will lessen as distance increases from the immediate incident area (minimal to severe).
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the trajectory of the windstorm. Revenue could be impacted if tourism, businesses are halted due to structural damages and infrastructure damage (minimal to severe).
Public Confidence in Jurisdiction‘s Governance	Minimal	Response and recovery will be in question if not timely and effective. Warning systems in place and the timeliness of those warnings could be questioned (minimal).

3.3.22. Winter Storm

Calculated Priority Risk Index	Planning Significance
3.3	High

Description/Location

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

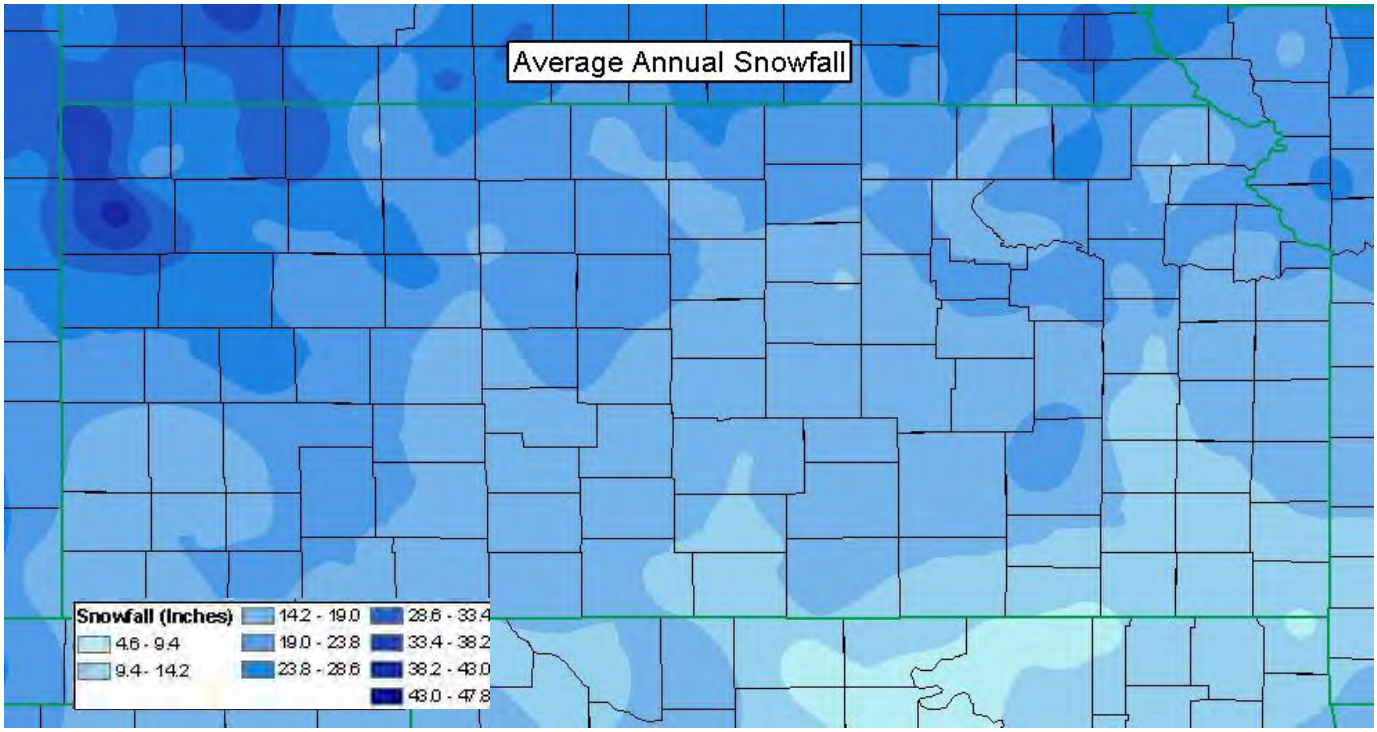
A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures (see **Section 3.3.7,** Extreme Temperatures). The National Weather Service describes different types of winter storm events as follows:

- **Blizzard**—Winds of 35 mph or more with snow and blowing snow reducing visibility to less than 1/4 mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers**—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain**—Measurable rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

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

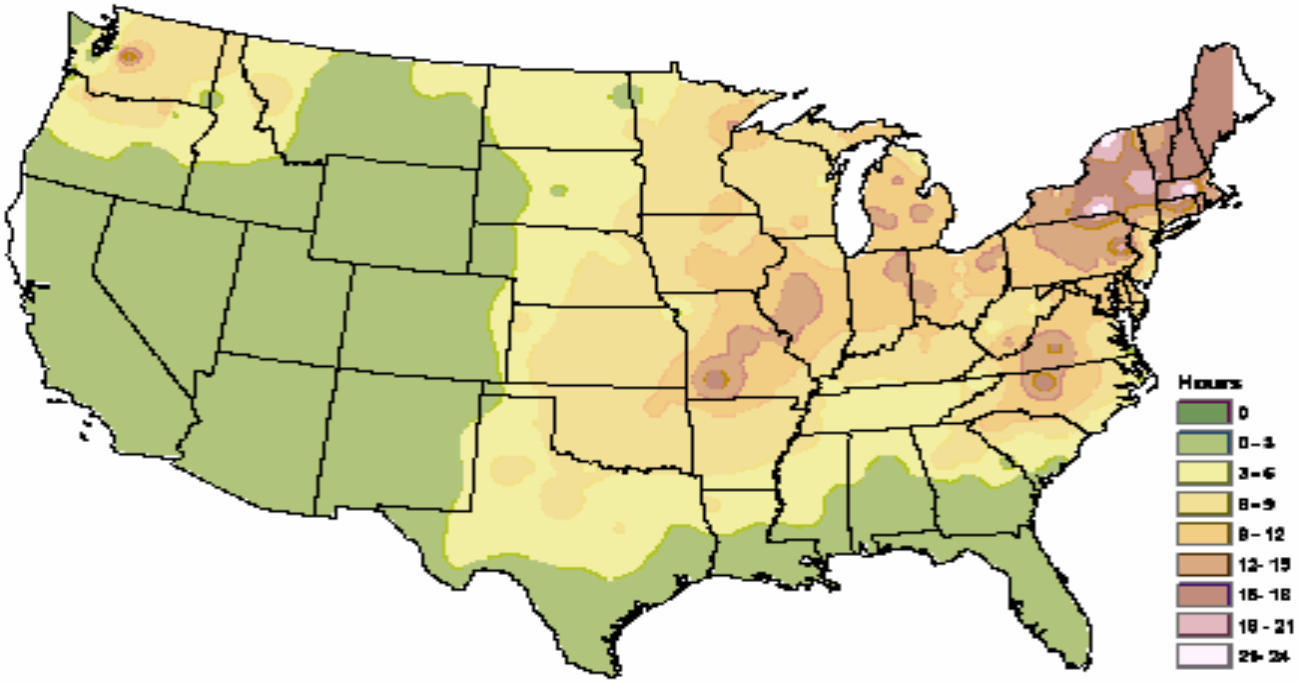
The entire State of Kansas is vulnerable to heavy snow and freezing rain. Northwestern Kansas receives the greatest average annual snowfall and the southeast receives the least (see **Figure 3.129**). Freezing rains occurs most frequently in southeastern Kansas and least frequently in western Kansas (see **Figure 3.130**).

Figure 3.129. Average Annual Snowfall



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

Figure 3.130. Average Number of Hours per Year with Freezing Rain in the United States



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

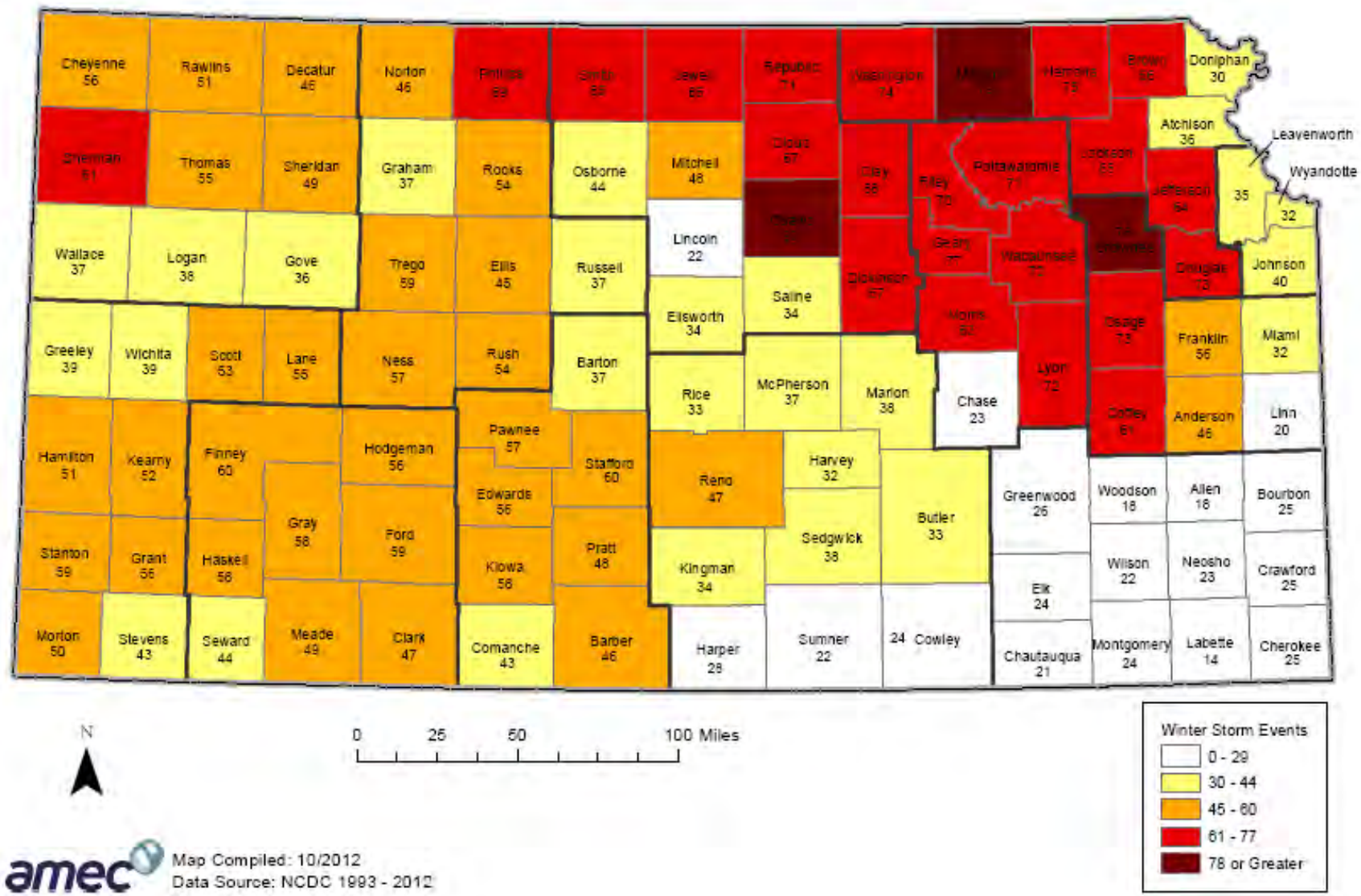
More information about location can be found in the Previous Occurrences and Vulnerability and Potential Losses by Jurisdiction sections.

Previous Occurrences

According to the National Climatic Data Center Storm Events database, there were 1,065 winter storms (blizzard, extreme wind chill, freeze, ice, sleet, and snow events) in Kansas between 1993 and 2012 (see **Figure 3.131**). Total property damage in NCDC is estimated at $233 million whereas the total public assistance and individual assistance from the eight Presidential Declarations listed below totaled over $972 million. This suggests that although there are more winter storm events recorded in NCDC than there have been declarations, damages to NCDC are likely hugely under-reported.

Analysis of the NCDC data indicates that Kansas experiences 53 winter storms and $11 million in winter storm losses each year. There were 52 deaths and 124 injuries in this time period, which averages out to approximately 3 deaths and 6 injuries each year.

Figure 3.131. Kansas Winter Storms, 1993–2012



The State of Kansas has had eight Presidential Declarations that involved winter storms since 1955 (see **Table 3.152** for the details).

Table 3.152. Kansas Presidential Declarations Involving Winter Storms

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)
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
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
1741	02/01/2008 (12/6-12/19/2008)	Severe Winter Storms	Atchison, Barber, Barton, Brown, Butler, Chase, Cherokee, Clark, Clay, Cloud, Comanche, Crawford, Dickinson, Doniphan, Edwards, Ellis, Ellsworth, Ford, Geary, Graham, Gove, Harvey, Hodgeman, Jackson, Jefferson, Jewell, Kingman, Kiowa, Labette, Leavenworth, Lincoln, Logan, Lyon, Marion, Marshall, McPherson, Miami, Mitchell, Morris, Nemaha, Osage, Osborne, Ottawa, Pawnee, Phillips, Pottawatomie, Pratt, Reno, Republic, Rice, Riley, Rooks, Rush, Russell, Saline, Sedgwick, Shawnee, Sheridan, Smith, Stafford, Thomas, Wabaunsee, Wallace, Washington, and Woodson.	$359,557,345
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
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
1579	2/8/2005	Severe Winter	Anderson, Atchison, Barber, Brown, Butler,	$106,873,672

Declaration Number	Declaration Date*	Disaster Description	Counties Involved	Disaster Cost**
	(1/4-6/2005)	Storm, Heavy Rains, and Flooding	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	
1402	2/6/2002 (1/29-2/15/2002)	Ice Storm	Allen, Anderson, Barber, Bourbon, Butler, Chautauqua, Cherokee, Coffey, Comanche, Cowley, Crawford, Douglas, Elk, Franklin, Greenwood, Harper, Jefferson, Johnson, Kingman, Kiowa, Labette, Leavenworth, Linn, Lyon, Miami, Montgomery, Neosho, Osage, Pratt, Sedgwick, Shawnee, Sumner, Wilson, Woodson, Wyandotte	$60,185,754

Sources: http://www.fema.gov/disasters, and Kansas Division of Emergency Management
* Incident dates are in parentheses.
** Disaster costs include Public Assistance and Individual Assistance

FEMA-4112-DR—April 26, 2013 (February 20-23, 2013): A very potent and significant winter storm passed through the Central Plains on February 21, bringing more than a foot of snow to several locations throughout the State. In northeast Kansas most locations saw between 8 and 10 inches of snow, with the highest reported total coming from Rossville, in Shawnee County, where 14 inches of snow fell between 6am and 9 pm on the 21st. The event was highlighted by extremely heavy snow, approaching 4 inches per hour at some points. Accompanying the heaviest snow was occasional lightning, causing a rare phenomenon called thundersnow. The storm caused numerous vehicle accidents and forced the closure of parts of almost every Interstate in Kansas.

FEMA-1885-DR—March 9, 2010 (December 21, 2009—January 10, 2010): Beginning December 22nd a strong, slow moving storm moved into the western Kansas leaving heavy snow causing icy and snow packed roads in portions of northwestern Kansas. The storm system continued easterly and continued to significantly impact portions of north central, northeastern, and southeastern areas of the State. This storm system created blizzard conditions with dangerously high winds causing blowing/drifting snow, treacherous travel conditions, and impassable roads. Two fatalities and three injuries occurred in two of the more severe accidents. FEMA Public Assistance funding for this disaster was $19,100,658.

FEMA-1868-DR—December 23, 2009 (November 14-16, 2009): The storm system began as rain on Saturday evening, November 14th and transitioned into snow early Sunday morning. The storm continued to move across the State on Sunday and Monday. This system produced extremely heavy snows that caused severe damage to electric infrastructure and disrupting power to several thousand customers. The majority of the snowfall occurred in the northern tier counties along the US-36 corridor. Northern Republic County reported eight inches of snow. Morrowville in Washington County reported a 12 inch accumulation. Marshall, Nemaha, and Brown Counties reported accumulations of five to seven inches. Areas south of the main storm system reported 2 inch accumulations or less. Damage estimates of $1.6 million included

damage to power poles across Washington, Marshall, Republic and Cloud Counties with the worst damage across Washington and Marshall Counties. FEMA Public Assistance funding for this disaster was $43,217,690.

FEMA-1848-DR— June 24, 2009 (March 26-29,2009): A late March blizzard produced record or near record snowfall of one to two feet across parts of central, south central and southwest Kansas. The heavy snow and high wind resulted in blizzard conditions on Friday into Saturday. Meanwhile, significant accumulations of ice from freezing rain and sleet also affected the Flint Hills and southeast Kansas, with some snow accumulations before the wintry precipitation ended Saturday evening. Several areas reported power outages due to the snow, ice and wind. FEMA Public Assistance funding for this disaster was $20,174,657.

FEMA-1741-DR—February, 2008 (December 6-19, 2007): Winter weather started across central and southeast Kansas with two different ice storms that moved across the area and produced significant accumulations. The ice caused numerous power outage and approximately 130,000 Kansas customers were without power. Specifically, Kansas Rural Electric Cooperatives reported 49,000 customers without power, Westar reported 76,000 customers, Kansas City Power & Light reported 4,300 customers, and Kansas City, Kansas Board of Public Utilities reported 800 customers without power. Then a major winter storm moved through Kansas during the evening hours of December 14th and the heaviest snow targeted areas still suffering from the ice storm that hit earlier in the week. FEMA Public Assistance funding for this disaster was $355,651,857.

FEMA-1675-DR—January 7, 2007 (December 28–30, 2006): This storm was one of Kansas' worst disasters on record. It began on December 28, 2006, and increased in intensity December 29 overnight into December 30. Snow depths ranged from four inches in Saline County to 30 inches in Wallace County. Several counties set snowfall records. Numerous highways were closed for days in western Kansas, and there were major power outages because of icing. The ice was 1/4 inch thick on guide wires that brought several communication towers down. During the peak of the storm there were 46,300 meters off-line and 10,500 power poles down. Approximately 60,000 people were without power. There were three storm-related fatalities. The storm also severely impacted ranchers, making it temporarily impossible for some to feed and water livestock. The Kansas National Guard used Black Hawk helicopters to feed stranded cattle. FEMA Public Assistance funding for this disaster was $315,201,639.

FEMA-1626-DR—January 26, 2006 (November 27-28, 2005): Much of the State was affected by this storm. Winds of 40 to 60 mph combined with two to seven inches of snow resulted in a blizzard, which raged across parts of north central Kansas. The wind whipped the snow into drifts 10 to 15 feet high in some places. Interstate 70 was closed west of Russell, and numerous other highways were impassable during the storm. There were several reports of auto accidents, including a 25-car pileup, and sporadic power outages. At least three auto-related deaths were attributed to the storm. FEMA Public Assistance funding for this disaster was $50,281,517.

FEMA-1579-DR—February 8, 2005 (January 4-6): This was one of the worst ice storms on record to hit central, south central, and southeast Kansas. Although freezing rain was the

primary culprit, sleet also played a vital role in coating nearly the entire region with one-two inches of ice, which caused incredible damage to trees, power lines, and power poles. Roads and highways were blocked by tree debris and downed power poles and lines. Many areas were without power for more than a week. Between three and five inches of snow accumulated in Russell, Lincoln and Saline Counties. Particularly hard hit were Butler and Sedgwick Counties, which sustained an estimated $8.5 million and $15 million damage, respectively. Three deaths were attributed to the storm. FEMA Public Assistance funding for this disaster was $106,873,672.

FEMA-1402-DR: Ice Storm—February 6, 2002 (January 29–February 15): Beginning on January 29, a three-day severe winter storm hit 35 Kansas counties in the southeast corner of the State with freezing rain, drizzle, sleet and snow. With one to two inches of ice accumulation, utility poles and power lines snapped, transportation was treacherous and fallen trees damaged many structures. The resulting power outages affected nearly the entire region and lasted nearly a week in some areas. Loss of power was particularly problematic for many nursing homes. There were seven fatalities. This was the worst ice storm in the metropolitan Kansas City area. FEMA Public Assistance funding for this disaster was $45,020,240.

Other Notable Winter Storms:

- **March 8, 2011:** A storm system moved out of the Rockies and onto the plains, producing a band of heavy snow across portions of northwest Kansas. The most significant snow fell along a line from Tribune and Leoti, northeast to Hoxie. Six to eight inches of snow was reported by observers. Elsewhere, snowfall amounts of two to four inches were common.
- **February 25, 2011:** Periods of freezing drizzle and freezing fog affected much of south central and southeast Kansas from the late evening on the 25th through the morning on the 26th. Area roads became very slick, producing numerous accidents and slide-offs. Unfortunately, three fatal accidents occurred: two in Sedgwick County and one in Cowley County.
- **December 23, 2010**: Patchy light freezing rain and freezing drizzle during the evening hours on the 23rd produced a thin glaze of ice across central, south central and portions of southeast Kansas. The glaze of ice produced very slick roads through the early morning hours on the 24th. Several automobile accidents and slide-offs occurred as a result, producing numerous injuries. One fatality occurred in Cowley County.
- **December 7, 2009:** A two pronged winter storm moved across south central region of Kansas during the period of December 6th through December the 8th, 2009. The initial system on December 6th spread a thin layer of freezing drizzle across portions of central Kansas, which produced numerous automobile accidents with one leading to a death. A more potent low pressure area tracked along the Kansas/Kansas border on December 7th and 8th, 2009. This system led to a band of heavy snow across central Kansas with a band of 6 to 12 inches along a line from Great Bend, Kansas to Salina, Kansas.
- **December 9, 2008:** One to three inches of snow fell across portions of the Sedgwick County leading to numerous traffic accidents. Over 650 traffic accidents were reported in and an around the Greater Wichita area during the morning commute, with 36 injuries reported. One accident of note was a five to six car pileup near Park City along Interstate 135.

