# 4.0 Hazard Profiles

## 4.1 – Introduction

The ultimate purpose of this HMP is to minimize the loss of life and property. To accomplish this, all relevant hazards and vulnerabilities the region faces have been identified. Once this identification has been completed, Kansas Region K and all participating jurisdictions can use the accumulated data to assist in the development of and prioritization of mitigation action to defend against these potential risks.

## 4.2 – Methodology

Each hazard that has historically, or could potentially, affect Kansas Region K is reviewed and discussed in detail. In general, each hazard details the following information:

- Location and Extent
- Previous Occurrences
- Hazard Probability Analysis
- Vulnerability Assessment

Data sets used for this HMP were designed to follow the lead of the 2018 State of Kansas Hazard Mitigation Plan. Ten-year data sets from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) (2009 to 2018, with 2009 and 2018 being full data set years) were used, where applicable, for hazard occurrence and impact data. Five-year data sets from the United States Department of Agriculture (USDA) Risk Management Agency (2009 to 2018, with 2013 and 2018 being full data set years) were used to determine agricultural losses. The ten-year data set was used to reflect the change in the climate and more accurately depict changes in the region. Where data sets were unavailable for a hazard, local reporting from participating jurisdictions was relied upon.

In addition, to ensure compliance with EMAP standards, a hazard consequence analysis was conducted for each hazard detailing the following potential impacts:

- Health and Safety of the Public
- Health and Safety of Responders
- Continuity of Operations; Property, Facilities, and Infrastructure
- Environment
- Economic Conditions
- Public Confidence in the Jurisdiction’s Governance.

## 4.3 – Declared Federal Disasters

Historical events of significant magnitude or impact can result in a Secretarial or Presidential Disaster Declaration. The MPC reviewed the historical federal disaster declarations to assist in hazard identification. Since the approval of the previous Kansas Region K hazard mitigation plan in 2013, there have been two federal disaster declaration for the region, as follows:

- DR 4417: Declared on February 25, 2019 – Severe Storms, Straight-Line Winds and Flooding

- DR 4230: Declared on July 20, 2015 – Severe Storms, Tornados, Straight-Line Winds and Flooding

Since the 2013 plan there have be no Fire Management Assistance Declarations

For the 20-year period from 2009 to 2018, Kansas Region K has had 17 federal disaster declarations. These declarations included the following identified hazards:

- Flooding
- Ice Storm
- Severe Storms
- Straight-Line Winds
- Severe Winter Storms
- Tornados

Information on past declared disasters are presented in the subsequent, relevant sections.

## 4.4 – Identified Potential Hazards

Based on the above data, and data contained in previous mitigation plans, Kansas Region K's MPC met to discuss previously identified hazards and deliberate on any changes or additions. Based on this review, no changes, additions or subtractions were indicated for any identified hazard. Additionally, a thorough and comprehensive revision of data for each hazard was completed as part of this plan update.

The MPC confirmed sixteen natural hazards that may impact Kansas Region K, as listed below:

- Agricultural Infestation
- Dam/Levee Failure
- Drought
- Earthquake
- Expansive Soils
- Extreme Temperatures

- Flood
- Hailstorm
- Land Subsidence
- Landslide

- Lightning
- Soil Erosion and Dust
- Tornado
- Wildfire
- Wind Storm
- Winter Storm

Additionally, the MPC confirmed six man-made hazards that may impact Kansas Region K, as listed below:

- Civil Disorder
- Hazardous Materials Incident
- Major Disease Outbreak
- Radiological Event
- Terrorism/Agri-Terrorism
- Utility/Infrastructure Failure

Based on discussion with the MPC, a lack of identified risk or history, and geographic improbability, numerous FEMA identified hazards such as coastal erosion, hurricane, tsunami were not included in the scope of this plan.

## 4.5 – Hazard Planning Significance

Previous planning efforts used the calculated priority risk index (CPRI) methodology to assign a planning significance to each of the identified hazards. CPRI considers the following four elements of risk:

- Probability of an Impactful Event
- Magnitude/Severity
- Warning Time
- Duration

Each element was then assigned a number based on pre-established rating parameters. The following tables provide a summary for each of the risk elements, including a rationale behind each numerical rating.