- **November 29–December 1, 2006:** A winter storm produced a period of freezing precipitation and sleet in east central Kansas on November 29 followed by snowfall of six to ten inches on the 30th through the early morning of December 1. Counties that were hit particularly hard include Franklin, Anderson, Coffey, Osage, Lyon, and Douglas. The storm also affected southeast Kansas where snowfall amounts exceeded 12 inches in some locations and almost paralyzed the area for a couple of days.
- **March 20, 2006:** A major late winter storm brought 12 to 14 inches of snow to most of the northwest counties and southwest counties received 8 to 10 inches of snow.
- **January 25-26, 2004:** A wintry mix of freezing rain, sleet and snow fell across north central, northeast and east central Kansas. Ice accumulations of 1/4 to 1/2 of an inch were reported across northeast and parts of east central Kansas. The ice built up on trees and power lines and caused numerous power outages and downed limbs across north central and northeast Kansas. Slick roads led to numerous accidents across the region. Strong winds on the 26th caused near whiteout conditions as the snow blew and drifted.
- **February 8-9, 2001:** Freezing rain and sleet fell across central and south central Kansas (mainly west of Wichita). For those locations from Wichita eastward, surface temperatures above freezing allowed the precipitation to initially fall as rain. The ice in central and portions of south central Kansas changed to snow, and the rain in south central Kansas changed to sleet and freezing rain. Many locations reported one-half inch of ice accumulation resulting in treacherous driving conditions and downed trees and power lines.
- **January 27-28, 2001:** Heavy snow fell in central Kansas west of Arlington and Marquette to Glendale, where accumulations ranged from six to twelve inches. An isolated area of 14 inches was reported in Hoisington and Hetzer in Barton County. A mixture of snow, sleet and freezing rain fell over south central Kansas, which changed to primarily sleet and freezing rain, causing ice accumulations on trees, overpasses, power lines and other elevated, exposed surfaces. Numerous vehicle accidents and scattered power outages were reported across south central and portions of southeastern Kansas.
- **January 2000:** An ice storm caused two major traffic accidents on Kansas‘ interstate highways that killed two and injured two others.
- **January 1999:** An ice storm caused almost $2 million in property damage. Damage to trees and power lines was extensive, resulting in widespread power outages and dangerous roadway conditions.
- **March 1998:** A blizzard dumped at least six inches of snow northwest of the Kansas Turnpike. Numerous accidents and stranded cars were reported. One fatal accident occurred in Dickinson County. Wind-caused drifts of four to seven feet were common, with some drifts exceeding 10 feet.
- **Fall 1997:** An autumn snowstorm surprised north central Kansas with wind driven snow depths in excess of one foot. Many roads west of Smith Center and Osborne became impassable at the height of the storm. As much as 15 inches paralyzed some areas, causing a roof of an auto dealership in Smith Center to collapse. Schools and businesses were closed for several days.
- **October 1996:** Record-setting snowfall knocked out power to an estimated 60,000 customers. Property damage was estimated at $500,000.
- **March 29, 1987:** A blizzard hit western and north central Kansas with a about a foot of snow and 78 mph winds were recorded in Dodge City. Nearly 250 miles of interstate 70 from

Russell west to Limon, Colorado were closed because of poor visibility from blowing and drifting snow. The Kansas Adjutant General's Office called out the National Guard because of severe icing stranded motorists on I-70. Hotels, motels, cafes, churches and town halls from eastern Colorado into Kansas were filled with motorists looking for a place to escape the weather and keep warm.

- **March 18, 1984:** Freezing rain, accompanied by lightning and thunder, accumulated to around an inch thick on trees, power lines, roads, and all exposed surfaces around Topeka. The heavy weight of the ice knocked out power to an estimated 100,000 people, most of the city of Topeka. A large television transmission tower collapsed under the weight of the ice, along with many trees and large tree branches. Destruction was widespread throughout the city. It was believed to be the most damaging ice storm in the city's history. Electricity was not restored in some areas for over a week.
- **December 1978:** Major ice storm
- **January 1974:** Major ice storm
- **February 21, 1971:** An intense winter storm buried southern Kansas with 10-13 inches of snow. Gusty north-northeast winds produced near zero visibility, bringing a large portion of southern Kansas to a standstill.
- **March 10, 1922:** Dodge City received 17.5 inches of snow in 24 hours.
- **1911-1912:** Beginning in late 1911 and continuing through March 1912, frequent bouts of snow and very cold temperatures pounded the Topeka area. Nearly 48 inches of snow fell that winter. The March snowfall alone totaled 26.2 inches. The blizzard of February 25-26 left 10-foot snow drifts, paralyzed Topeka, cut rail traffic for days and killed many cattle.

Table 3.153 lists Kansas snowfall and snow depth extremes from the National Data Climatic Center.

Table 3.153. Kansas Snowfall and Snow Depth Extremes

	Snow Amount (inches)	County	Event Ending Date
Greatest Daily Snowfall	25.0	Cherokee	03/14/1896
Greatest 2-Day Snowfall (Snowed Both Days)	37.0	Johnson	03/24/1912
Greatest 3-Day Snowfall (Snowed All 3 Days)	33.0	Morton	02/26/1903
Greatest 4-Day Snowfall (Snowed All 4 Days)	30.5	Stanton	12/20/1918
Greatest 5-Day Snowfall (Snowed All 5 Days)	29.0	Stanton	11/06/1946
Greatest 6-Day Snowfall (Snowed All 6 Days)	30.0	Rawlins	04/02/1980
Greatest 7-Day Snowfall (Snowed All 7 Days)	35.0	Rawlins	04/02/1980
Greatest Monthly Snowfall Total	55.9	Johnson	03/1912
Greatest Aug-July Snowfall Total	103.6	Rawlins	1984
Greatest Daily Snow Depth	31.0	Jackson	03/16/1960

Source: National Data Climatic Center Snow Climatology, http://www.ncdc.noaa.gov/ussc/USSCAppController?action=extremes&state=14

In addition, the Kansas Department of Transportation (KDOT) incurs statewide annual costs for snow and ice removal. The average cost per year for snow and ice efforts for fiscal years 2008-2011 is $15.9 million for labor, equipment and materials. However, the cost for snow and ice

efforts in fiscal year 2012 was only $6.7 million because it was a mild winter (source: Translines Express, Kansas Department of Transportation, April 11, 2012).

Insured Crop Loss Data

According to the USDA Risk Management Agency, insured crop losses through the State of Kansas as a result of cold wet weather, cold winter, freeze, frost and snow for the ten year period of 2002-2011 totaled $435,132,610. Also 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 3.154** in the State Vulnerability Analysis section.

Table 3.154. Total Insured Crop Insurance Paid by Year, 2002-2011

Year	Crop Insurance Paid
2011	$4,694,069
2010	$4,575,394
2009	$43,867,939
2008	$16,023,887
2007	$243,660,980
2006	$23,315,866
2005	$19,023,220
2004	$55,194,707
2003	$3,475,612
2002	$21,300,937
Total	**$435,132,610**

Source: USDA Risk Management Agency

Probability of Future Hazard Events

According to the National Climatic Data Center Storm Events database, there were 1,065 winter storms (blizzard, cold/wind chill, damaging freeze, extreme cold, sleet, snow and ice events) in Kansas between 1993 and 2012 (20 years). Based on this information, the probability that at least one winter storm will occur in Kansas in any given year is 100 percent. Kansas can expect approximately $11 million in winter storm losses each year based on NCDC data. This hazard's CPRI probability is "**Highly Likely**" within a calendar year.

State Vulnerability Analysis

Winter Storms including snow and ice have caused more damage for Kansans in recent years with eight Presidential Declarations between 2002 and 2010. The majority of Kansas counties and all of the mitigation planning regions have been included in Presidential Declarations. The entire State has been affected by winter storms.

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 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). It was determined that for winter storms historical events and property damages is needed back to 1993 to adequately describe the winter storm hazard in Kansas.

Table 3.155 below provides the factor‘s amount per county that are considered for winter storm vulnerability. The factors are based on available data from a variety of sources for each hazard.

Table 3.155. Vulnerability of Kansas Counties Factor Amounts for Winter Storm

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region A									
Cheyenne	5	56	$502,000	$25,100	$189,307	2.7	$52,458,000	$6,013,675	$601,368
Decatur	5	46	$40,000	$2,000	$232,035	3.3	$49,747,000	$2,383,597	$238,360
Gove	4	36	$380,000	$19,000	$224,662	2.5	$59,084,000	$2,469,015	$246,902
Logan	4	38	$12,605,000	$630,250	$223,349	2.6	$47,558,000	$2,872,150	$287,215
Rawlins	5	51	$40,000	$2,000	$205,462	2.4	$59,406,000	$8,721,950	$872,195
Sheridan	5	49	$13,305,000	$665,250	$200,661	2.9	$95,542,000	$3,149,809	$314,981
Sherman	4	61	$1,096,000	$54,800	$461,185	5.7	$108,370,000	$6,232,442	$623,244
Thomas	4	55	$5,136,000	$256,800	$599,973	7.4	$129,521,000	$5,081,664	$508,166
Wallace	3	37	$355,000	$17,750	$117,421	1.6	$47,203,000	$4,064,730	$406,473
Subtotal		**429**	**$33,459,000**	**$1,672,950**	**$2,454,055**		**$648,889,000**	**$40,989,033**	**$4,098,903**
Mitigation Planning Region B									
Ellis	2	45	$1,371,000	$68,550	$1,735,474	31.6	$27,729,000	$2,075,206	$207,521
Graham	4	37	$681,000	$34,050	$201,852	2.9	$42,105,000	$2,766,292	$276,629
Ness	5	57	$1,371,000	$68,550	$241,794	2.9	$37,636,000	$2,126,329	$212,633
Norton	5	46	$40,000	$2,000	$371,491	6.5	$42,614,000	$1,830,340	$183,034
Phillips	4	69	$4,720,000	$236,000	$439,444	6.4	$41,104,000	$1,296,867	$129,687
Rooks	4	54	$4,685,000	$234,250	$601,846	5.8	$46,688,000	$1,668,819	$166,882
Rush	5	54	$2,571,000	$128,550	$202,357	4.6	$33,863,000	$2,078,316	$207,832
Russell	4	37	$11,923,000	$596,150	$488,994	7.9	$23,659,000	$1,990,060	$199,006
Trego	5	59	$2,571,000	$128,550	$215,776	3.4	$30,057,000	$2,616,123	$261,612
Subtotal		**458**	**$29,933,000**	**$1,496,650**	**$4,499,028**		**$325,455,000**	**$18,448,352**	**$1,844,835**
Mitigation Planning Region C									
Grant	3	56	$2,571,000	$128,550	$469,849	13.6	$63,853,000	$4,049,209	$404,921
Greeley	4	39	$790,000	$39,500	$131,666	1.6	$64,552,000	$12,657,654	$1,265,765
Hamilton	4	51	$2,571,000	$128,550	$187,869	2.7	$51,817,000	$4,485,464	$448,546
Kearny	4	52	$2,571,000	$128,550	$228,723	4.6	$66,321,000	$2,345,299	$234,530

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Lane	4	55	$2,571,000	$128,550	$162,362	2.4	$31,082,000	$2,823,109	$282,311
Morton	4	50	$1,371,000	$68,550	$230,152	4.4	$42,645,000	$2,860,050	$286,005
Scott	2	53	$2,571,000	$128,550	$350,514	6.9	$71,718,000	$5,236,258	$523,626
Stanton	4	59	$2,571,000	$128,550	$151,658	3.3	$76,592,000	$5,731,212	$573,121
Stevens	2	43	$2,571,000	$128,550	$293,762	7.9	$124,066,000	$4,143,141	$414,314
Wichita	5	39	$355,000	$17,750	$175,679	3.1	$0	$8,318,308	$831,831
Subtotal		**497**	**$20,513,000**	**$1,025,650**	**$2,382,234**		**$592,646,000**	**$52,649,703**	**$5,264,970**
Mitigation Planning Region D									
Clark	5	47	$171,000	$8,550	$182,482	2.3	$15,466,000	$551,653	$55,165
Finney	2	60	$1,371,000	$68,550	$2,042,592	28.2	$140,746,000	$3,939,060	$393,906
Ford	2	59	$2,571,000	$128,550	$1,731,663	30.8	$87,004,000	$3,476,309	$347,631
Gray	2	58	$2,571,000	$128,550	$360,141	6.9	$109,340,000	$4,223,284	$422,328
Haskell	3	58	$2,571,000	$128,550	$252,803	7.4	$116,154,000	$4,797,936	$479,794
Hodgeman	3	56	$2,571,000	$128,550	$131,155	2.2	$41,068,000	$1,837,579	$183,758
Meade	4	49	$1,371,000	$68,550	$295,936	4.7	$91,206,000	$795,850	$79,585
Seward	2	44	$2,571,000	$128,550	$1,021,471	35.9	$81,688,000	$1,244,194	$124,419
Subtotal		431	$15,768,000	$788,400	$6,018,243		$682,672,000	$20,865,866	$2,086,587
Mitigation Planning Region E									
Barber	4	46	$170,000	$8,500	$388,136	4.3	$15,969,000	$5,699,988	$569,999
Barton	3	37	$10,998,000	$549,900	$1,772,118	30.9	$65,249,000	$6,498,762	$649,876
Comanche	5	43	$170,000	$8,500	$135,138	2.4	$13,395,000	$946,077	$94,608
Edwards	4	56	$1,371,000	$68,550	$232,382	4.9	$73,732,000	$3,445,591	$344,559
Kiowa	4	58	$1,370,000	$68,500	$237,655	3.5	$34,681,000	$1,486,331	$148,633
Pawnee	5	57	$1,621,000	$81,050	$449,592	9.2	$67,357,000	$3,323,349	$332,335
Pratt	3	48	$2,570,000	$128,500	$689,239	13.1	$62,967,000	$9,132,493	$913,249
Stafford	4	60	$2,570,000	$128,500	$295,331	5.6	$74,613,000	$7,957,675	$795,768
Subtotal		405	$20,840,000	$1,042,000	$4,199,591		$407,963,000	$38,490,268	$3,849,027

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region F									
Clay	3	68	$15,010,000	$750,500	$599,823	13.2	$47,769,000	$3,959,991	$395,999
Cloud	5	67	$14,780,000	$739,000	$691,783	13.3	$55,096,000	$4,593,621	$459,362
Dickinson	4	67	$14,840,000	$742,000	$1,262,865	23.3	$50,121,000	$9,698,846	$969,885
Ellsworth	5	34	$10,860,000	$543,000	$459,624	9.1	$19,376,000	$5,190,164	$519,016
Jewell	5	66	$4,270,000	$213,500	$254,815	3.4	$61,168,000	$2,647,465	$264,746
Lincoln	4	22	$10,860,000	$543,000	$234,746	4.5	$32,667,000	$4,741,149	$474,115
Mitchell	4	48	$3,505,000	$175,250	$510,997	9.1	$61,762,000	$4,575,233	$457,523
Osborne	5	44	$3,925,000	$196,250	$343,004	4.3	$37,801,000	$2,599,580	$259,958
Ottawa	2	93	$18,575,000	$928,750	$418,316	8.5	$35,560,000	$7,957,621	$795,762
Republic	5	71	$14,950,000	$747,500	$417,216	6.9	$79,639,000	$4,645,714	$464,571
Saline	2	34	$11,975,000	$598,750	$3,591,872	77.2	$26,903,000	$11,245,420	$1,124,542
Smith	5	65	$4,680,000	$234,000	$278,296	4.3	$54,022,000	$1,747,246	$174,725
Subtotal		**679**	**$128,230,000**	**$6,411,500**	**$9,063,357**		**$561,884,000**	**$63,602,051**	**$6,360,205**
Mitigation Planning Region G									
Butler	1	33	$18,890,000	$944,500	$3,509,143	46.1	$41,249,000	$3,342,061	$334,206
Cowley	3	24	$19,457,000	$972,850	$2,180,637	32.3	$23,126,000	$5,061,482	$506,148
Harper	4	28	$16,068,000	$803,400	$455,272	7.5	$17,809,000	$22,239,860	$2,223,986
Harvey	2	32	$19,195,000	$959,750	$2,143,090	64.3	$49,189,000	$8,949,588	$894,959
Kingman	3	34	$15,095,000	$754,750	$606,598	9.1	$25,749,000	$13,054,360	$1,305,436
Marion	4	38	$33,335,000	$1,666,750	$762,377	13.4	$43,687,000	$9,844,378	$984,438
McPherson	2	37	$10,155,000	$507,750	$854,909	32.5	$57,227,000	$20,242,010	$2,024,201
Reno	3	47	$54,681,000	$2,734,050	$4,120,706	51.4	$69,497,000	$15,787,022	$1,578,702
Rice	4	33	$8,530,000	$426,500	$668,411	13.9	$53,225,000	$13,314,882	$1,331,488
Sedgwick	1	38	$19,051,000	$952,550	$31,528,899	499.6	$56,918,000	$14,122,543	$1,412,254
Sumner	2	22	$15,192,000	$759,600	$1,574,242	20.4	$50,711,000	$36,191,887	$3,619,189
Subtotal		**366**	**$229,649,000**	**$11,482,450**	**$48,404,284**		**$488,387,000**	**$162,150,072**	**$16,215,007**

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Mitigation Planning Region H									
Allen	3	18	$2,100,000	$105,000	$983,778	26.7	$15,462,000	$1,658,942	$165,894
Bourbon	4	25	$8,745,000	$437,250	$1,102,488	23.9	$9,918,000	$432,574	$43,257
Chautauqua	5	21	$1,933,000	$96,650	$285,438	5.7	$4,971,000	$207,675	$20,768
Cherokee	4	25	$6,195,000	$309,750	$1,293,753	36.8	$53,420,000	$3,028,377	$302,838
Crawford	3	25	$8,755,000	$437,750	$2,588,817	66.4	$34,463,000	$1,498,817	$149,882
Elk	5	24	$1,925,000	$96,250	$187,291	4.5	$0	$283,961	$28,396
Greenwood	5	26	$3,855,000	$192,750	$491,412	5.9	$8,087,000	$328,973	$32,897
Labette	4	14	$275,000	$13,750	$1,453,850	33.5	$22,765,000	$2,170,952	$217,095
Montgomery	4	24	$378,000	$18,900	$2,432,183	55.1	$16,616,000	$1,925,856	$192,586
Neosho	4	23	$2,193,000	$109,650	$1,174,150	28.9	$17,811,000	$1,243,377	$124,338
Wilson	4	22	$2,183,000	$109,150	$671,059	16.5	$26,882,000	$2,203,182	$220,318
Woodson	5	18	$1,925,000	$96,250	$207,905	6.6	$14,486,000	$641,703	$64,170
Subtotal		**265**	**$40,462,000**	**$2,023,100**	**$12,872,124**		**$224,881,000**	**$15,624,390**	**$1,562,439**
Mitigation Planning Region I									
Chase	3	23	$16,965,000	$848,250	$183,326	3.6	$6,222,000	$389,958	$38,996
Geary	2	77	$18,198,000	$909,900	$1,453,512	89.3	$11,039,000	$780,925	$78,092
Lyon	3	72	$18,210,000	$910,500	$2,366,508	39.8	$24,554,000	$1,463,506	$146,351
Morris	3	63	$18,190,000	$909,500	$421,954	8.5	$21,783,000	$1,523,454	$152,345
Pottawatomie	1	71	$18,425,000	$921,250	$1,157,180	25.7	$30,455,000	$563,450	$56,345
Riley	2	70	$18,575,000	$928,750	$3,814,017	116.6	$23,622,000	$714,399	$71,440
Wabaunsee	2	72	$18,225,000	$911,250	$439,179	8.9	$17,358,000	$330,613	$33,061
Subtotal		**448**	**$126,788,000**	**$6,339,400**	**$9,835,676**		**$135,033,000**	**$5,766,305**	**$576,631**
Mitigation Planning Region J									
Anderson	3	46	$18,082,000	$904,100	$518,401	14	$33,029,000	$1,708,726	$170,873
Coffey	3	61	$18,043,000	$902,150	$670,953	13.7	$25,497,000	$1,460,308	$146,031
Franklin	2	56	$18,048,000	$902,400	$1,598,004	45.5	$32,349,000	$972,452	$97,245
Linn	2	20	$9,771,000	$488,550	$659,126	16.3	$13,053,000	$690,019	$69,002
Miami	1	32	$9,520,000	$476,000	$2,106,266	57	$27,726,000	$484,797	$48,480

County	SoVI Rating (1-5)	Prior Events 1993-2012	Property Damages	Annualized Property Damage	Total Building Exposure ($000)	Population Density	Crop Exposure	Crop Loss Insurance Paid	Annualized Crop Loss Insurance Paid
Osage	2	73	$18,248,000	$912,400	$977,110	23.1	$27,618,000	$849,551	$84,955
Shawnee	2	78	$18,377,000	$918,850	$11,828,241	327.1	$32,959,000	$192,209	$19,221
Subtotal		366	$110,089,000	$5,504,450	$18,358,101		$192,231,000	$6,358,062	$635,806
Mitigation Planning Region K									
Atchison	3	36	$560,000	$28,000	$1,333,363	39.3	$42,536,000	$306,509	$30,651
Brown	5	66	$6,220,000	$311,000	$713,225	17.5	$86,532,000	$379,982	$37,998
Doniphan	3	30	$550,000	$27,500	$557,109	20.2	$67,800,000	$14,305	$1,431
Douglas	1	73	$18,235,000	$911,750	$6,614,269	243.1	$27,973,000	$436,844	$43,684
Jackson	3	65	$18,200,000	$910,000	$788,323	20.5	$21,169,000	$274,993	$27,499
Jefferson	1	64	$18,190,000	$909,500	$1,130,852	35.9	$33,429,000	$312,963	$31,296
Marshall	4	79	$19,930,000	$996,500	$2,054,603	11.2	$81,815,000	$2,955,616	$295,562
Nemaha	4	75	$14,975,000	$748,750	$711,896	14.2	$67,091,000	$1,395,463	$139,546
Washington	4	74	$16,208,000	$810,400	$396,656	6.5	$65,762,000	$3,737,803	$373,780
Subtotal		**562**	**$113,068,000**	**$5,653,400**	**$14,300,296**		**$494,107,000**	**$9,814,478**	**$981,448**
Mitigation Planning Region L									
Johnson	1	40	$10,010,000	$500,500	$43,871,468	1,149.60	$29,472,000	$197,938	$19,794
Leavenworth	1	35	$9,770,000	$488,500	$4,877,783	164.7	$20,983,000	$162,813	$16,281
Wyandotte	3	32	$9,760,000	$488,000	$12,066,666	1,039.00	$0	$0	$0
Subtotal		**107**	**$29,540,000**	**$1,477,000**	**$60,815,917**		**$50,455,000**	**$360,751**	**$36,075**
Statewide Total		**5,013**	**$898,339,000**	**$44,916,950**	**$193,202,906**		**$4,804,603,000**	**$435,119,330**	**$43,511,933**

Note: The Census of Agriculture did not publish crop exposure in Elk, Wichita and Wyandotte Counties to avoid disclosure of individual operations.

Table 3.156 provides the 1 – 10 ranges for the winter storm vulnerability factor ratings. These factor ranges are calculated based on that range of data not comparing the range to another factor‘s ratings range. The Social Vulnerability Index is in a range of 1- 5. To give Social Vulnerability Index the same weight as the other factors, the numbers were multiplied by two.

Table 3.156. Ranges for Winter Storm Vulnerability Factor Ratings

Ratings	Social Vulnerability	Prior Events	Annualized Property Damage	Building Exposure Valuation	Population Density *	Crop Exposure	Annualized Crop Loss Insurance Paid
1		14 - 21	$2,000 - $50,000	$117,421 - $4,492,825	1.6 - 116.3	0 - $18,548,500	0 - $200,000
2	1	21 - 29	$50,001 - $100,000	$4,492,826 - $8,868,229	116.4 - 231.1	$18,548,501 - $32,126,000	$200,001 - $400,000
3		30 - 36	$100,001 - $300,000	$8,868,230 - $13,243,634	231.2 - 345.9	$32,126,001 - $45,703,500	$400,000 - $600,000
4	2	37 - 44	$300,001 - $500,000	$13,243,635 - $17,619,039	346 - 460.7	$45,703,501 - $59,281,000	$600,001 - $800,000
5		45 - 52	$500,001 - $700,000	$17,619,040 - $21,994,444	460.8 - 575.5	$59,281,001 - $72,858,500	$800,001 - $1,000,000
6	3	53 - 60	$700,001 - $900,000	$21,994,445 - $26,369,848	575.6 - 690.3	$72,858,501 - $86,436,000	$1,100,001 - $1,300,000
7		61 - 69	$900,001 - $1,100,000	$26,369,849 - $30,745,253	690.4 - 805.1	$86,436,001 - $100,013,500	$1,300,001 - $1,500,000
8	4	70 - 77	$1,100,001 - $1,700,000	$30,745,254 - $35,120,658	805.2 - 919.9	$100,031,501 - $113,591,000	$1,500,001 - $1,700,000
9		78 - 85	$1,700,001 - $2,200,000	$35,120,659 - $39,496,062	920- 1,034.7	$113,591,001 - $127,168,500	$1,700,001 - $2,700,000
10	5	86 - 93	$2,200,001 - $2,800,000	$39,496,063 - $43,871,468	1,034.8 - 1,149.6	$127,168,501 - $140,746,000	$2,700,001 - $3,700,000

* Population density is the number of people per square mile.
Note: The assigned 1-10 range would be based on the range of dollar losses, not comparing the range of losses to another factor‘s range

Table 3.157 provides the calculated ranges applied to determine the Low, Medium-Low, Medium, Medium-High and High vulnerable counties and **Table 3.158** provides the rating values determined for each factor that was considered in determining overall vulnerability to winter storm. **Figure 3.132** that follows provides the mapped results of this analysis by county.

Table 3.157. Ranges for Overall Winter Storm Vulnerability

Ranges	Low	Medium-Low	Medium	Medium-High	High
	13 - 17	18 - 22	23 - 27	28 - 32	33 - 37

Table 3.158. Vulnerability of Kansas Counties to Winter Storm

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Winter Storm Vulnerability
Mitigation Planning Region A									
Cheyenne	10	6	1	1	1	4	4	27	Medium
Decatur	10	5	1	1	1	4	2	24	Medium
Gove	8	3	1	1	1	4	2	20	Medium-Low
Logan	8	4	5	1	1	4	2	25	Medium
Rawlins	10	5	1	1	1	5	5	28	Medium-High
Sheridan	10	5	5	1	1	7	2	31	Medium-High
Sherman	8	7	2	1	1	8	4	31	Medium-High
Thomas	8	6	3	1	1	10	3	32	Medium-High
Wallace	6	4	1	1	1	4	3	20	Medium-Low
Mitigation Planning Region B									
Ellis	4	5	2	1	1	2	2	17	Low
Graham	8	4	1	1	1	3	2	20	Medium-Low
Ness	10	6	2	1	1	3	2	25	Medium
Norton	10	5	1	1	1	3	1	22	Medium-Low
Phillips	8	7	3	1	1	3	1	24	Medium
Rooks	8	6	3	1	1	4	1	24	Medium
Rush	10	6	3	1	1	3	2	26	Medium
Russell	8	4	5	1	1	2	1	22	Medium-Low
Trego	10	6	3	1	1	2	2	25	Medium
Mitigation Planning Region C									
Grant	6	6	3	1	1	5	3	25	Medium
Greeley	8	4	1	1	1	5	6	26	Medium
Hamilton	8	5	3	1	1	4	3	25	Medium
Kearny	8	5	3	1	1	5	2	25	Medium
Lane	8	6	3	1	1	2	2	23	Medium
Morton	8	5	2	1	1	3	2	22	Medium-Low
Scott	4	6	3	1	1	5	3	23	Medium
Stanton	8	6	3	1	1	6	3	28	Medium-High
Stevens	4	4	3	1	1	9	3	25	Medium
Wichita	10	4	1	1	1		5	22	Medium-Low
Mitigation Planning Region D									
Clark	10	5	1	1	1	1	1	20	Medium-Low
Finney	4	6	2	1	1	10	2	26	Medium
Ford	4	6	3	1	1	7	2	24	Medium
Gray	4	6	3	1	1	8	3	26	Medium
Haskell	6	6	3	1	1	9	3	29	Medium-High
Hodgeman	6	6	3	1	1	3	1	21	Medium-Low
Meade	8	5	2	1	1	7	1	25	Medium

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Winter Storm Vulnerability
Seward	4	4	3	1	1	6	1	20	Medium-Low
Mitigation Planning Region E									
Barber	8	5	1	1	1	1	3	20	Medium-Low
Barton	6	4	5	1	1	5	4	26	Medium
Comanche	10	4	1	1	1	1	1	19	Medium-Low
Edwards	8	6	2	1	1	6	2	26	Medium
Kiowa	8	6	2	1	1	3	1	22	Medium-Low
Pawnee	10	6	2	1	1	5	2	27	Medium
Pratt	6	5	3	1	1	5	5	26	Medium
Stafford	8	6	3	1	1	6	4	29	Medium-High
Mitigation Planning Region F									
Clay	6	7	6	1	1	4	2	27	Medium
Cloud	10	7	6	1	1	4	3	32	Medium-High
Dickinson	8	7	6	1	1	4	5	32	Medium-High
Ellsworth	10	3	5	1	1	2	3	25	Medium
Jewell	10	7	3	1	1	5	2	29	Medium-High
Lincoln	8	2	5	1	1	3	3	23	Medium
Mitchell	8	5	3	1	1	5	3	26	Medium
Osborne	10	4	3	1	1	3	2	24	Medium
Ottawa	4	10	7	1	1	3	4	30	Medium-High
Republic	10	8	6	1	1	6	3	35	High
Saline	4	3	5	1	1	2	6	22	Medium-Low
Smith	10	7	3	1	1	4	1	27	Medium
Mitigation Planning Region G									
Butler	2	3	7	1	1	3	2	19	Medium-Low
Cowley	6	2	7	1	1	2	3	22	Medium-Low
Harper	8	2	6	1	1	1	9	28	Medium-High
Harvey	4	3	7	1	1	4	5	25	Medium
Kingman	6	3	6	1	1	2	7	26	Medium
Marion	8	4	8	1	1	3	5	30	Medium-High
McPherson	4	4	5	1	1	4	9	28	Medium-High
Reno	6	5	10	1	1	5	8	36	High
Rice	8	3	4	1	1	4	7	28	Medium-High
Sedgwick	2	4	7	8	5	4	7	37	High
Sumner	4	2	6	1	1	4	10	28	Medium-High
Mitigation Planning Region H									
Allen	6	1	3	1	1	1	1	14	Low
Bourbon	8	2	4	1	1	1	1	18	Medium-Low
Chautauqua	10	1	2	1	1	1	1	17	Low
Cherokee	8	2	4	1	1	4	2	22	Medium-Low

County	SoVI Converted Rating	Prior Event Rating	Annualized Property Damage Rating	Bldg Exposure Valuation Rating	Population Density Rating	Crop Exposure Rating	Annualized Crop Insurance Rating	Overall Vulnerability Rating	Winter Storm Vulnerability
Crawford	6	2	4	1	1	3	1	18	Medium-Low
Elk	10	2	2	1	1		1	17	Low
Greenwood	10	2	3	1	1	1	1	19	Medium-Low
Labette	8	1	1	1	1	2	2	16	Low
Montgomery	8	2	1	1	1	1	1	15	Low
Neosho	8	2	3	1	1	1	1	17	Low
Wilson	8	2	3	1	1	2	2	19	Medium-Low
Woodson	10	1	2	1	1	1	1	17	Low
Mitigation Planning Region I									
Chase	6	2	6	1	1	1	1	18	Medium-Low
Geary	4	8	7	1	1	1	1	23	Medium
Lyon	6	8	7	1	1	2	1	26	Medium
Morris	6	7	7	1	1	2	1	25	Medium
Pottawatomie	2	8	7	1	1	2	1	22	Medium-Low
Riley	4	8	7	1	2	2	1	25	Medium
Wabaunsee	4	8	7	1	1	1	1	23	Medium
Mitigation Planning Region J									
Anderson	6	5	7	1	1	3	1	24	Medium
Coffey	6	7	7	1	1	2	1	25	Medium
Franklin	4	6	7	1	1	3	1	23	Medium
Linn	4	1	4	1	1	1	1	13	Low
Miami	2	3	4	1	1	2	1	14	Low
Osage	4	8	7	1	1	2	1	24	Medium
Shawnee	4	9	7	3	3	3	1	30	Medium-High
Mitigation Planning Region K									
Atchison	6	3	1	1	1	3	1	16	Low
Brown	10	7	4	1	1	7	1	31	Medium-High
Doniphan	6	3	1	1	1	5	1	18	Medium-Low
Douglas	2	8	7	2	3	2	1	25	Medium
Jackson	6	7	7	1	1	2	1	25	Medium
Jefferson	2	7	7	1	1	3	1	22	Medium-Low
Marshall	8	9	7	1	1	6	2	34	High
Nemaha	8	8	6	1	1	5	1	30	Medium-High
Washington	8	8	6	1	1	5	2	31	Medium-High
Mitigation Planning Region L									
Johnson	2	4	5	10	10	2	1	34	High
Leavenworth	2	3	4	2	2	2	1	16	Low
Wyandotte	6	3	4	3	10	0	1	27	Medium

Figure 3.132. Vulnerability Summary for Winter Storm

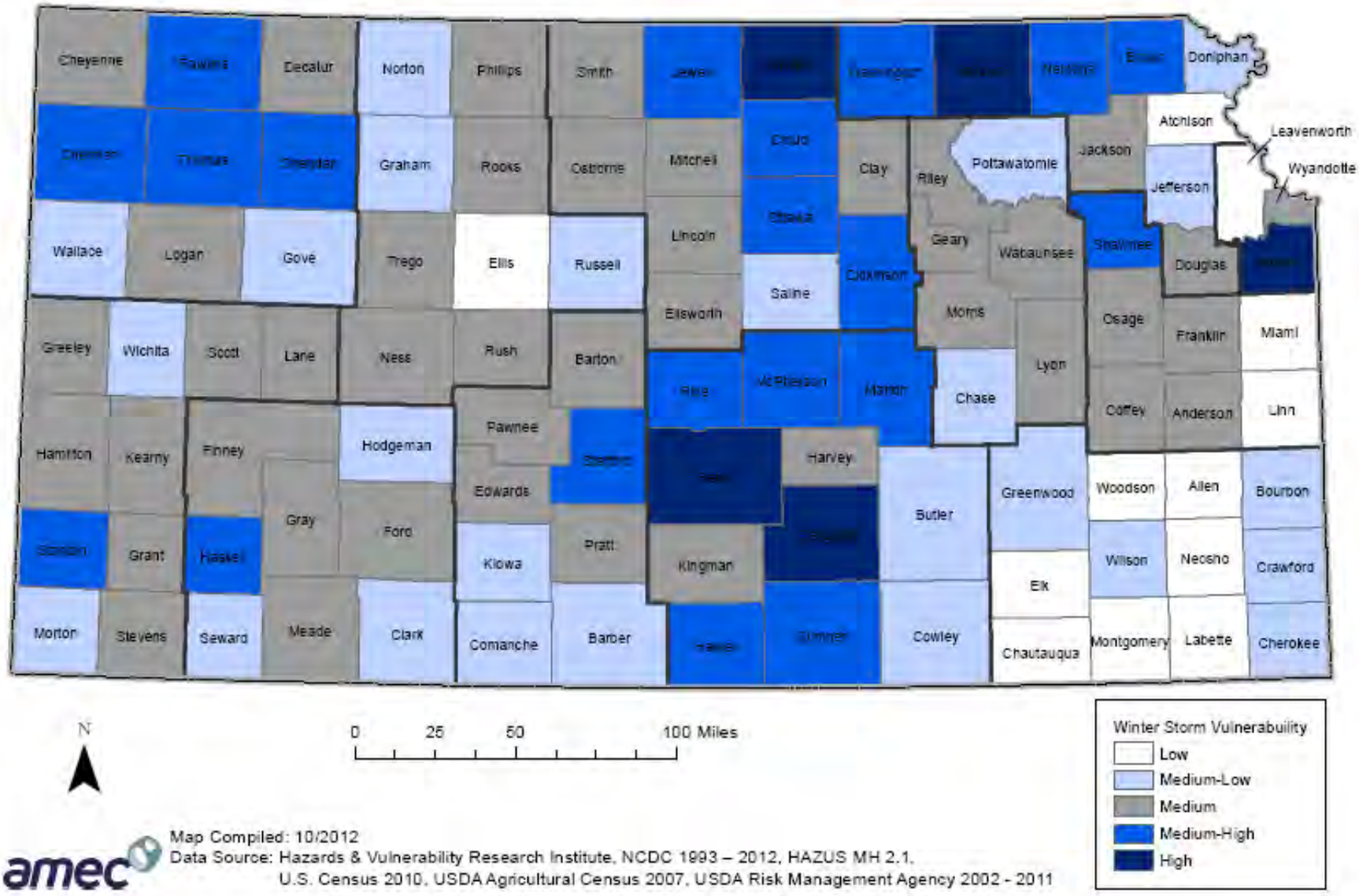


Table 3.159 below lists the top vulnerable counties in Kansas relative to each other concerning winter storm events.

Table 3.159. Top Counties: Vulnerable to Winter Storm

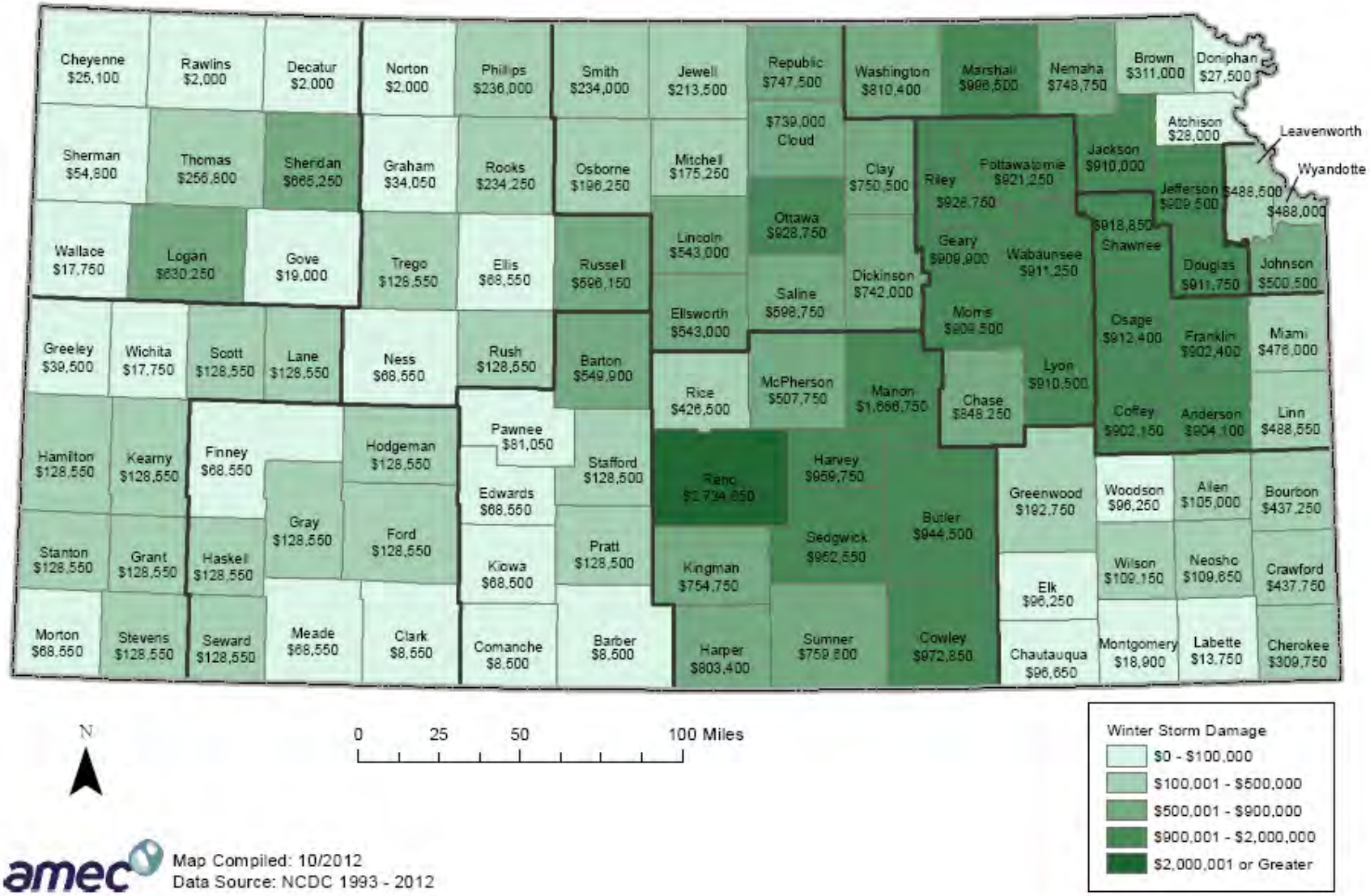
Mitigation Planning Region	County	Overall Vulnerability Rating	Winter Storm Vulnerability
G	Sedgwick	37	High
G	Reno	36	High
F	Republic	35	High
K	Marshall	34	High
L	Johnson	34	High
A	Thomas	32	Medium-High
F	Cloud	32	Medium-High
F	Dickinson	32	Medium-High
A	Sheridan	31	Medium-High
A	Sherman	31	Medium-High
K	Brown	31	Medium-High
K	Washington	31	Medium-High

State Estimates of Potential Losses

To determine potential financial loss estimates to winter storms in Kansas, the available historical loss data was annualized to determine future potential losses. As discussed above in the vulnerability overview for winter storm, the planning team obtained loss data for the National Climatic Data Center (NCDC) storm events (1993 – 2012). According to this data, the annualized property loss for the State of Kansas from winter storms is $44,916,950 as can be viewed in **Table 3.155** (vulnerability overview section). Most of the property damages that occur as a result of winter storms are a result of loss of power. For additional information regarding vulnerability to utility failure, see **Section 0**, Utility/Infrastructure Failure.

Figure 3.133 provided the annualized property loss damages per county. Reno County has the highest annualized damage mainly because of an ice storm event in December 2007 that caused approximately $37.5 million in damages to their electrical infrastructure. Otherwise, the pattern of loss is in south central and north eastern counties of Kansas.

Figure 3.133. Annualized Property Loss from Winter Storm, by County, 1993 - 2012



Development in Hazard Prone Areas

In recent years, except the winter of 2011-2012, the weather patterns have created significant snow accumulations and ice storms throughout the State. Also future development could potentially increase vulnerability to this hazard by increasing the demand on the utilities and increasing the exposure of aging infrastructure networks.

Consequence Analysis

People and crops are adversely affected by winter storms especially when accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, severe drifting and dangerous wind chill. Strong winds with these intense storms and cold fronts can knock down trees, utility poles and power lines. Observations from the National Oceanic and Atmospheric Administration (NOAA) http://www.nws.noaa.gov/om/brochures/wntrstm.htm indicate the following:

Winter deaths related to snow:

- About 70 percent occur in automobiles, and
- About 25 percent are people caught out in the storms.

Winter Deaths related to exposure to cold:

- 50 percent are people over 60 years old,
- Over 75 percent are males, and
- About 20 percent occur in the house.

The information in **Table 3.160** provides the Consequence Analysis of Potential for Detrimental Impacts of Hazards done for accreditation with the Emergency Management Accreditation Program (EMAP).

Table 3.160. EMAP Consequence Analysis: Winter Storm

Subject	Ranking	Impacts/Winter Storm
Health and Safety of Persons in the Area of the Incident	Severe	Impact of the immediate area could be severe for affected areas and moderate to light for other less affected areas.
Responders	Minimal	Impact to responders could be severe for unprotected personnel and moderate to light for prepared personnel.
Continuity of Operations	Minimal	Minimal expectation of execution of the COOP.
Property, Facilities, and Infrastructure	Minimal to Severe	Localized impact to facilities and infrastructure in the incident area. Utility lines most affected. (minimal to severe).
Delivery of Services	Minimal to Severe	Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained. (Minimal to severe)
Environment	Severe	Greatest impact will be to trees, bushes, foliage, crops, and wildlife, which could be severe.
Economic Conditions	Minimal to Severe	Impacts to the economy will greatly depend on the severity of the winter storm, longevity of the storm, and any damages sustained such as utilities and roads. (Minimal to severe).
Public Confidence in Jurisdiction‘s Governance	Minimal to Severe	Response and recovery will be in question if not timely and effective. Utility failure could be called in to question if outages are persistent. (minimal to severe).

3.4. Integration of Local Plans: Vulnerability and Loss Estimates

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.

3.4.1. Overview and Analysis of Local Plan Vulnerability Assessments

As of May 2013, 104 county-level mitigation plans in Kansas had been approved by the Federal Emergency Management Agency. This gave the HMPC the opportunity to review the local risk assessments to help the State better understand its vulnerability in terms of the jurisdictions most threatened by hazards. Copies of the majority of the local hazard mitigation plans in Kansas are available on local emergency management websites for review by the public and others.

In its analysis, the HMPC was interested in how the local governments ranked the hazards in their jurisdictions in terms of planning significance and the potential losses (i.e., people, buildings, and dollar values) associated with the hazards of greatest concern (most local plans only considered natural hazards). This ranking factor is based on a combination of probability, severity, and extent of the hazard and was determined to be the best measure of overall risk in the plans. This ranking was either numeric or described in terms of high, moderate, or low. In cases where this information was not available, rankings were determined from other factors such as risk priority, severity and previous losses. Most local plans ranked only natural hazards, only a limited number rated human caused hazards.

To properly analyze and summarize the data, a common scale was required. During the review of the local plan risk assessments, all rankings of adverse impact were converted to a High, Moderate, Low scale. In about half of the plans, the original ranking was done using the CPRI methodology which is also utilized by the Kansas State Mitigation Plan. Based on their CPRI scores, the hazards were separated into three categories of planning significance: High (3.0-4.0), Moderate (2.0-2.95), and Low (1.1-1.95). These 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. However, in the other half of the plans other scales were employed and documented during the process and it was necessary to convert them to the same high, moderate, low rankings. All information was summarized to the county level. Based on the analysis of all approved local plans, **Figure 3.134**, **Figure 3.135**, and

Figure 3.136 indicate the hazard rankings (High, Moderate, and Low) for each county for nine commonly rated natural hazards in local plans.

Figure 3.134. Local Plan Risk Summary for Dam & Levee Failure, Utility/Infrastructure Failure, and Winter Storm

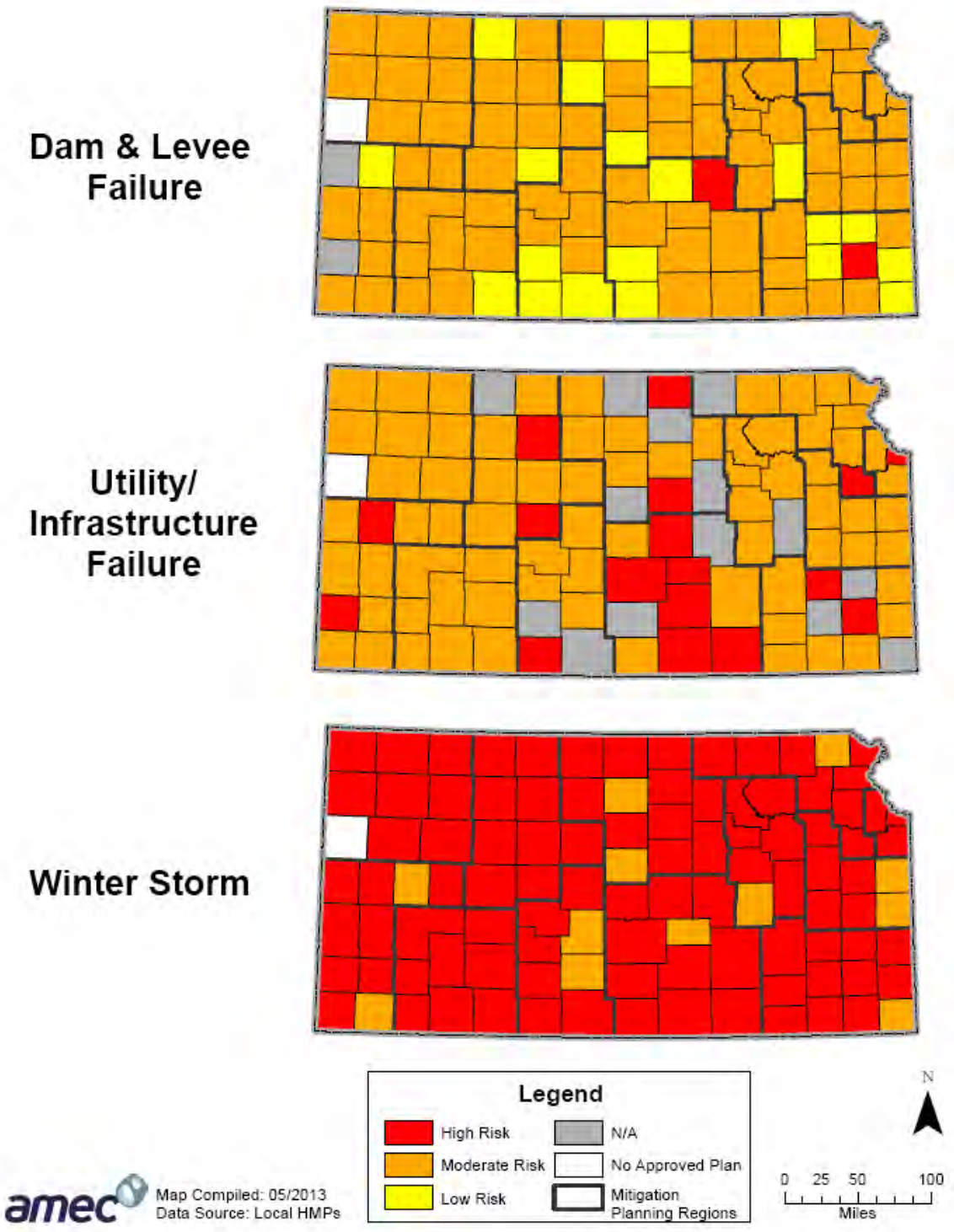


Figure 3.135. Local Plan Risk Summary for Drought, Hailstorm, and Wildfire

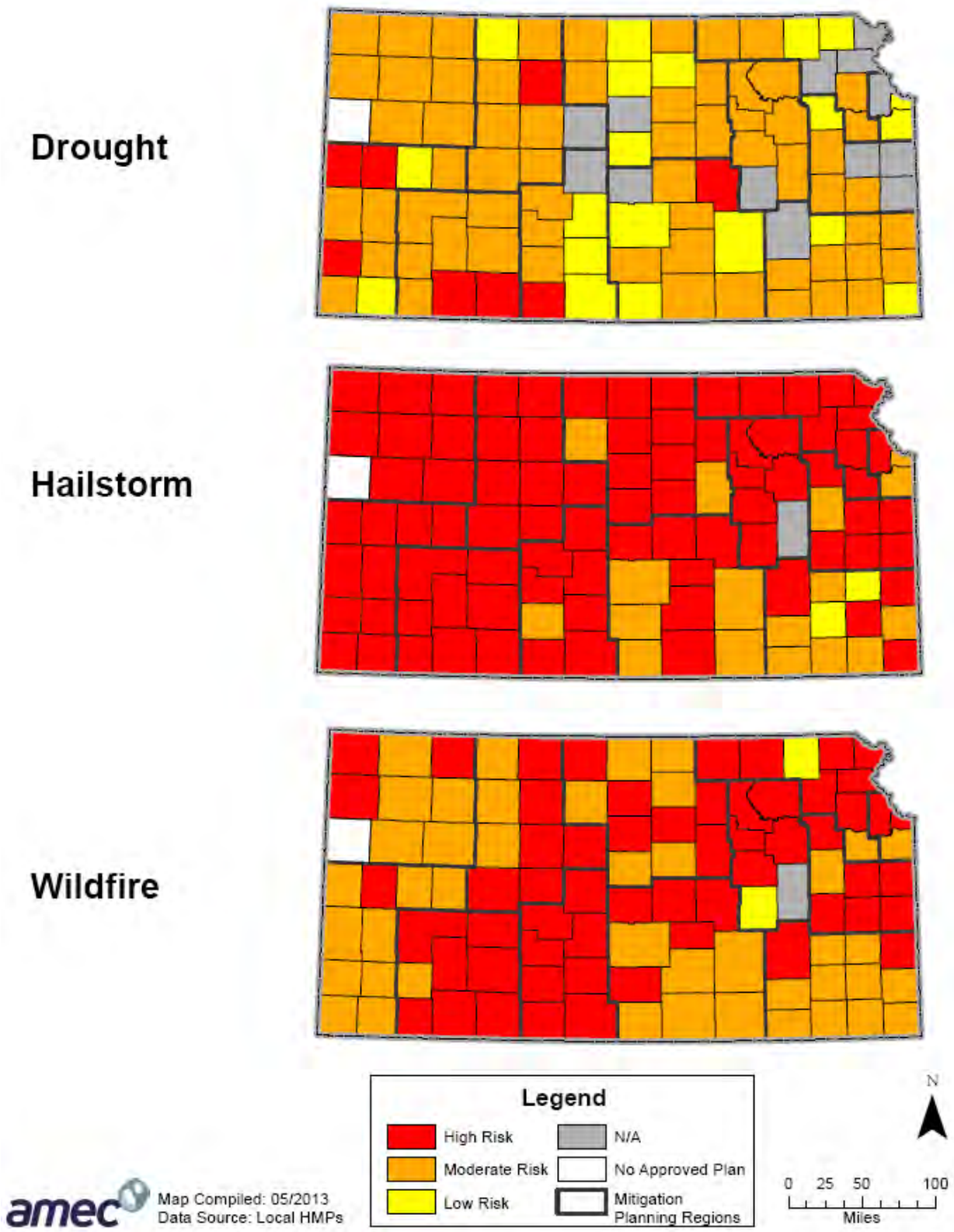
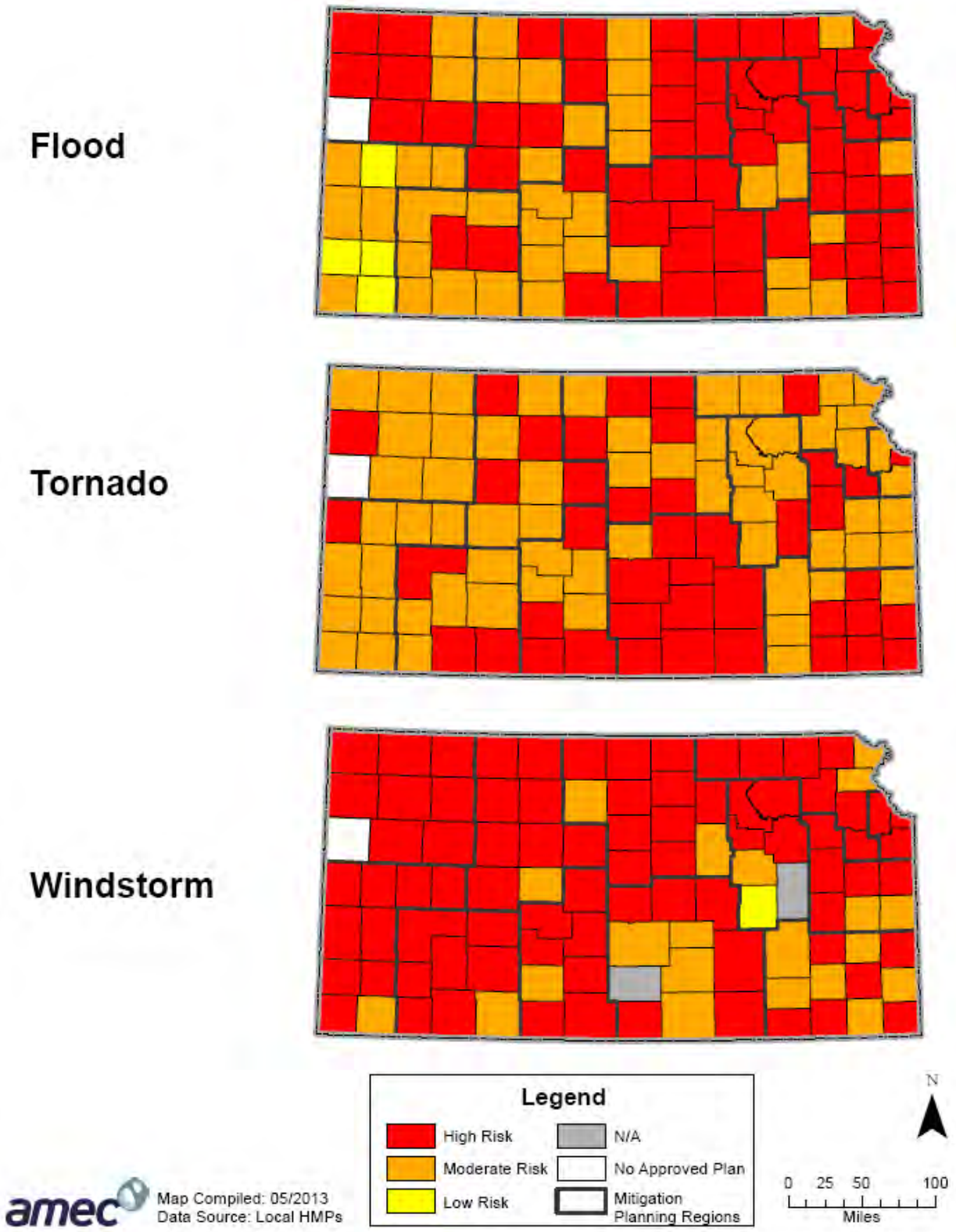


Figure 3.136. Local Plan Risk Summary for Flood, Tornado, and Windstorm



The local risk assessment summary allowed for an analysis of which hazards are of high concern to particular counties. **Table 3.161** lists the 11 most commonly rated hazards and the number of counties that ranked them at each of the scale levels: High, Moderate, and Low. The data suggests that the top ranked hazards statewide in order are Winter Storm, Hailstorm, Wind Storm, Flooding, Wildfire and Tornado. Although not in exactly the same order, the top 5 hazards from the Kansas State Mitigation Plan are mirrored in the local plans.

Table 3.161. Local Risk Assessment Hazards Ranking Summary

Hazard	High	Moderate	Low	Not Rated
Dam and Levee Failure	2	78	22	2
Drought	8	63	20	13
Earthquake	0	3	89	12
Extreme Temperatures	7	51	13	33
Flood	62	38	4	0
Hailstorm	85	17	2	1
Tornado	42	62	0	0
Utility Infrastructure Failure	17	73	0	14
Wildfire	58	44	2	0
Windstorm	80	21	1	2
Winter Storm	92	12	0	0

Source: Kansas Local Hazard Mitigation Plans, May 2013

Table 3.162 shows the rankings each county assigned these hazards. At the time of this analysis, only Wallace County did not have an approved plan. For those hazards indicating n/a, that hazard was not separately profiled in the local plan.

Table 3.162. Priority Risk Hazard Rankings by County in the Mitigation Planning Regions

County	Dam /Levee Failure	Drought	Earthquake	Extreme Temps	Flood	Hail Storm	Tornado	Utility Failure	Wildfire	Windstorm	Winter Storm
Mitigation Planning Region A											
Cheyenne	M	M	L	n/a	H	H	M	M	H	H	H
Decatur	M	M	L	n/a	M	H	M	M	H	H	H
Gove	M	M	L	n/a	H	H	M	M	M	H	H
Logan	M	M	L	n/a	H	H	M	M	M	H	H
Rawlins	M	M	L	n/a	H	H	M	M	M	H	H
Sheridan	M	M	L	n/a	M	H	M	M	M	H	H
Sherman	M	M	L	n/a	H	H	H	M	H	H	H
Thomas	M	M	L	n/a	H	H	M	M	M	H	H
Mitigation Planning Region B											
Ellis	M	M	L	n/a	H	H	M	M	H	H	H
Graham	M	M	L	n/a	M	H	M	M	M	H	H
Ness	M	M	L	n/a	H	H	M	M	H	H	H
Norton	L	L	L	L	M	H	H	n/a	M	H	H
Phillips	M	M	L	n/a	H	H	M	M	H	H	H
Rooks	M	H	M	M	M	H	H	H	H	H	H
Rush	L	M	n/a	L	M	H	M	H	H	M	H
Russell	M	n/a	L	L	M	H	H	M	H	H	H
Trego	M	M	L	n/a	H	H	H	M	M	H	H
Mitigation Planning Region C											
Grant	M	M	L	n/a	L	H	M	M	M	H	H
Greeley	n/a	H	L	M	M	H	H	M	M	H	H
Hamilton	M	M	L	n/a	M	H	M	M	M	H	H
Kearny	M	M	L	n/a	M	H	M	M	M	H	H
Lane	M	M	L	n/a	M	H	M	M	M	H	H

County	Dam /Levee Failure	Drought	Earthquake	Extreme Temps	Flood	Hail Storm	Tornado	Utility Failure	Wildfire	Windstorm	Winter Storm
Morton	M	M	L	n/a	M	H	M	M	M	H	H
Scott	M	L	L	n/a	M	H	M	M	M	H	M
Stanton	n/a	H	n/a	M	L	H	M	H	M	H	H
Stevens	M	L	L	n/a	L	H	M	M	M	M	M
Wichita	L	H	n/a	M	L	H	M	H	H	H	H
Mitigation Planning Region D											
Clark	L	H	L	H	M	H	H	M	H	M	H
Finney	M	M	L	n/a	M	H	H	M	H	H	H
Ford	M	M	L	M	H	H	M	M	H	H	H
Gray	M	M	L	n/a	H	H	M	M	H	H	H
Haskell	M	M	L	n/a	M	H	M	M	M	H	H
Hodgeman	M	M	L	n/a	M	H	M	M	H	H	H
Meade	M	H	L	H	M	H	H	M	H	H	H
Seward	M	M	L	n/a	M	H	M	M	H	H	H
Mitigation Planning Region E											
Barber	L	L	L	L	H	H	H	n/a	H	H	H
Barton	M	n/a	L	M	H	H	H	M	H	H	H
Comanche	L	H	L	M	M	H	H	H	H	H	H
Edwards	M	M	L	n/a	M	H	M	M	H	H	H
Kiowa	L	M	L	M	M	M	H	n/a	H	M	H
Pawnee	M	M	n/a	n/a	M	H	M	M	H	H	H
Pratt	M	L	L	n/a	M	H	M	M	H	H	M
Stafford	M	L	L	n/a	M	H	M	M	H	H	M
Mitigation Planning Region F											
Clay	M	M	L	M	H	H	M	M	H	H	H
Cloud	L	L	L	L	H	H	H	n/a	M	H	H

County	Dam /Levee Failure	Drought	Earthquake	Extreme Temps	Flood	Hail Storm	Tornado	Utility Failure	Wildfire	Windstorm	Winter Storm
Dickinson	M	M	L	M	H	M	M	n/a	H	M	H
Ellsworth	L	L	L	L	M	H	H	n/a	M	H	M
Jewell	L	L	L	L	M	H	H	n/a	M	H	H
Lincoln	M		L	L	M	H	M	M	H	H	H
Mitchell	M	L	L	n/a	M	H	M	M	H	H	M
Osborne	L	M	n/a	M	H	M	H	M	M	M	H
Ottawa	M	M	L	M	H	H	M	M	H	H	H
Republic	L	M	L	M	H	H	H	H	M	H	H
Saline	M	M	L	M	H	H	H	H	M	H	H
Smith	M	M	L	n/a	H	H	M	M	H	H	H
Mitigation Planning Region G											
Butler	M	L	L	M	H	M	H	M	M	H	H
Cowley	M	M	L	H	H	M	H	H	M	H	H
Harper	L	L	L	M	H	M	H	M	M	H	H
Harvey	M	M	n/a	M	H	H	H	H	H	M	M
Kingman	L	M	L	M	M	M	H	n/a	H	n/a	H
Marion	H	H	n/a	H	H	H	H	n/a	H	H	H
McPherson	L	M	L	M	H	H	H	H	H	H	H
Reno	M	L	L	M	H	M	H	H	M	M	H
Rice	M	n/a	L	L	H	H	M	M	H	H	H
Sedgwick	M	M	L	M	H	H	H	H	M	M	H
Sumner	M	M	n/a	M	H	H	H	H	M	M	H
Mitigation Planning Region H											
Allen	L	M	L	L	H	L	H	n/a	M	M	H
Bourbon	M	M	n/a	M	H	H	M	M	H	H	H
Chautauqua	M	M	n/a	L	M	M	M	M	M	H	H
Cherokee	L	L	L	M	H	H	H	n/a	M	H	M

County	Dam /Levee Failure	Drought	Earthquake	Extreme Temps	Flood	Hail Storm	Tornado	Utility Failure	Wildfire	Windstorm	Winter Storm
Crawford	L	M	L	M	H	M	H	M	M	M	H
Elk	M	M	L	L	M	M	M	M	M	M	H
Greenwood	M	n/a	L	n/a	H	H	M	M	H	M	H
Labette	M	M	L	M	H	M	H	M	M	M	H
Montgomery	M	M	L	M	M	M	H	M	M	H	H
Neosho	H	M	L	M	H	H	H	H	M	H	H
Wilson	L	M	L	M	H	L	H	n/a	M	M	H
Woodson	L	L	n/a	M	M	M	M	H	M	H	H
Mitigation Planning Region I											
Chase	M	n/a	L	L	M	H	M	M	L	L	M
Geary	M	M	L	M	H	H	M	M	H	H	H
Lyon	L	M	n/a	M	M	n/a	H	n/a	n/a	n/a	H
Morris	M	M	L	M	H	H	M	M	H	M	H
Pottawatomie	M	M	L	M	H	H	M	M	H	H	H
Riley	M	M	L	M	H	H	M	M	H	H	H
Wabaunsee	M	M	L	M	H	H	M	M	H	H	H
Mitigation Planning Region J											
Anderson	M	M	L	M	H	H	M	M	H	M	H
Coffey	M	M	L	M	H	H	M	M	H	H	H
Franklin	M	n/a	L	H	H	H	M	M	H	H	H
Linn	M	n/a	L	M	H	H	M	M	H	M	M
Miami	M	n/a	L	M	M	H	M	M	H	H	M
Osage	M	M	L	M	H	M	H	M	M	H	H
Shawnee	M	L	L	M	H	H	H	M	H	H	H
Mitigation Planning Region K											
Atchison	M	n/a	L	M	H	H	M	M	H	M	H

County	Dam /Levee Failure	Drought	Earthquake	Extreme Temps	Flood	Hail Storm	Tornado	Utility Failure	Wildfire	Windstorm	Winter Storm
Brown	M	L	L	n/a	M	H	M	M	H	H	M
Doniphan	M	n/a	L	M	H	H	M	M	H	M	H
Douglas	M	M	L	H	H	H	H	H	M	H	H
Jackson	M	n/a	L	M	H	H	M	M	H	H	H
Jefferson	M	M	L	M	H	H	M	M	H	H	H
Marshall	M	M	L	M	H	H	M	M	H	H	H
Nemaha	L	L	L	M	H	H	H	M	L	H	H
Washington	M	M	L	M	H	H	M	n/a	H	H	H
Mitigation Planning Region L											
Johnson	M	L	M	M	H	M	M	M	M	H	H
Leavenworth	M	n/a	L	M	H	H	M	M	H	H	H
Wyandotte	M	L	M	H	H	M	H	H	H	H	H

Source: Kansas Local Hazard Mitigation Plans, May 2013. Wallace is the only county with no approved plan at the time of this analysis was developed. H=High, M=Moderate, L=Low Ranking Hazards, n/a=not available as it was not profiled in that local plan.

Table 3.163 below shows the 22 hazards in the 2013 Kansas Hazard Mitigation Plan and the percentage of local plans that ranked the hazard. All local hazard mitigation plans included the hazards of flood, tornado, wildfire, and winter storms.

Table 3.163. Percent of Local Plans Ranking the 2013 Kansas Hazard Mitigation Plan Hazards

Kansas Hazard Mitigation Plan Hazards	Percentage of Local Plans Ranking the Hazard
Agricultural Infestation	35%
Civil Disorder	NEW for 2013
Dam/Levee Failure	98%
Drought	87%
Earthquake	88%
Expansive Soils	26%
Extreme Temperatures	68%
Flood	100%
Hailstorm	99%
Hazardous Materials	23%
Land Subsidence	22%
Landslide	19%
Lightning	51%
Major Disease Outbreak	23%
Radiological	13%
Soil Erosion /Dust	31%
Terrorism / Agri-Terrorism	71%
Tornado	100%
Utility Infrastructure Failure	87%
Wildfire	100%
Windstorm	98%
Winter Storm	100%

Source: Kansas Local Hazard Mitigation Plans, May 2013

3.4.2. Overview and Analysis of Local Plan Potential Loss Estimates

To assess potential losses, the HMPC extracted data from local plans‘ vulnerability assessments. A generic statement in many of the plans reads —loss estimates were calculated using a combination of information from the community profiles, historical loss data in the hazard profiles, parcel information, and general knowledge of the jurisdiction. Rough economic estimates were also included. For assessments reflecting 100 percent of the county‘s total resources, the planning area should be assumed to be evenly at risk to that respective hazard.” Thus, for many hazards that could have an impact anywhere in the county, such as severe winter weather or tornadoes, it was difficult to refine the loss estimate further.

After review of the loss-estimate data, the HMPC determined that it was not suitable for county to county comparisons of loss, due largely to the different methods used by the counties to estimate, or interpret, potential loss. These types of data inconsistencies are being addressed by the regional planning process used for updates of the local plans. Reasons for largely excluding this data include:

- Hazard scenarios were not consistent and therefore not comparable (e.g., one county may have considered vulnerability to an EF2 tornado that has an impact on 10 percent of the jurisdiction, where another county considered an EF4 tornado with an impact on 40 percent of the jurisdiction).
- A large number of plans provided only a vulnerability analysis for hazards ranked as high. This did not allow for vulnerability to be compared for any one hazard. For hazards ranked as low or moderate planning significance, vulnerability analyses were either omitted or did not contain dollar loss estimates.
- Many local plans based vulnerability on the percentage of assets that might be damaged as a result of the hazard. Within a single plan, the percentage of damage estimates varied for either each hazard or each jurisdiction within the planning area. For example, for winter storm some plans utilized 10 percent damage for unincorporated areas, 20 percent damage for some larger cities, and 5 percent damage for small cities. Other plans utilized 20 percent damage for all types of jurisdictions.

The exception to the above issues was flood, where many of the plans were able to summarize the population and buildings at risk within the 1-percent annual chance floodplain. However because several different methodologies were employed to arrive at dollar loss estimates, there was no appropriate method available to compare all local plans simultaneously. Two methods were used by 91 percent of the plans. The two methods are described below and **Table 3.164** and **Table 3.165** details the result for each in the counties in which that method was employed.

- **Method A** -- The best available flood data for Counties was generated by HAZUS-MH, FEMA‘s software program for estimating potential losses from disasters. The 1-percent annual chance floodplain was generated for major rivers and creeks in the county (those with a 10 square mile minimum drainage area). A USGS 30 meter resolution digital elevation model (DEM) was used as the terrain base in the model. HAZUS-MH produces a flood polygon and flood-depth grid that represents the base flood. While not as accurate as official flood maps, such as digital flood insurance rate maps, these floodplain boundaries are suitable for use in GIS-based loss estimation. Potential losses to the county were analyzed with HAZUS-MH, based on Census Block-based buildings and population inventory and the flood hazard data. For a few plans additional more accurate DIRM data was incorporated into HAZUS for the analysis. The results for these plans were deemed sufficiently similar to allow analysis under this methodology. Building damage is estimated by Census Block based on the average depth of flooding within a given Census Block. Flood damage is directly related to the depth of flooding. HAZUS-MH uses depth-damage functions to model the losses. For example, a two-foot flood generally results in about 20 percent damage to the structure (which translates to 20 percent of the structure‘s replacement value). To estimate the monetary loss for each city, the flooded Census Blocks were extracted, and the damage costs were totaled using GIS. This was done for each city and unincorporated area to illustrate how the risk varies across the planning area.

Table 3.164. HAZUS Generated Flood Loss Estimates from Local Hazard Mitigation Plans

Mitigation Planning Region	County	Flood Vulnerability in Terms of Dollar Loss Estimates
H	Allen	$38,507,000
G	Butler	$1,295,133
H	Chautauqua	$6,244,000
D	Clark	$2,348,281
E	Comanche	$2,360,000
G	Cowley	$210,463,135
H	Crawford	$33,962,000
F	Dickinson	$81,063,000
K	Douglas	$228,657,359
H	Elk	$3,148,000
C	Greeley	$0
G	Harper	$7,547,000
G	Harvey	$194,223
L	Johnson	$1,508,593,670
G	Kingman	$34,601,000
E	Kiowa	$1,434,000
H	Labette	$80,896,000
G	McPherson	$530,106,000
D	Meade	$7,140,000
H	Montgomery	$91,643,000
H	Neosho	$28,220,000
J	Osage	$68,852,000
F	Osborne	$10,388,000
G	Reno	$546,827,000
F	Republic	$340,882
B	Rooks	$7,330,000
B	Rush	$23,299,000
F	Saline	$2,302,595,000
G	Sedgwick	$2,853,315,149
C	Stanton	$2,494,000
G	Sumner	$40,382,000
C	Wichita	$0
H	Wilson	$26,249,000
H	Woodson	$4,748,000
L	Wyandotte	$380,583,000

Source: Kansas Local Hazard Mitigation Plans, May 2013

Method B -- Flood inundation areas for Counties were determined by use of FEMA boundary maps which were geo-coded using Manifold.Net, a GIS application. The GIS application calculates the percentage of areas affected by dividing affected square footage by total square

footage. Historical records provided limited flood level or damage data. In a worst case scenario, the plans estimated that the affected areas would be inundated by an average of one foot of water. Using the tables from FEMA 386-2, page 4-13, an average damage percent of 10 percent was estimated based on the values for a one foot flooding event. This percentage estimate was then applied to determine the worst case for potential flash flood damage based on a 1-percent annual chance flood event. This approach allowed the communities to average the impacts of the variety of hazard designations, flood depths and assets impacted. The values for exposed population and exposed asset values identified in the tables are estimated by multiplying affected area percentage to the appraised values supplied by the County Appraiser. Then the resulting value is discounted using the 10 percent average damage factor to produce potential dollar loss.

Table 3.165. GIS-based Generated Flood Loss Estimates from Local Hazard Mitigation Plans

Mitigation Planning Region	County	Flood Vulnerability in Terms of Dollar Loss Estimates
J	Anderson	$3,859,526
K	Atchison	$6,190,105
E	Barton	$24,050,724
H	Bourbon	$10,119,753
K	Brown	$21,508,401
I	Chase	$302,500
A	Cheyenne	$0
F	Clay	$2,408,619
J	Coffey	$7,174,454
A	Decatur	$779,727
K	Doniphan	$1,705,960
E	Edwards	$3,222,402
B	Ellis	$36,444,399
D	Finney	$42,871,695
D	Ford	$24,708,000
J	Franklin	$20,999,763
I	Geary	$43,716,754
A	Gove	$35,779
B	Graham	$105,405
C	Grant	$0
D	Gray	$1,287,250
H	Greenwood	$531,624
C	Hamilton	$1,649,098
D	Haskell	$0
D	Hodgeman	$453,544
K	Jackson	$7,239,739
K	Jefferson	$12,750,006
C	Kearny	$451,279
C	Lane	$0
L	Leavenworth	$30,901,842

Mitigation Planning Region	County	Flood Vulnerability in Terms of Dollar Loss Estimates
F	Lincoln	$0
J	Linn	$52,242,530
A	Logan	$129,052
K	Marshall	$7,250,068
J	Miami	$35,999,931
F	Mitchell	$786,766
I	Morris	$742,527
C	Morton	$0
B	Ness	$463,529
F	Ottawa	$6,064,091
E	Pawnee	$5,983,375
B	Phillips	$642,564
I	Pottawatomie	$17,669,123
E	Pratt	$879,804
A	Rawlins	$2,369,111
G	Rice	$7,712,372
I	Riley	$89,336,300
B	Russell	$664,435
C	Scott	$0
D	Seward	$12,027,858
J	Shawnee	$203,589,762
A	Sheridan	$198,131
A	Sherman	$195,263
F	Smith	$65,270
E	Stafford	$154,412
C	Stevens	$20,000
A	Thomas	$1,656,235
B	Trego	$0
I	Wabaunsee	$7,404,773
K	Washington	$670,094

Source: Kansas Local Hazard Mitigation Plans, May 2013

3.5. State Owned and Operated Facilities: Vulnerability and Loss Estimates

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] the state risk assessment. State owned critical or operated facilities located in the identified hazard areas shall also be addressed.

[The State risk assessment shall include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

This section includes analysis of the State owned and operated facilities and their vulnerability to hazard events. The State's resources, both monetary and fixed assets depend heavily upon these facilities and their continuity.

For the 2013 update to the State Hazard Mitigation Plan, significant progress has been made to develop a GIS-based inventory of State owned and operated facilities. In 2010, the Kansas Department of Administration implemented a new Statewide Management and Reporting Tool (SMART) to provide a centralized way to integrate the State's workforce, business processes and technology investment for 108 state agencies. One of the components of SMART is a module to track State owned and operated assets. The data from the SMART module was not available directly from the Department of Administration as a GIS layer. Therefore, the Kansas Division of Emergency Management GIS Department took on the task of geo-referencing the facilities in the inventory. In addition, KDEM identified those State owned and operated facilities that are considered to be critical facilities. The full inventory includes 3,276 State owned properties and 402 State operated (leased) facilities representative of 81 State Agencies. Of the 3,276 State owned facilities, 122 were determined to be critical facilities by KDEM's Technological Hazards Section. Additionally, 527 of the State owned properties were determined to be unimproved land or land with very minor improvements (such as park shelters or boat ramps). Therefore, these 527 properties were removed from the analysis for a total of 2,749 State owned facilities. None of the State operated (leased) facilities were determined to be critical facilities. **Table 3.166** provides a summary, by agency, of the State owned and operated facilities inventory that has been used for analyses described in the remainder of this section.

Table 3.166. Summary of State Owned and Operated Facilities by Agency

Agency Name	# of State Owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State Operated Facilities	Annual Rent for State operated Facilities
Adjutant General	80	$5,898,283	33	15	$698,522
Administration DISC	0	N/A	0	3	$160,945
Bank Commissioner	0	N/A	0	7	$273,210
Board of Barbering	0	N/A	0	1	$8,414

Agency Name	# of State Owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State Operated Facilities	Annual Rent for State operated Facilities
Board of Citizens Utility Ratepayer	0	N/A	0	1	$24,723
Board of Cosmetology	0	N/A	0	2	$38,124
Board of Education	0	N/A	0	7	$338,689
Board of Hearing Aid Examiners	0	N/A	0	2	$1,800
Board of Mortuary Arts	0	N/A	0	1	$8,003
Board of Optometry Examiners	0	N/A	0	1	$3,960
Board of Pharmacy	0	N/A	0	2	$25,000
Commission On Veterans Affairs	20	$4,031,633	0	0	N/A
Department of Administration	20	$442,240,328	6	3	$2,601,187
Department of Agriculture	0	N/A	0	12	$1,059,273
Department of Commerce	11	$6,805,146	11	23	$431,824
Department of Corrections	The State owned facilities under the Department of Corrections are listed separately under each facility name.			17	$751,955
Department of Credit Unions	0	N/A	0	1	$22,325
Department of Labor	8	$14,374,861	4	9	$589,195
Department of Revenue	0	N/A	0	41	$599,586
Department of Social and Rehab Svcs	22	$5,142,280	1	0	N/A
Department of Transportation	936	$0	39	2	$24,600
Department of Wildlife and Parks	301	$10,278,658	0	7	$166,116
Department on Aging	0	N/A	0	3	$384,516
El Dorado Correctional Facility	47	$90,398,700	1	0	N/A
Ellsworth Correctional Facility	19	$0	1	0	N/A
Emporia State University	75	$372,521,144	1	8	$263,756
Fire Marshal	0	N/A	0	2	$79,469
Fort Hays State University	50	$489,796,659	1	4	$36,197
Governmental Ethics Commission	0	N/A	0	2	$38,047
Governor	2	$0	1	0	N/A
Health Care Stabilization Fund	0	N/A	0	1	$71,641
Human Rights Commission	0	N/A	0	2	$3,950
Hutchinson Correctional Facility	31	$94,137,205	1	0	N/A
Indigents Defense Services	0	N/A	0	16	$663,445
Insurance Department	1	$5,200,000	1	0	N/A
Judicial Branch	0	N/A	0	3	$100,571
Juvenile Justice Authority	20	$23,142,786	1	1	$152,241
Kansas Board of Veterinary Examiners	0	N/A	0	2	$4,200
Kansas Bureau of Investigation	3	$7,213,470	2	6	$113,920
Kansas Corporation Commission	0	N/A	0	5	$610,183
Kansas Correctional Industries	17	$0	0	0	N/A
Kansas Department of Health and Environment	0	N/A	0	17	$383,077
Kansas Highway Patrol	16	$38,483,563	3	30	$758,688
Kansas Historical Society	41	$101,521,680	0	2	$175,120
Kansas Juvenile Correctional Cmplx	27	$72,070,902	1	0	N/A

Agency Name	# of State Owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State Operated Facilities	Annual Rent for State operated Facilities
Kansas Lottery	0	N/A	0	4	$659,161
Kansas Neurological Institute	11	$48,297,452	1	0	N/A
Kansas Public Employees Rtrmnt Sys	1	$8,500,000	0	0	N/A
Kansas State University	284	$2,411,625,200	1	18	$472,681
Kansas Water Office	0	N/A	0	2	$97,989
Lansing Correctional Facility	26	$126,218,803	1	0	N/A
Larned Corr Mental Hlth Facility	8	$22,812,445	0	0	N/A
Larned Juvenile Correct Facility	1	$20,281,623	0	0	N/A
Larned State Hospital	41	$122,513,556	1	0	N/A
Legislative Administrative Services	0	N/A	0	1	$20,904
Legislative Post Audit	0	N/A	0	1	$67,152
Long Term Care Ombudsman	0	N/A	0	2	$1,621
Norton Correctional Facility	41	$0	1	0	N/A
Office of the Attorney General	0	N/A	0	1	$50,444
Osawatomie State Hospital	39	$53,094,005	1	0	N/A
Parson State Hospital and Training Center	54	$60,082,214	1	0	N/A
Peace Officer's Standards Commission	0	N/A	0	1	$38,040
Pittsburg State University	39	$428,146,700	1	3	$178,541
Rainbow Mental Health Facility	2	$7,430,150	0	0	N/A
Real Estate Appraisal Board	0	N/A	0	1	$14,243
Real Estate Commission	0	N/A	0	1	$57,156
Retirement System, Kansas Public Employees	0	N/A	0	1	$2,160
School for the Blind	22	$54,042,414	1	0	N/A
Securities Commissioner, Office of	0	N/A	0	3	$105,441
Sentencing Commission	0	N/A	0	2	$29,826
Social Rehabilitation Svcs	0	N/A	0	48	$8,227,319
State Board of Healing Arts	0	N/A	0	1	$184,815
State Fair Board	67	$0	0	0	N/A
State Gaming Commission	0	N/A	0	2	$172,901
State Library	0	N/A	0	3	$75,818
Topeka Correctional Facility	27	$44,369,656	1	0	N/A
University of Kansas	201	$3,774,901,329	1	10	$5,349,362
University of Kansas Medical Cntr	38	$588,835,787	1	11	$939,001
Veterans Affairs Commission	0	N/A	0	8	$50,697
Wichita State University	78	$845,841,000	1	17	$1,726,556
Winfield Correctional Facility	22	$46,905,104	1	0	N/A
Total	**2,749**	**$10,447,154,736**	**122**	**402**	**$30,188,301**

Source: Kansas Office of Administration, Data converted to geodatabase by KDEM GIS Department

Table 3.167 that follows provides a summary of the State owned and operated facilities in Kansas for each county, organized by Mitigation Planning Region.

Table 3.167. Summary of State Owned and Operated Facilities by County

County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
Mitigation Planning Region A					
Cheyenne	10	$144,216	0	0	$0
Decatur	5	$0	0	0	$0
Gove	5	$0	0	0	$0
Logan	16	$0	1	1	$1,200
Rawlins	8	$0	1	0	$0
Sheridan	14	$37,187	0	0	$0
Sherman	6	$0	0	1	$20,218
Thomas	16	$2,649,911	2	6	$142,307
Wallace	5	$0	0	0	$0
Subtotal	**85**	**$2,831,314**	**4**	**8**	**$163,725**
Mitigation Planning Region B					
Ellis	85	$499,944,440	4	14	$259,590
Graham	5	$0	0	0	$0
Ness	6	$0	0	0	$0
Norton	56	$0	3	0	$0
Phillips	8	$0	1	3	$120,140
Rooks	11	$21,113	0	2	$18,000
Rush	5	$0	0	0	$0
Russell	9	$0	0	0	$0
Trego	9	$681,383	0	3	$3,600
Subtotal	**194**	**$500,646,936**	**8**	**22**	**$401,330**
Mitigation Planning Region C					
Grant	9	$0	1	0	$0
Greeley	12	$2,119,260	0	0	$0
Hamilton	10	$15,849	1	0	$0
Kearny	5	$0	0	0	$0
Lane	6	$0	0	0	$0
Morton	7	$0	0	0	$0
Scott	24	$1,145,163	0	0	$0
Stanton	0	$0	0	0	$0
Stevens	5	$0	0	0	$0
Wichita	3	$0	0	0	$0
Subtotal	**81**	**$3,280,272**	**2**	**0**	**$0**
Mitigation Planning Region D					
Clark	21	$246,443	0	0	$0
Finney	31	$369,794	2	11	$385,136
Ford	38	$1,312,803	3	11	$241,284
Gray	7	$0	0	0	$0

County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
Haskell	8	$0	1	0	$0
Hodgeman	5	$0	0	0	$0
Meade	18	$780,407	0	0	$0
Seward	7	$0	2	4	$149,050
Subtotal	**135**	**$2,709,446**	**8**	**26**	**$775,470**
Mitigation Planning Region E					
Barber	10	$55,058	0	0	$0
Barton	27	$9,109,427	3	7	$175,208
Comanche	5	$0	0	0	$0
Edwards	7	$0	0	0	$0
Kiowa	6	$16,874	0	1	$19,701
Pawnee	59	$165,607,624	1	0	$0
Pratt	51	$1,878,745	2	2	$80,730
Stafford	4	$501,600	0	2	$33,000
Subtotal	**169**	**$177,169,327**	**6**	**12**	**$308,639**
Mitigation Planning Region F					
Clay	10	$0	2	0	$0
Cloud	9	$23,466	1	4	$65,208
Dickinson	11	$0	1	0	$0
Ellsworth	30	$0	2	0	$0
Jewell	9	$12,489	1	0	$0
Lincoln	5	$0	0	0	$0
Mitchell	5	$0	0	0	$0
Osborne	7	$0	0	0	$0
Ottawa	15	$194,263	0	0	$0
Republic	8	$0	0	0	$0
Saline	48	$121,235,236	5	17	$1,331,186
Smith	6	$0	1	0	$0
Subtotal	**163**	**$121,465,454**	**13**	**21**	**$1,396,394**
Mitigation Planning Region G					
Butler	61	$90,437,351	3	6	$254,739
Cowley	44	$36,176,435	2	2	$168,591
Harper	8	$0	0	0	$0
Harvey	6	$0	1	2	$124,562
Kingman	23	$134,964	0	0	$0
Marion	12	$0	1	1	$1,200
McPherson	21	$162,848	0	3	$37,500
Reno	139	$244,179,141	4	11	$399,784
Rice	7	$0	0	0	$0
Sedgwick	123	$868,325,498	7	38	$5,247,898
Sumner	7	$0	0	1	$0
Subtotal	**451**	**$1,239,416,238**	**18**	**64**	**$6,234,275**

County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
Mitigation Planning Region H					
Allen	16	$0	2	2	$51,680
Bourbon	9	$35,070	0	3	$6,120
Chautauqua	5	$0	0	0	$0
Cherokee	12	$1,003,200	0	3	$138,751
Crawford	78	$429,685,629	4	14	$424,507
Elk	3	$0	0	0	$0
Greenwood	10	$145,000	0	1	$7,200
Labette	81	$67,009,404	1	6	$157,063
Montgomery	19	$34,208	1	13	$151,912
Neosho	31	$5,380,255	3	5	$100,504
Wilson	7	$0	0	0	$0
Woodson	12	$28,157	0	0	$0
Subtotal	**283**	**$503,320,923**	**11**	**47**	**$1,037,737**
Mitigation Planning Region I					
Chase	7	$39,014	0	0	$0
Geary	20	$823,290	2	7	$209,756
Lyon	92	$372,860,191	4	11	$230,768
Morris	7	$0	0	0	$0
Pottawatomie	21	$9,445,555	1	2	$4,200
Riley	207	$2,274,143,645	2	16	$434,863
Wabaunsee	16	$0	0	0	$0
Subtotal	**370**	**$2,657,311,696**	**9**	**36**	**$879,587**
Mitigation Planning Region J					
Anderson	13	$0	1	3	$12,300
Coffey	9	$0	0	0	$0
Franklin	10	$0	1	3	$137,152
Linn	27	$168,597	0	0	$0
Miami	51	$55,764,214	2	2	$65,600
Osage	16	$56,027	1	0	$0
Shawnee	196	$758,214,399	21	93	$8,361,725
Subtotal	**322**	**$814,203,236**	**26**	**101**	**$8,576,777**
Mitigation Planning Region K					
Atchison	37	$23,563,802	2	4	$138,670
Brown	18	$48,872	2	1	$38,530
Doniphan	11	$0	0	2	$1,680
Douglas	207	$3,575,686,086	2	14	$5,173,947
Jackson	13	$0	1	0	$0
Jefferson	10	$7,794,240	0	1	$452,038
Marshall	7	$0	1	1	$61,498
Nemaha	8	$21,656	0	1	$2,400

County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
Washington	10	$24,780	0	0	$0
Subtotal	**321**	**$3,607,139,436**	**8**	**24**	**$5,868,763**
Mitigation Planning Region L					
Johnson	50	$83,631,716	3	20	$1,706,467
Leavenworth	49	$126,218,803	1	4	$209,158
Wyandotte	76	$607,809,938	5	14	$2,601,623
Subtotal	**175**	**$817,660,457**	**9**	**38**	**$4,517,248**
Facilities in Other States					
Oklahoma	0	$0	0	1	$4,500
Utah	0	$0	0	1	$1,500
Missouri	0	$0	0	1	$22,357
Subtotal	**0**	**$0**	**0**	**3**	**$28,357**
Statewide Totals					
Totals	**2,749**	**$10,447,154,736**	**122**	**402**	**$30,188,301**

Source: Kansas Office of Administration, Data converted to geodatabase by KDEM GIS Department

Figure 3.137 shows the number of state owned facilities in each Kansas county and **Figure 3.138** shows the number of state operated facilities in each Kansas county.

Figure 3.137. Number of State Owned Facilities in each County

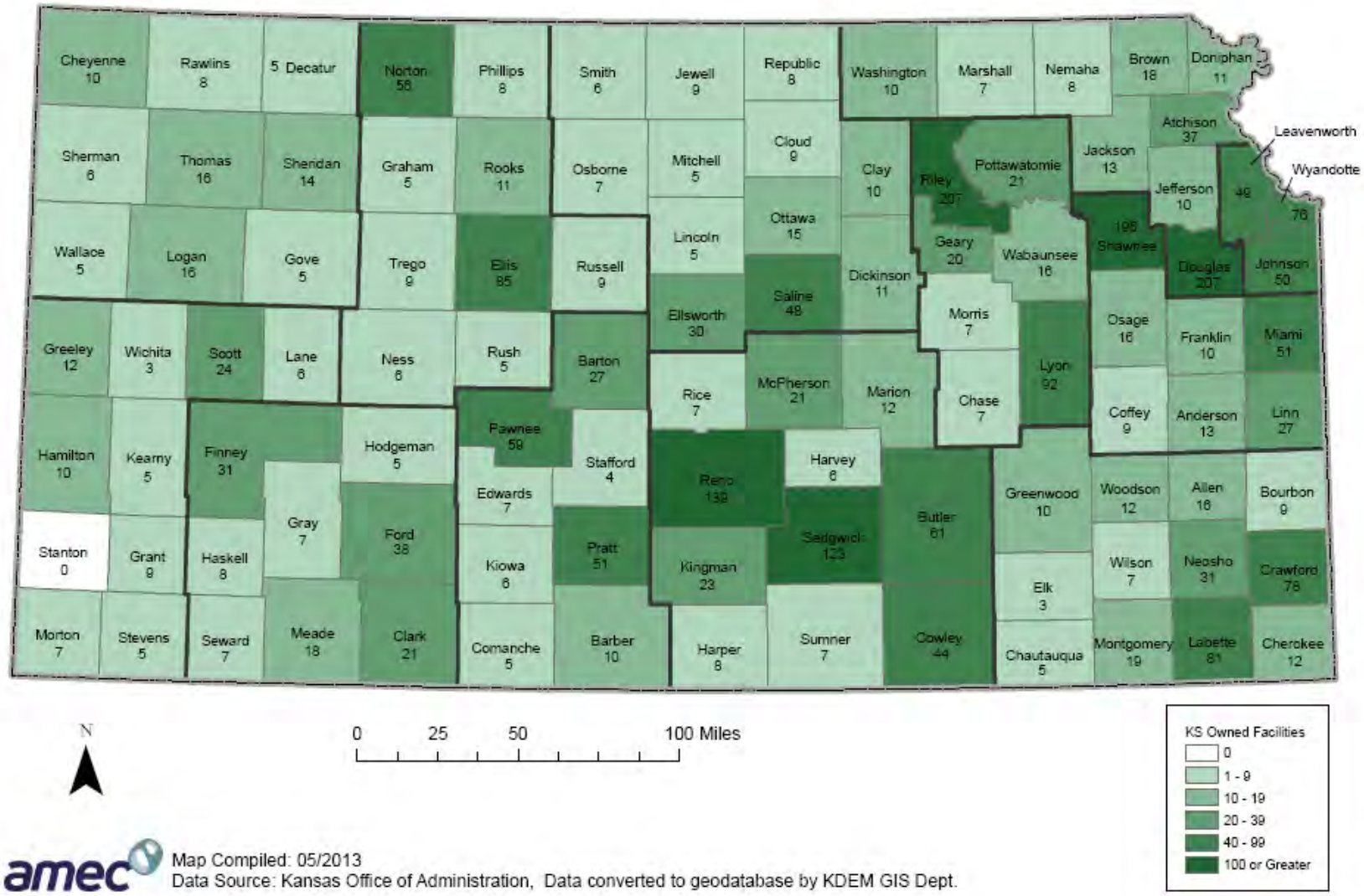
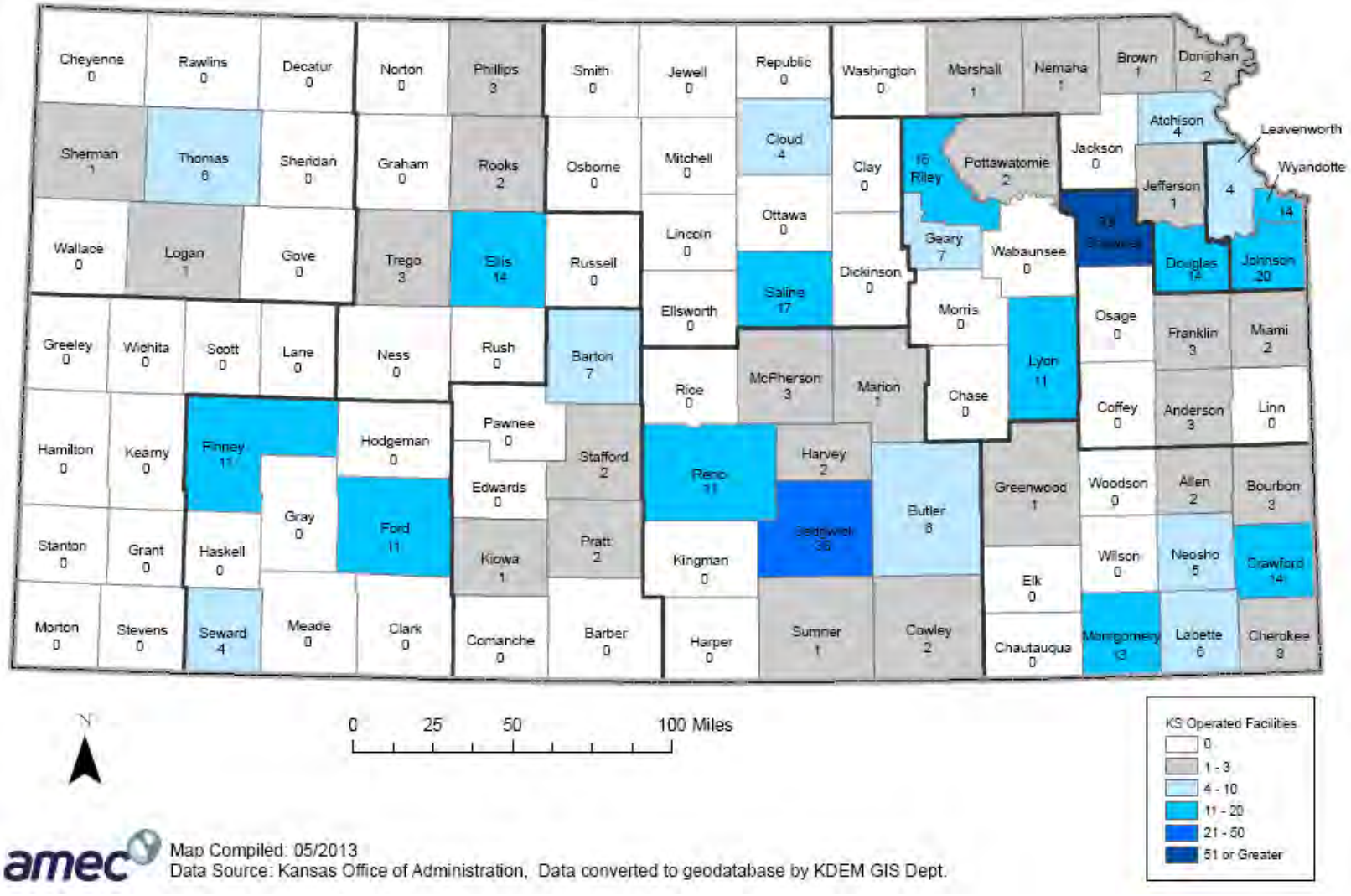


Figure 3.138. Number of State Operated Facilities in each County



According to the regulatory requirements of the disaster mitigation Act, the State must provide an overview vulnerability analysis and loss estimates for State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

Identified GIS-based hazard areas exist for the following hazards:

- Dam And Levee Failure,
- Earthquake,
- Flood, and
- Hazardous Materials.

Therefore, for those hazards, a more comprehensive quantitative analysis has been completed, including loss estimates. For other hazards, clearly identified geographic hazard areas are not established due to data limitations or the random nature of the hazards. For these hazards, where appropriate, the State has utilized the statewide vulnerability analysis overview completed for each hazard to identify State owned facilities within counties indicated to have increased vulnerability. Finally, some of the hazards analyzed have neither an identified hazard area nor sufficient statistical data to determine areas at increased vulnerability. For these counties, a narrative is provided to discuss vulnerability of State owned facilities.

It should also be noted that of the 2,749 State owned properties, 1,393 (50.6 percent) of them indicated $0 as the insured value. Additionally, of the 402 State operated facilities, 31 (7 percent) indicated $0 for annual rent. This limitation in the data significantly impacts the ability to perform quantitative loss estimates. Therefore, where applicable, loss estimates for specific hazards will indicate the number of facilities with no insured values indicated.

Where data is available, vulnerability and loss estimation are described in more detail by hazard in the sections that follow.

3.5.1. Agricultural Infestation

Structures that are part of the State owned facility inventory are not directly vulnerable to losses as a result of agricultural infestation. Therefore, specific loss estimates are not provided. However, the conservation areas owned and operated by the Kansas Department of Wildlife and Parks could be impacted as a result of infestations to wildlife and/or native grasses and plants.

3.5.2. Civil Disorder

Civil disorder can occur at random times and locations. As a result it is difficult to specify State owned or operated facilities that may be impacted by this hazard. As indicated in **Section 3.3.2** incarcerated populations can be more prone to civil disorder as a concentrated group of high risk individuals. Therefore, the State owned correctional facilities with incarcerated populations could be considered to be at higher risk to civil disorder than other State owned facilities. Additionally, colleges/universities are also a consideration for potential civil disorder. This is due

to the high concentration of individuals that may become emotionally charged as a result of the outcome of sporting events, political events, or world events.

Vulnerability Overview

According to the information included in the State owned facility data from the Office of Administration, there are 266 facilities associated with State owned correctional facilities (see **Table 3.168**) and 765 facilities associated with State owned universities in Kansas (see **Table 3.169**).

Table 3.168. Kansas State Owned Correctional Facilities

Name	Mitigation Planning Region	County	# of Associated State owned Facilities.
El Dorado Correctional Facility	G	Butler	47
Ellsworth Correctional Facility	F	Ellsworth	19
Hutchinson Correctional Facility	G	Reno	31
Kansas Correctional Industries	L	Leavenworth	17
Kansas Juvenile Correctional Complex	J	Shawnee	27
Lansing Correctional Facility	L	Leavenworth	26
Larned Correctional Mental Health Facility	E	Pawnee	8
Larned Juvenile Correctional Facility	E	Pawnee	1
Norton Correctional Facility	B	Norton	41
Topeka Correctional Facility	J	Shawnee	27
Wichita Work Release Facility	G	Sedgwick	1
Winfield Correctional Facility	G	Cowley	21
Total			**266**

Table 3.169. Kansas State Owned Universities

Name	Mitigation Planning Region	County	# of State owned Facilities
Emporia State University	H	Greenwood	1
Emporia State University	I	Lyon	74
Fort Hays University	E	Barton	1
Fort Hays University	B	Ellis	49
Kansas State University	H	Cherokee	3
Kansas State University	K	Douglas	3
Kansas State University	B	Ellis	18
Kansas State University	D	Finney	3
Kansas State University	J	Franklin	2
Kansas State University	C	Greeley	6
Kansas State University	L	Johnson	1
Kansas State University	H	Labette	12
Kansas State University	I	Pottawatomie	6
Kansas State University	G	Reno	6
Kansas State University	F	Republic	1
Kansas State University	I	Riley	187
Kansas State University	F	Saline	19
Kansas State University	G	Sedgwick	3
Kansas State University	J	Shawnee	6
Kansas State University	E	Stafford	1

Name	Mitigation Planning Region	County	# of State owned Facilities
Kansas State University	A	Thomas	7
Pittsburg State University	H	Crawford	39
University of Kansas	K	Douglas	180
University of Kansas	K	Jefferson	4
University of Kansas	L	Johnson	5
University of Kansas	G	Reno	11
University of Kansas Medical Center	G	Sedgwick	2
University of Kansas Medical Center	L	Wyandotte	37
Wichita State University	G	Sedgwick	78
Total			**765**

Loss Estimates

Civil Disorder events do not usually result in extensive damages to buildings/ facilities. As reported in **Section 3.3.2** damage as a result of Civil Disturbance is usually related to deaths or injuries of persons involved.

3.5.3. Dam and Levee Failure

The vulnerability and loss estimate analysis for State owned facilities at risk to dam and levee failure is presented in subsections beginning with Dam Failure.

Dam Failure

To determine State owned facilities that are potentially vulnerable to dam failure, GIS analysis was performed to determine those facilities within 5 miles of a dam and also in the floodplain. It is anticipated that analysis of actual inundation areas will be possible for the 2016 update of the State Hazard Mitigation Plan. The State Department of Agriculture; Division of Water Resources is currently engaged in an effort to map priority high and significant hazard dams. This effort is being funded by a grant that runs through the fall of 2013. Once the specific inundation maps are created, it is suggested that they be compiled into a statewide layer that would facilitate more accurate analysis of State owned facilities within inundation areas. In the absence of an existing statewide layer for inundation areas, this analysis of facilities within 5 miles and in the floodplain utilizes best available information at this time.

Vulnerability Overview

According to this analysis, a total of 89 State owned facilities are vulnerable to dam failure of state-regulated high and significant hazard dams. Of those 89, 2 were determined by KDEM to be critical facilities. Of the State operated facilities, 7 are vulnerable to dam failure of high and significant state-regulated dams.

Table 3.170 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.170. County Summary of State Owned and Operated Facilities in Potential Inundation Zones of State-Regulated High and Significant Hazard Dams

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
A	Lyon	3	$6,463,428	0	0	N/A
B	Ellis	40	$429,912,837	2	0	N/A
C	Morris	2	$0	0	0	N/A
E	Barton	8	$206,312	0	0	N/A
G	Butler	16	$0	0	0	N/A
G	Sedgwick	6	$0	0	0	N/A
H	Montgomery	2	$0	0	0	N/A
I	Pottawatomie	4	$8,301,280	0	0	N/A
J	Miami	1	$0	0	0	N/A
J	Shawnee	2	$0	0	5	$837,300
K	Atchison	0	N/A	N/A	1	$9,603
L	Wyandotte	5	$0	0	1	$6,199
Total		**89**	**$444,883,857**	**2**	**7**	**$853,102**

Loss Estimates

Insured values were provided for 50 of the 89 State owned facilities determined to be vulnerable to failure of State-regulated High and Significant Hazard dams. By applying a 50 percent damage estimate to the insured values provided, losses could be $222,444,929. A 50 percent damage estimate was chosen due to the level of damage that would be expected as a result of speed of onset and wave action that would occur as a result of a dam failure event.

Levee Failure

To determine State owned and operated facilities that are potentially vulnerable to levee failure, the FEMA Mid-term Levee Inventory (MLI) geodatabase was utilized. The MLI included levee protected areas for 107 of 136 levee systems included in the inventory. Therefore, the GIS analysis was done to determine the number and values of State owned and operated facilities within those levee protected areas. GIS data of levee protected areas does not exist for all levees in Kansas. However, this is the best available data at this time.

Vulnerability Overview

According to this analysis of available levees, a total of 271 State owned facilities were determined to be vulnerable to failure of levees. Of those, 17 were determined by KDEM to be critical facilities. Of the State operated facilities, 62 were determined to be vulnerable to failure of levees for which GIS data was available.

Table 3.171 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.171. County Summary of State Owned and Operated Facilities In Levee Protected Areas (Vulnerable to Levee Failure)

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
B	Ellis	54	$331,470,461	3	5	$42,397
E	Barton	14	$5,639,942	2	7	$175,208
F	Saline	17	$2,591,742	3	6	$523,652
G	Butler	2	$0	0	0	N/A
G	Cowley	2	$0	0	1	$163,191
G	Dickinson	7	$0	1	0	N/A
G	Marion	2	$0	0	0	N/A
G	Reno	118	$97,428,190	4	7	$379,117
G	Sedgwick	14	$14,428,640	1	19	$3,797,610
I	Pottawatomie	4	$8,301,280	0	0	N/A
I	Riley	1	$0	1	4	$28,061
J	Franklin	0	N/A	0	2	$14,400
J	Shawnee	28	$77,086,926	2	8	$1,152,926
K	Douglas	2	$3,760,000	0	2	$32,338
K	Marshall	0	N/A	0	1	$61,498
L	Leavenworth	2	$0	0	0	N/A
L	Wyandotte	4	$0	0	0	N/A
Totals		**271**	**$540,707,181**	**17**	**62**	**$6,370,398**

Loss Estimates

Insured values were provided for 104 of the 271 State owned facilities determined to be vulnerable to failure of levees for which protected areas were available. By applying a 50 percent damage estimate to the insured values provided, losses could be $270,353,590.30. A 50 percent damage estimate was chosen due to the level of damage that would be expected as a result of speed of onset and wave action that would occur as a result of a levee failure event.

3.5.4. Drought

Structures that are part of the State owned facility inventory are not directly vulnerable to losses as a result of drought. However, the shrink-swell cycle that occurs as soils swell during wet periods and shrink during drought periods can cause damages to concrete components and structure foundations. Bridges and roads are especially vulnerable to damages as a result of the shrink-swell cycle. The Kansas Department of Transportation monitors this type of damage and is responsible for the repairs of those roads and bridges that are State owned/maintained.

3.5.5. Earthquake

To determine State owned and operated facilities that are vulnerable to damage from earthquakes in Kansas, the Peak-Ground Accelerations (PGA) resulting from the HAZUS 2,500-Year Probabilistic 6.7 Magnitude earthquake scenario were analyzed and compared with the perceived shaking and potential damage classifications developed by USGS for specific PGA ranges and corresponding Modified Mercalli Intensity ratings. GIS analysis was done to

determine the number and values of State owned and operated facilities within the areas of the State that would have PGA's that would result in damages. **Table 3.172** below provides the Modified Mercalli Intensity and corresponding PGA values, perceived shaking, and potential damage.

Table 3.172. Ground Shaking and Potential Damage Classifications

Modified Mercalli Intensity	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	<0.17	Not felt	None
II	0.17 – 1.4	Weak	None
III	0.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 – 18	Strong	Light
VII	18 – 34	Very Strong	Moderate
VIII	34 – 65	Severe	Moderate to Heavy
IX	65 – 124	Violent	Heavy
X	>124	Extreme	Very Heavy
XI	>124	Extreme	Very Heavy
XII	>124	Extreme	Very Heavy

Source: United States Geological Survey, http://earthquake.usgs.gov/earthquakes/shakemap/background.php

According to this data, PGA's below 3.9 percent would not result in any damage. Therefore, for the vulnerability analysis of State owned and operated buildings, the facilities that fall within areas that would have a PGA 3.9 percent and higher were determined.

Vulnerability Overview

All State owned and operated facilities fell within a PGA range from 0.0 percent to 9.2 percent, indicating that the highest perceived shaking for any facility would be "not felt" and the greatest potential damage would be "very light". When analyzing just those facilities that would have a PGA of 3.9 or above, there are a total of 2,480 State owned facilities in the range from 3.9 to 9.2. The highest PGA of any State owned facility was 9.2 percent. There are 11 State owned facilities with this PGA rating. All are Department of Transportation's facilities in Pottawatomie County. Of the 2,480 State owned facilities with a PGA of 3.9-9.2. 108 have been determined by KDEM to be critical facilities. Of the State operated facilities, 355 of the 402 facilities had PGAs in the range from 3.9-9.2. Again, the highest PGA of any State operated facility was 9.2 percent. There are 3 State operated facilities with this PGA rating. Two are facilities operated by the Kansas Board of Veterinary Examiners, both in Pottawatomie County and one is operated by the Kansas Highway Patrol in Riley County.

Table 3.173 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.173. County Summary of State Owned and Operated Facilities In Areas with PGA of 3.9 percent to 9.2 percent

County	Average PGA of State Owned Facilities in County	# State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
Mitigation Planning Region A						
Cheyenne	5.10%	5	$144,216	0	0	N/A
Gove	4.10%	5	$0	0	0	N/A
Sheridan	4.18%	14	$37,187	1	0	N/A
Subtotal		**24**	**$181,403**	**1**	**0**	**$0**
Mitigation Planning Region B						
Ellis	6.32%	85	$499,944,440	4	14	$259,590
Graham	5.60%	5	$0	1	0	N/A
Ness	4.40%	6	$0	3	0	N/A
Norton	4.77%	56	$0	1	0	N/A
Phillips	4.80%	8	$0	1	3	$120,140
Rooks	5.97%	11	$21,113	0	2	$18,000
Rush	5.00%	5	$0	0	0	N/A
Russell	5.03%	9	$0	5	0	N/A
Trego	5.47%	9	$681,383	0	3	$3,600
Subtotal		**194**	**$500,646,936**	**15**	**22**	**$401,330**
Mitigation Planning Region C						
Grant	4.00%	9	$0	0	0	N/A
Hamilton	4.20%	10	$15,849	0	0	N/A
Morton	4.33%	7	$0	0	0	N/A
Stevens	4.10%	5	$0	0	0	N/A
Subtotal		**31**	**$15,849**	**0**	**0**	**$0**
Mitigation Planning Region D						
Clark	4.29%	21	$246,443	0	0	N/A
Ford	4.10%	5	$0	1	0	N/A
Meade	4.10%	18	$780,407	2	0	N/A
Seward	4.20%	7	$0	21	4	$149,050
Subtotal		**51**	**$1,026,850**	**24**	**4**	**$149,050**
Mitigation Planning Region E						
Barber	5.10%	9	$55,058	0	0	N/A
Barton	4.57%	27	$9,109,427	3	7	$175,208
Comanche	4.60%	5	$0	0	0	N/A
Edwards	4.03%	7	$0	0	0	N/A
Kiowa	4.30%	6	$16,874	1	1	$19,701
Pawnee	4.30%	59	$165,607,624	1	0	N/A
Pratt	4.69%	50	$1,877,707	4	2	$80,730
Stafford	4.40%	4	$501,600	0	2	$33,000

County	Average PGA of State Owned Facilities in County	# State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
Subtotal		**167**	**$177,168,289**	**9**	**12**	**$308,639**
Mitigation Planning Region F						
Clay	6.28%	10	$0	2	0	N/A
Cloud	4.80%	9	$23,466	1	4	$65,208
Dickinson	5.77%	11	$0	1	0	N/A
Ellsworth	4.40%	30	$0	2	0	N/A
Jewell	4.30%	9	$12,489	3	0	N/A
Lincoln	4.40%	5	$0	0	0	N/A
Mitchell	4.40%	5	$0	1	0	N/A
Osborne	4.54%	7	$0	0	0	N/A
Ottawa	4.98%	15	$194,263	1	0	N/A
Republic	4.84%	8	$0	0	0	N/A
Saline	4.85%	48	$121,235,236	7	17	$1,331,186
Smith	4.30%	6	$0	0	0	N/A
Subtotal		163	$121,465,454	18	21	$1,396,394
Mitigation Planning Region G						
Butler	5.01%	61	$90,437,351	3	6	$254,739
Cowley	5.13%	44	$36,176,435	2	2	$168,591
Harper	5.53%	8	$0	1	0	N/A
Harvey	5.10%	6	$0	1	2	$124,562
Kingman	5.07%	23	$134,964	0	0	N/A
Marion	5.18%	12	$0	1	1	$1,200
McPherson	4.90%	21	$162,848	0	3	$37,500
Reno	4.91%	139	$244,179,141	0	11	$399,784
Rice	4.60%	7	$0	2	0	N/A
Sedgwick	5.20%	123	$868,325,498	2	38	$5,247,898
Sumner	5.33%	7	$0	0	0	$0
Subtotal		**451**	**$1,239,416,238**	**12**	**63**	**$6,234,275**
Mitigation Planning Region H						
Allen	4.92%	16	$0	2	2	$51,680
Bourbon	5.39%	9	$35,070	0	3	$6,120
Chautauqua	4.90%	5	$0	0	0	N/A
Cherokee	5.82%	10	$1,003,200	0	2	$138,751
Crawford	5.67%	78	$429,685,629	4	14	$424,507
Elk	4.80%	3	$0	0	0	N/A
Greenwood	4.84%	10	$145,000	1	0	N/A
Labette	5.12%	81	$67,009,404	1	6	$157,063
Montgomery	4.93%	19	$34,208	0	13	$151,912
Neosho	4.92%	31	$5,380,255	0	5	$100,504
Wilson	4.80%	7	$0	0	0	N/A
Woodson	4.77%	12	$28,157	0	0	N/A

County	Average PGA of State Owned Facilities in County	# State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
Subtotal		**281**	**$503,320,923**	**8**	**45**	**$1,030,537**
Mitigation Planning Region I						
Chase	5.26%	7	$39,014	0	0	N/A
Geary	7.09%	20	$823,290	0	7	$209,756
Lyon	5.58%	92	$372,860,191	1	11	$230,768
Morris	6.70%	7	$0	0	0	N/A
Pottawatomie	8.98%	21	$9,445,555	2	2	$4,200
Riley	8.90%	207	$2,274,143,645	0	16	$434,863
Wabaunsee	8.17%	16	$0	0	0	N/A
Subtotal		**370**	**$2,657,311,696**	**3**	**36**	**$879,587**
Mitigation Planning Region J						
Anderson	5.10%	13	$0	1	3	$12,300
Coffey	5.13%	9	$0	0	0	N/A
Franklin	5.22%	10	$0	2	3	$137,152
Linn	5.33%	27	$168,597	4	0	N/A
Miami	5.22%	51	$55,764,214	0	2	$65,600
Osage	6.07%	16	$56,027	0	0	N/A
Shawnee	6.75%	192	$758,214,399	0	92	$8,361,725
Subtotal		**318**	**$814,203,236**	**7**	**100**	**$8,576,777**
Mitigation Planning Region K						
Atchison	5.63%	16	$212,119	0	0	N/A
Brown	6.08%	18	$48,872	2	1	$38,530
Doniphan	5.14%	9	$0	0	2	$1,680
Douglas	5.71%	204	$3,572,474,286	2	14	$5,173,947
Jackson	6.93%	13	$0	0	0	N/A
Jefferson	5.94%	10	$7,794,240	1	1	$452,038
Marshall	6.90%	7	$0	0	1	$61,498
Nemaha	6.95%	8	$21,656	3	1	$2,400
Washington	6.42%	10	$24,780	0	0	N/A
Subtotal		**295**	**$3,580,575,953**	**8**	**20**	**$5,730,093**
Mitigation Planning Region L						
Johnson	5.42%	50	$83,631,716	0	20	$1,706,467
Leavenworth	5.40%	49	$126,218,803	0	4	$209,158
Wyandotte	5.41%	36	$16,663,546	3	6	$312,095
Subtotal		**135**	**$226,514,065**	**3**	**30**	**$2,227,721**
Statewide Totals						
Totals		**2,480**	**$9,821,846,892**	**108**	**353**	**$26,934,403**

Loss Estimates

To generate potential loss estimates, a percent loss was applied to the potential damage classifications in the following manner: Very Light-5 percent, Light-10 percent, Moderate-25 percent, Moderate to Heavey-30 percent, Heavey-50 percent, and Very Heavy, 60 percent. All of the Kansas State owned facilities fall within the —Very Light" potential damage classification. Therefore, the loss estimates at 5 percent of the reported insured value is $491,092,345. 0Please note: the earthquake scenario is a worst-case probabilistic event. Although an attempt has been made to quantify losses, the data on relative PGA values is generally more useful in determining numbers and values of State owned facilities in counties that would have greater shaking/damage from an earthquake. Additional, although this estimate uses best available data, 1,235 of the 2,480 State owned facilities within the 3.9 to 9.2 PGA range did not have reported insured values.

3.5.6. Expansive Soils

As mentioned in the section on Drought, the shrink-swell cycle that occurs as soils swell during wet periods and shrink during drought periods can cause damages to concrete components and structure foundations. Bridges and roads are especially vulnerable to damages as a result of the shrink-swell cycle. The Kansas Department of Transportation monitors and makes necessary repairs as a result of this type of damage to roads and bridges that are State owned/ maintained.

3.5.7. Extreme Temperatures

Extreme temperatures do not directly impact State owned buildings. However, asphalt parking lots and roads are routinely damaged during periods of extreme heat as the hot asphalt becomes less rigid and can be displaced by heavy equipment or automobiles.

3.5.8. Flood

To determine State owned and operated facilities that are potentially vulnerable to flood, HAZUS generated floodplain was utilized. This flood layer is the best available statewide flood layer that is in GIS format allowing comparison against the State owned and operated facility GIS data. As discussed in **Section 3.3.3**, 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 analyze State owned and operated facilities at risk to flooding.

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.

This analysis is limited to identifying State owned and operated facilities vulnerable to riverine flooding only and does not take into account those facilities which may be prone to flash flooding. Flash flooding varies depending on intensity and duration of rainfall, topography, and drainage and is therefore not considered a —geographic hazard".

Vulnerability Overview

According to the analysis comparing GIS data of State owned and operated facilities against the HAZUS 1-percent annual chance floodplain, a total of 182 State owned facilities are vulnerable to riverine flooding. Of those 182, seven were determined by KDEM to be critical facilities. Of the State operated facilities, 35 are vulnerable to riverine flooding, according to this analysis.

Table 3.174 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.174. County Summary of State Owned and Operated Facilities Vulnerable to Riverine Flooding

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
B	Ellis	41	$429,914,931	2	0	N/A
C	Hamilton	2	$15,849	0	0	N/A
C	Scott	5	$0	0	0	N/A
D	Clark	1	$23,730	0	0	N/A
D	Finney	10	$100,647	0	1	$246,251
D	Ford	1	$13,540	0	0	N/A
D	Seward	4	$0	1	0	N/A
E	Barton	20	$2,315,432	2	3	$24,397
E	Pratt	2	$36,200	0	0	N/A
E	Stafford	1	$501,600	0	0	N/A
F	Cloud	1	$17,825	0	0	N/A
F	Dickinson	7	$0	1	0	N/A
F	Republic	1	$0	0	0	N/A
F	Saline	11	$10,723,887	0	4	$401,374
G	Butler	16	$0	0	0	N/A
G	Cowley	0	N/A	0	1	$163,191
G	Kingman	12	$134,964	0	0	N/A
G	Reno	13	$3,290,985	1	3	$77,078
G	Sedgwick	12	$18,534,840	0	14	$3,601,059
H	Cherokee	1	$0	0	0	N/A
H	Montgomery	2	$0	0	0	N/A
I	Lyon	3	$6,463,428	0	0	N/A
I	Morris	2	$0	0	0	N/A
I	Pottawatomie	4	$8,301,280	0	0	N/A
J	Miami	1	$0	0	0	N/A
J	Shawnee	4	$0	0	5	$837,300
K	Atchison	0	N/A	0	1	$9,603

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
K	Douglas	0	N/A	0	2	$32,338
L	Wyandotte	5	$0	0	1	$6,199
Total		**182**	**$480,389,138**	**7**	**35**	**$5,398,790**

Loss Estimates

With a conservative loss estimate of 20 percent damages to State owned facilities as a result of riverine flood, damages would be $96,077,827 based on the insured value of State owned facilities in the HAZUS 1-percent annual chance floodplain. However, it should be noted that of the 182 facilities in the floodplain, insured values were provided for only 94 (51 percent). A 20 percent damage estimate was chosen based on FEMA Flood Insurance Administration depth-damage curves based on an assumption of flood levels of two feet in the structure.

3.5.9. Hailstorm

All State owned and operated facilities are vulnerable to hailstorm to some extent. However, to refine the analysis of State owned and operated facilities that are vulnerable to hailstorm, the number and insured values/Annual Rent for State owned and operated facilities was determined for those counties in the State that were determined to be in the top 10 counties vulnerable to hail damage (see **Table 3.88)**.

Vulnerability Overview

According to this analysis, a total of 336 State owned facilities were determined to be in the top 10 counties vulnerable to hailstorm. Of those, 21 were determined by KDEM to be critical facilities. Of the State operated facilities, 77 were determined to be in the top counties vulnerable to hail.

Table 3.175 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.175. Summary of State Owned and Operated Facilities In Top Counties Vulnerable to Hailstorm

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
A	Sheridan	14	$37,187	0	0	N/A
A	Sherman	6	Not Reported	0	1	$20,218
A	Thomas	16	$2,649,911	2	6	$142,307
B	Norton	56	Not Reported	3	0	N/A
C	Stanton	0	N/A	0	0	N/A
C	Stevens	5	Not Reported	0	0	N/A
D	Finney	31	$369,794	2	11	$385,136
D	Haskell	8	Not Reported	1	0	N/A

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
F	Jewell	9	$12,489	1	0	N/A
F	Smith	6	Not Reported	1	0	N/A
G	Marion	12	Not Reported	1	1	$1,200
G	Sedgwick	123	$868,325,498	7	38	$5,247,898
L	Johnson	50	$83,631,716	3	20	$1,706,467
Total		**336**	**$955,026,595**	**21**	**77**	**$7,503,226**

Loss Estimates

The type and severity of damages caused by hailstorm vary with each event as well as the type of structure impacted. With these variables, it is not possible to generate reasonable loss estimates to State owned and operated facilities as a result of hailstorm.

3.5.10. Hazardous Materials

Facilities covered by The Emergency Planning and Community Right to Know Act (EPCRA) must submit emergency and hazardous chemical inventory forms each year. In Kansas, forms are submitted to the Kansas Department of Health and Environment and the county emergency management office.

A GIS-based inventory containing point locations of over 13,600 fixed chemical facilities was obtained from the Kansas Department of Emergency Management GIS Department. To determine State owned and operated facilities that are potentially vulnerable to hazardous materials incidents, GIS analysis was performed to determine those State owned and operated facilities within the ½ mile initial isolation zone of the reported chemical facilities.

Vulnerability Overview

According to this analysis, a total of 1,104 State owned facilities were determined to be in the initial isolation zone of chemical facilities. Of those, 70 were determined by KDEM to be critical facilities. Of the State operated facilities, 304 were determined to be in the initial isolation zone of chemical facilities.

Table 3.176 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.176. County Summary of State Owned and Operated Facilities In Initial Isolation Zone of Chemical Facilities

County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
Mitigation Planning Region A					
Cheyenne	5	$0	0	0	N/A
Decatur	5	$0	0	0	N/A

County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
Gove	5	$0	0	0	N/A
Logan	13	$0	1	1	$1,200
Rawlins	8	$0	1	0	N/A
Sheridan	9	$0	0	0	N/A
Sherman	5	$0	0	1	$20,218
Thomas	0	0	0	4	$126,763
Wallace	2	$0	0	0	N/A
Subtotal	**52**	**$0**	**2**	**6**	**$148,181**
Mitigation Planning Region B					
Ellis	35	$239,961,606	4	8	$62,797
Ness	6	$0	0	0	N/A
Norton	13	$0	1	0	N/A
Phillips	8	$0	1	3	$120,140
Rooks	9	$0	0	2	$18,000
Rush	5	$0	0	0	N/A
Russell	9	$0	0	0	N/A
Trego	6	$0	0	1	$900
Subtotal	**91**	**$239,961,606**	**6**	**14**	**$201,837**
Mitigation Planning Region C					
Grant	9	$0	1	0	N/A
Greeley	12	$2,119,260	0	0	N/A
Hamilton	8	$0	1	0	N/A
Kearny	4	$0	0	0	N/A
Lane	6	$0	0	0	N/A
Morton	5	$0	0	0	N/A
Scott	5	$0	0	0	N/A
Stevens	5	$0	0	0	N/A
Wichita	3	$0	0	0	N/A
Subtotal	**57**	**$2,119,260**	**2**	**0**	**$0**
Mitigation Planning Region D					
Clark	10	$23,730	0	0	N/A
Finney	26	$295,899	2	11	$385,136
Ford	25	$601,976	3	8	$108,600
Gray	7	$0	0	0	N/A
Haskell	8	$0	1	0	N/A
Hodgeman	5	$0	0	0	N/A
Meade	9	$0	0	0	N/A
Seward	3	$0	1	3	$145,299
Subtotal	**93**	**$921,605**	**7**	**22**	**$639,035**
Mitigation Planning Region E					
Barber	10	$55,058	0	0	N/A

County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
Barton	6	$2,109,120	1	7	$175,208
Comanche	5	$0	0	0	N/A
Edwards	7	$0	0	0	N/A
Kiowa	6	$16,874	0	1	$19,701
Pawnee	1	$20,281,623	0	0	N/A
Pratt	39	$1,780,684	1	2	$80,730
Stafford	0	N/A	0	2	$33,000
Subtotal	**74**	**$24,243,359**	**2**	**12**	**$308,639**
Mitigation Planning Region F					
Clay	10	$0	2	0	N/A
Cloud	3	$0	0	2	$60,408
Dickinson	9	$0	1	0	N/A
Ellsworth	2	$0	0	0	N/A
Jewell	9	$12,489	1	0	N/A
Lincoln	5	$0	0	0	N/A
Osborne	5	$0	0	0	N/A
Ottawa	5	$0	0	0	N/A
Republic	6	$0	0	0	N/A
Saline	31	$86,096,394	4	15	$1,235,546
Subtotal	**85**	**$86,108,883**	**8**	**17**	**$1,295,954**
Mitigation Planning Region G					
Butler	13	$0	1	2	$181,489
Cowley	28	$36,142,013	1	0	$168,591
Harper	8	$0	0	0	N/A
Harvey	1	$0	1	2	$124,562
Kingman	10	$0	0	0	N/A
Marion	12	$0	1	1	$1,200
McPherson	8	$112,447	0	2	$36,600
Reno	41	$92,641,220	2	10	$395,055
Rice	7	$0	0	0	N/A
Sedgwick	19	$20,989,288	1	24	$4,488,751
Sumner	5	$0	0	0	N/A
Subtotal	**152**	**$149,884,968**	**7**	**41**	**$5,396,248**
Mitigation Planning Region H					
Allen	16	$0	2	2	$51,680
Bourbon	6	$0	0	3	$6,120
Chautauqua	5	$0	0	0	N/A
Cherokee	8	$0	0	3	$138,751
Crawford	4	$398,772	1	6	$113,215
Elk	3	$0	0	0	N/A
Greenwood	10	$145,000	0	0	N/A
Labette	68	$66,935,742	1	6	$157,063

County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
Montgomery	17	$34,208	1	11	$151,912
Neosho	24	$211,817	2	3	$76,560
Woodson	5	$0	0	0	N/A
Subtotal	**166**	**$67,725,540**	**7**	**34**	**$695,301**
Mitigation Planning Region I					
Geary	14	$755,822	2	7	$209,756
Lyon	28	$222,538,890	2	10	$224,768
Morris	7	$0	0	0	N/A
Pottawatomie	4	$8,301,280	0	2	$4,200
Riley	7	$1,392,373	1	9	$103,481
Wabaunsee	3	$0	0	0	N/A
Subtotal	**63**	**$232,988,365**	**5**	**28**	**$542,205**
Mitigation Planning Region J					
Anderson	11	$0	1	3	$12,300
Coffey	2	$0	0	2	N/A
Franklin	2	$0	0	1	$5,400
Linn	6	$0	0	0	N/A
Miami	2	$0	0	1	$65,000
Shawnee	78	$548,772,088	13	83	$7,211,807
Subtotal	**101**	**$548,772,088**	**14**	**90**	**$7,294,507**
Mitigation Planning Region K					
Atchison	9	$253,358	1	4	$138,670
Brown	3	$0	1	1	$38,530
Doniphan	2	$0	0	2	$1,680
Douglas	20	$202,180,911	1	4	$371,682
Jackson	2	$0	0	0	N/A
Marshall	1	$0	1	1	$61,498
Nemaha	8	$21,656	0	1	$2,400
Washington	5	$0	0	0	N/A
Subtotal	**50**	**$202,455,925**	**4**	**13**	**$614,460**
Mitigation Planning Region L					
Johnson	33	$37,882,416	2	15	$1,445,090
Leavenworth	19	$78,420,223	1	3	$197,818
Wyandotte	68	$607,809,938	3	9	$2,427,946
Subtotal	**120**	**$724,112,577**	**6**	**27**	**$4,070,854**
Statewide Totals	**1104**	**$2,279,294,174**	**70**	**304**	**$21,207,220**

Loss Estimates

Due to the limitless variables associated with this hazard, including type of chemical, medium of release, population within proximity, method of containment, method of remediation, etc., It is

not possible to quantify future loss estimates to State owned and operated facilities due to Hazardous Materials Incidents.

3.5.11. Land Subsidence

To determine how vulnerability to this hazard varies across the State, a weighted calculation was performed based on the known number of acres in each subsurface void space risk category for each county. Acreage in risk Category I (High Risk) received a multiplier of three, acreage in risk Category II (Moderate Risk) received a multiplier of two and acreage in risk Category III (Low Risk) received a multiplier of one. See **Section 3.3.11** for additional information. The top 10 counties based on this methodology are listed in **Table 3.177**.

Table 3.177. Top 10 Counties Vulnerable to Land Subsidence According to Weighted Calculation

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

The results of this analysis were then used to determine State owned and operated facilities within these counties. Although this analysis does not indicate specific facilities that are constructed over subsurface void space, it does provide information on the number and values of State owned facilities that are in the counties with the highest risk.

Vulnerability Overview

According to this analysis, a total of 467 State owned facilities were determined to be in the top 10 counties vulnerable to land subsidence. Of those, 20 were determined by KDEM to be critical facilities. Of the State operated facilities, 46 were determined to be in the top 10 counties vulnerable to land subsidence.

Table 3.178 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.178. Summary of State Owned and Operated Facilities In Top 10 Counties Vulnerable to Land Subsidence

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
E	Barber	10	$55,058	0	0	N/A
F	Ellsworth	30	Not Reported	2	0	N/A
G	Reno	139	$244,179,141	4	10	$395,055
G	Rice	7	Not Reported	0	0	N/A
H	Cherokee	12	$1,003,200	0	3	$138,751
H	Crawford	78	$429,685,629	4	6	$113,215
J	Osage	16	$56,027	1	0	N/A
L	Johnson	50	$83,631,716	3	15	$1,445,090
L	Leavenworth	49	$126,218,803	1	3	$197,818
L	Wyandotte	76	$607,809,938	5	9	$2,427,946
Total		**467**	**$1,492,639,512**	**20**	**46**	**$4,717,875**

Loss Estimates

With a conservative loss estimate of 10 percent damages to State owned facilities as a result of damages from land subsidence, damages would be $149,263,951 based on the insured value of State owned facilities in the top 10 counties vulnerable to land subsidence. However, it should be noted that of the 467 facilities in these counties, insured values were provided for only 45 percent of the facilities (less than half). A 10 percent damage estimate was chosen to reflect damages that might be incurred as a result of cracks to foundations and/or footings as a result of subsidence impacting state owned facilities. Although damage would be higher to buildings impacted by a large sinkhole, damages are not likely to occur to all of the State owned buildings within these vulnerable counties.

3.5.12. Landslide

According to the Kansas Geological Survey, there are some areas in the State that are more prone to landslides than others (see **Section 3.3.12**). For the analysis of State owned and operated facilities that may be vulnerable to landslide, the number and insured values of State owned and operated facilities was determined for those counties in the State that are determined to have landslide prone areas. **Table 3.179** is the list of Kansas counties with landslide-prone areas.

Table 3.179. Counties in Kansas With Landslide-prone Areas

Mitigation Planning Region	County
A	Cheyenne
B	Ellis
B	Rush
B	Russell
C	Stanton
D	Ford
D	Hodgeman

Mitigation Planning Region	County
G	Marion
G	Rice
I	Riley
J	Shawnee
K	Atchison
K	Brown
K	Doniphan

Mitigation Planning Region	County
E	Pawnee
F	Clay
F	Cloud
F	Ellsworth
F	Lincoln
F	Mitchell
F	Osborne
F	Republic
F	Saline

Mitigation Planning Region	County
K	Jefferson
K	Washington
K	Douglas
L	Johnson
L	Leavenworth
L	Wyandotte

Vulnerability Overview

According to this analysis, a total of 1,223 State owned facilities were determined to be in counties with landslide-prone areas. Of those, 57 were determined by KDEM to be critical Facilities. Of the State operated facilities, were determined to be in counties with landslide prone areas.

Table 3.180 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.180. Summary of State Owned and Operated Facilities Kansas Counties with Landslide-prone Areas

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
A	Cheyenne	10	$144,216	0	0	N/A
A Total		10	$144,216	0	0	0
B	Ellis	85	$499,944,440	4	14	$259,590
B	Rush	5	$0	0	0	N/A
B	Russell	9	$0	0	0	N/A
B Total		99	$499,944,440	4	14	259590
C	Stanton	0	N/A	0	0	N/A
C Total		0	0	0	0	0
D	Ford	38	$1,312,803	3	0	$241,284
D	Hodgeman	5	$0	0	11	N/A
D Total		43	$1,312,803	3	11	241284
E	Pawnee	59	$165,607,624	1	0	N/A
E Total		59	$165,607,624	1	0	0
F	Clay	10	$0	2	0	N/A
F	Cloud	9	$23,466	1	4	$65,208
F	Ellsworth	30	$0	2	0	N/A
F	Lincoln	5	$0	0	0	N/A
F	Mitchell	5	$0	0	0	N/A

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	#of State Operated Facilities	Annual Rent for State operated Facilities
F	Osborne	7	$0	0	0	N/A
F	Republic	8	$0	0	0	N/A
F	Saline	48	$121,235,236	5	17	$1,331,186
F Total		122	$121,258,702	10	21	$1,396,394
G	Marion	12	$0	1	1	$1,200
G	Rice	7	$0	0	0	N/A
G Total		19	$0	1	1	1200
I	Riley	207	$2,274,143,645	2	16	$434,863
I Total		207	$2,274,143,645	2	16	$434,863
J	Shawnee	196	$758,214,399	21	93	$8,361,725
J Total		196	$758,214,399	21	93	$8,361,725
K	Atchison	37	$23,563,802	2	4	$138,670
K	Brown	18	$48,872	2	1	$38,530
K	Doniphan	11	$0	0	2	$1,680
K	Douglas	207	$3,575,686,086	2	14	$5,173,947
K	Jefferson	10	$7,794,240	0	1	$452,038
K	Washington	10	$24,780	0	0	N/A
K Total		293	$3,607,117,780	6	22	5804865
L	Johnson	50	$83,631,716	3	20	$1,706,467
L	Leavenworth	49	$126,218,803	1	4	$209,158
L	Wyandotte	76	$607,809,938	5	14	$2,601,623
L Total		175	$817,660,457	9	38	$4,517,248
Grand Total		**1,223**	**$8,245,404,066**	**57**	**216**	**$21,017,169**

Loss Estimates

Since specific buildings that are prone to landslide are not known, it is not possible to generate reasonable loss estimates to State owned and operated facilities as a result of landslide.

3.5.13. Lightning

All State owned and operated facilities are vulnerable to lightning to some extent. However, to refine the analysis of State owned and operated facilities that are vulnerable to lightning, the number and insured values/annual rent for State owned and operated facilities was determined for those counties in the State that were determined to be in the top 10 counties vulnerable to lightning (see**Table 3.116)**.

Vulnerability Overview

According to this analysis, a total of 749 State owned facilities were determined to be in the top 10 counties vulnerable to lightning. Of those, 46 were determined by KDEM to be critical Facilities. Of the State operated facilities, 190 were determined to be in the top 10 counties vulnerable to lightning.

Table 3.181 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.181. Summary of State owned and Operated Facilities In Top 10 Counties Vulnerable to Lightning

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
A	Rawlins	8	$0	1	0	$0
A	Thomas	16	$2,649,911	2	6	$142,307
F	Dickinson	11	$0	1	0	$0
G	Cowley	44	$36,176,435	2	2	$168,591
G	Sedgwick	123	$868,325,498	7	38	$5,247,898
I	Riley	207	$2,274,143,645	2	16	$434,863
J	Shawnee	196	$758,214,399	21	93	$8,361,725
K	Brown	18	$48,872	2	1	$38,530
L	Johnson	50	$83,631,716	3	20	$1,706,467
L	Wyandotte	76	$607,809,938	5	14	$2,601,623
Total		**749**	**$4,631,000,414**	**46**	**190**	**$18,702,004**

Loss Estimates

The type and severity of damages caused by lightning varies with each event. It is not possible to generate reasonable loss estimates to State owned and operated facilities as a result of lightning.

3.5.14. Major Disease Outbreak

State owned facilities are not directly impacted by this hazard. However, the Kansas Department of Health and Environment would be heavily involved in response to an incident.

3.5.15. Radiological

There are several Kansas counties included in 10-mile and 50-mile emergency planning zones (EPZ) for nuclear power plants. There are two commercial plants that could pose a threat to Kansas: The Wolf Creek Nuclear Power Plant in Coffey County and the Cooper Nuclear Station in Nemaha County, Nebraska (southeast).There is also Kansas State University‘s TRIGA research reactor that supports education, research, training, and regional industries. The following lists the counties in the EPZ for each of these nuclear facilities:

Cooper Generating Station 50 mile EPZ

- Brown

Wolf Creek Generating Station 50 mile EPZ

- Allen

KSU Research Reactor

- Riley

- Doniphan
- Marshall
- Nemaha
- Anderson
- Bourbon
- Chase
- Coffey
- Douglas
- Franklin
- Linn
- Lyon
- Miami
- Morris
- Neosho
- Osage
- Shawnee
- Wabaunsee
- Wilson
- Woodson

To determine State owned and operated facilities at-risk to radiological incidents from these facilities, the State owned and operated facility inventory was analyzed to determine the number and values of facilities within these counties.

Vulnerability Overview

According to this analysis, a total of 977 State owned facilities were determined to be in counties within EPZs of Radiological facilities. Of those, 42 were determined by KDEM to be Critical Facilities. Of the State operated facilities, 157 were determined to be in counties within EPZs of radiological facilities.

Table 3.182 provides the results of this analysis by county, organized by Mitigation Planning Region. The data is also highlighted to correspond with the previous table indicating the nuclear power plant/reactor and EPZ area.

Table 3.182. County Summary of State owned and Operated Facilities In EPZs of Nuclear Power Plants/ Reactors

Mitigation planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
H	Allen	16	$0	2	2	$51,680
H	Bourbon	9	$35,070	0	3	$6,120
H	Neosho	31	$5,380,255	3	5	$100,504
H	Wilson	7	$0	0	0	N/A
H	Woodson	12	$28,157	0	0	N/A
I	Chase	7	$39,014	0	0	N/A

Mitigation planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
I	Lyon	92	$372,860,191	4	11	$230,768
I	Morris	7	$0	0	0	N/A
I	Riley	207	$2,274,143,645	2	16	$434,863
I	Wabaunsee	16	$0	0	0	N/A
J	Anderson	13	$0	1	3	$12,300
J	Coffey	9	$0	0	0	N/A
J	Franklin	10	$0	1	3	$137,152
J	Linn	27	$168,597	0	0	N/A
J	Miami	51	$55,764,214	2	2	$65,600
J	Osage	16	$56,027	1	0	N/A
J	Shawnee	196	$758,214,399	21	93	$8,361,725
K	Brown	18	$48,872	2	1	$38,530
K	Doniphan	11	$0	0	2	$1,680
K	Douglas	207	$3,575,686,086	2	14	$5,173,947
K	Marshall	7	$0	1	1	$61,498
K	Nemaha	8	$21,656	0	1	$2,400
Totals		**977**	**$7,042,446,183**	**42**	**157**	**$14,678,766**

Loss Estimates

It is not possible to quantify specific loss estimates as a result of a radiological event due to the variables involved.

3.5.16. Soil Erosion and Dust

State owned facilities are not directly impacted by this hazard.

3.5.17. Terrorism/Agri-terrorism

Due to the variables involved, data is not available to quantify vulnerability or estimated losses to State owned or operated facilities as a result of terrorism.

3.5.18. Tornado

All State owned and operated facilities are vulnerable to tornado to some extent. However, to refine the analysis of State owned and operated facilities that are vulnerable to tornado, the number and insured values/annual rent for State owned and operated facilities was determined for those counties in the State that were determined to be in the top counties vulnerable to tornado damage (see **Table 3.88)**.

Vulnerability Overview

According to this analysis, a total of 256 State owned facilities were determined to be in the top 10 counties vulnerable to tornado. Of those, 13 were determined by KDEM to be critical facilities. Of the State operated facilities, 70 were determined to be in the top counties vulnerable to tornado.

Table 3.183 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.183. Summary of State Owned and Operated Facilities In Top 10 Counties Vulnerable to Tornado

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
A	Sheridan	14	$37,187	0	0	$0
A	Sherman	6	$0	0	1	$20,218
B	Rooks	11	$21,113	0	2	$18,000
B	Rush	5	$0	0	0	$0
E	Barton	27	$9,109,427	3	7	$175,208
E	Stafford	4	$501,600	0	2	$33,000
F	Republic	8	$0	0	0	$0
G	Harper	8	$0	0	0	$0
G	Sedgwick	123	$868,325,498	7	38	$5,247,898
L	Johnson	50	$83,631,716	3	20	$1,706,467
Total		**256**	**$961,626,541**	**13**	**70**	**$7,200,791**

Loss Estimates

The type and severity of damages caused by tornadoes varies with each event. With these variables, it is not possible to generate reasonable loss estimates to State owned and operated facilities as a result of tornado.

3.5.19. Utility/Infrastructure Failure

The primary impact to State owned and operated facilities from utility failure is the inability to provide continuous state government services.

3.5.20. Wildfire

A ‗Wildfire Risk' composite layer was developed for the 2011 *Kansas Forest Action Plan* (http://www.kansasforests.org/assessment.shtml). This layer was created using a ‗Weighted Sum' analysis to combine six data layers produced from a combination of eight separate datasets. In close consultation with the Kansas Forest Service's Fire Management Coordinator and other Fire Management staff six data inputs were developed to represent Wildfire Risk in Kansas. These data inputs and their corresponding analysis weight are listed below:

1. Wildland Urban Interface—from 3 data sets (.85)
2. ISO Fire Station Coverage Gaps (.75);
3. Conservation Reserve Program Lands (.60);
4. Eastern Redcedar in Grasslands (.75);
5. ‗Moderate' Fire Potential risk and (.53);
6. ‗High' Fire Potential risk (.80).

The six data layer inputs were combined using the _Weighted Sum' analysis. The results contain values ranging from 0 to 3.48. The complete list of counties and their mean wildfire risk scores can be found in **Table 3.142**. **Table 3.184** provides top 10 Kansas counties according to the mean wildfire risk scores.

Table 3.184. Top 10 Counties by Mean Wildfire Risk Score

Mitigation Planning Region	County	Mean Wildfire Risk Score
C	Morton	1.02080094814
C	Hamilton	1.00021004677
I	Chase	0.98686426878
C	Greeley	0.89731788635
D	Meade	0.89620631933
A	Logan	0.87758433819
A	Wallace	0.85376489162
H	Greenwood	0.84238952398
C	Stevens	0.83445894718
A	Cheyenne	0.83202922344

To determine State owned and operated facilities at-risk to wildfire, the State owned and operated facility inventory was analyzed to determine the number and values of facilities within these counties.

Vulnerability Overview

According to this analysis, a total of 100 State owned facilities were determined to be in the top 10 counties by mean wildfire risk score. Of those, 2 were determined by KDEM to be critical facilities. Of the State operated facilities, 2 were determined to be in the top 10 counties by mean wildfire risk score.

Table 3.185 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.185. County Summary of State Owned and Operated Facilities in Top 10 Wildfire Risk Counties

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
A	Cheyenne	10	$144,216	0	0	N/A
A	Logan	16	$0	1	1	$1,200
A	Wallace	5	$0	0	0	N/A
C	Greeley	12	$2,119,260	0	0	N/A
C	Hamilton	10	$15,849	1	0	N/A

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
C	Morton	7	$0	0	0	N/A
C	Stevens	5	$0	0	0	N/A
D	Meade	18	$780,407	0	0	N/A
H	Greenwood	10	$145,000	0	1	$7,200
I	Chase	7	$39,014	0	0	N/A
Totals		**100**	**$3,243,746**	**2**	**2**	**$8,400**

Loss Estimates

Due to the variables associated with specific wildfire events, it is not possible to estimate losses.

3.5.21. Windstorm

All State owned and operated facilities are vulnerable to windstorm to some extent. However, to refine the analysis of State owned and operated facilities that are vulnerable to windstorm, the number and insured values/annual rent for State owned and operated facilities was determined for those counties in the State that were determined to be in the top counties vulnerable to wind damage (see **Table 3.150)**.

Vulnerability Overview

According to this analysis, a total of 324 State owned facilities were determined to be in the top counties vulnerable to windstorm. Of those, 18 were determined by KDEM to be critical facilities. Of the State operated facilities, 76 were determined to be in the top counties vulnerable to wind.

Table 3.186 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.186. Summary of State Owned and Operated Facilities In Top Counties Vulnerable to Windstorm

Mitigation Planning Region	County	# of State Owned Facilities	Insured Value of State Owned Facilities	# of State Owned Critical Facilities	# of State Operated Facilities	Annual Rent for State Operated Facilities
A	Cheyenne	10	$144,216	0	0	$0
A	Sherman	6	$0	0	1	$20,218
A	Thomas	16	$2,649,911	2	6	$142,307
B	Norton	56	$0	3	0	$0
C	Greeley	12	$2,119,260	0	0	$0
C	Morton	7	$0	0	0	$0
C	Stanton	0	$0	0	0	$0
C	Stevens	5	$0	0	0	$0
D	Finney	31	$369,794	2	11	$385,136

D	Haskell	8	$0	1	0	$0
G	Sedgwick	123	$868,325,498	7	38	$5,247,898
L	Johnson	50	$83,631,716	3	20	$1,706,467
Total		**324**	**$957,240,395**	**18**	**76**	**$7,502,026**

Loss Estimates

The type and severity of damages caused by windstorms vary with each event as well as the type of structure impacted. With these variables, it is not possible to generate reasonable loss estimates to State owned and operated facilities as a result of windstorm.

3.5.22. Winter Storm

All State owned and operated facilities are vulnerable to winter storm to some extent. However, to refine the analysis of State owned and operated facilities that are most vulnerable to winter storm, the number and insured values/annual rent for State owned and operated facilities was determined for those counties in the State that were determined to be in the top counties vulnerable to winter storm (see **Table 3.159)**.

Vulnerability Overview

According to this analysis, a total of 411 State owned facilities were determined to be in the top counties vulnerable to winter storm. Of those, 21 were determined by KDEM to be critical facilities. Of the State operated facilities, 82 were determined to be in the top counties vulnerable to winter storm

Table 3.187 provides the results of this analysis by county, organized by Mitigation Planning Region.

Table 3.187. Summary of State Owned and Operated Facilities In Top Counties Vulnerable to Winter Storm

Mitigation Planning Region	County	# of State owned Facilities	Insured Value of State owned Facilities	# of State owned Critical Facilities	# of State operated Facilities	Annual Rent for State operated Facilities
A	Sheridan	14	$37,187	0	0	$0
A	Sherman	6	$0	0	1	$20,218
A	Thomas	16	$2,649,911	2	6	$142,307
F	Cloud	9	$23,466	1	4	$65,208
F	Dickinson	11	$0	1	0	$0
F	Republic	8	$0	0	0	$0
G	Reno	139	$244,179,141	4	11	$399,784
G	Sedgwick	123	$868,325,498	7	38	$5,247,898
K	Brown	18	$48,872	2	1	$38,530
K	Marshall	7	$0	1	1	$61,498
K	Washington	10	$24,780	0	0	$0
L	Johnson	50	$83,631,716	3	20	$1,706,467
Total		**411**	**$1,198,920,571**	**21**	**82**	**$7,681,910**

Loss Estimates

The type and severity of damages caused by winter storm vary with each event as well as the type of structure impacted. With these variables, it is not possible to generate reasonable loss estimates to State owned and operated facilities as a result of winter storm.

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