**Table 4.1: CPRI Element Ratings**

| CPRI Element | Rating Number and Definition | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Probability** | Unlikely (10% chance of occurrence) | Occasional (20% chance of occurrence) | Likely (33% chance of occurrence) | Highly Likely (100% chance of occurrence) |

| Magnitude | Negligible (Minor injuries and <10% of property severely damaged) | Limited (Multiple injuries and 10-25% of property severely damaged) | Critical (Multiple disabling injuries and 25-50% of property severely damaged) | Catastrophic (Multiple deaths and 50% of property severely damaged) |
|---|---|---|---|---|
| **Warning Time** | 24+ hours | 12-24 hours | 6-12 hours | <6 hours |
| **Duration** | < 6 hours | < 1 day | < 1 week | 1 week + |

Using the rankings, the following weighted formula was used to determine each hazard's CPRI:

**+ (Probability x 0.45) (Magnitude/Severity x 0.30) + (Warning Time x 0.15) + (Duration x 0.10)**

Each planning significance category was assigned a CPRI range, with a higher score indicating greater planning criticality. The following table details planning significance CPRI ranges.

**Table 4.2: CPRI Planning Significance Range**

| | CPRI Range | |
|---|---|---|
| **Planning Significance** | **Low CPRI** | **High CPRI** |
| **High** | 3.0 | 4.0 |
| **Moderate** | 2.0 | 2.9 |
| **Low** | 1.0 | 1.9 |

The terms high, moderate and low indicate the level of planning significance for each hazard, and do not indicate the potential impact of a hazard occurring. Hazards rated with moderate or high planning significance were more thoroughly investigated and discussed due to the availability of data and historic occurrences, while those with a low planning significance were generally addressed due to lack of available data and historical occurrences. The following table shows the CPRI ratings for Kansas Region K.

**Table 4.3: Kansas Region K Natural Hazard CPRI Planning Significance**

| Hazard | Probability | Magnitude/Severity | Warning Time | Duration | CPRI |
|---|---|---|---|---|---|
| Agricultural Infestation | 1.5 | 2.0 | 1.0 | 4.0 | **1.7** |
| Dam and Levee Failure | 1.5 | 3.0 | 2.0 | 3.5 | **2.1** |
| Drought | 2.5 | 2.0 | 1.0 | 4.0 | **2.2** |
| Earthquake | 1.0 | 1.0 | 4.0 | 1.0 | **1.5** |
| Expansive Soils | 1.5 | 1.0 | 1.0 | 4.0 | **1.6** |
| Extreme Temperature | 3.0 | 2.0 | 1.0 | 3.0 | **2.4** |
| Flood | 3.0 | 3.0 | 2.5 | 3.0 | **3.0** |
| Hailstorm | 4.0 | 2.5 | 3.0 | 1.0 | **3.0** |

| | | | | | |
|---|---|---|---|---|---|
| Land Subsidence | 1.0 | 1.0 | 2.0 | 4.0 | **1.5** |
| Landslide | 1.0 | 1.0 | 3.5 | 1.0 | **1.4** |
| Lightning | 2.5 | 1.0 | 2.5 | 1.0 | **1.9** |
| Soil Erosion & Dust | 2.0 | 1.0 | 1.0 | 4.0 | **1.7** |
| Tornado | 3.0 | 3.0 | 4.0 | 1.0 | **2.9** |

**Table 4.3: Kansas Region K Natural Hazard CPRI Planning Significance**

| Hazard | Probability | Magnitude/Severity | Warning Time | Duration | CPRI |
|---|---|---|---|---|---|
| Wildfire | 3.0 | 3.0 | 4.0 | 2.0 | **3.0** |
| Windstorm | 3.5 | 2.5 | 3.0 | 2.0 | **3.0** |
| Winter Storm | 4.0 | 2.5 | 2.0 | 3.0 | **3.1** |

**Table 4.4: Kansas Region K Man-Made Hazard CPRI Planning Significance**

| Hazard | Probability | Magnitude/Severity | Warning Time | Duration | CPRI |
|---|---|---|---|---|---|
| Civil Disorder | 1.0 | 2.0 | 4.0 | 1.0 | **1.8** |
| Hazardous Materials Event | 2.0 | 2.0 | 4.0 | 2.0 | **2.3** |
| Major Disease Outbreak | 1.0 | 3.0 | 1.0 | 4.0 | **2.0** |
| Radiological Event | 1.0 | 1.5 | 3.5 | 4.0 | **1.8** |
| Terrorism, Agri-Terrorism | 1.0 | 2.5 | 4.0 | 1.5 | **1.9** |
| Utility / Infrastructure Failure | 3.0 | 2.0 | 3.5 | 3.0 | **2.9** |

The average CPRI for each identified hazard remained the same as the calculated CPRI for the 2014 planning effort, where individual county rankings were combined into a regional ranking.

## 4.6 – Hazard Profiles

*44 CFR 201.6(c)(2)(i): A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

*44 CFR 201.7(c)(2)(i): A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*

Each identified hazard is profiled in the subsequent sections, with the level of detail varying based on available information. Sources of information are cited in the detailed hazard profiles below.

With each update of this plan, new information will be incorporated to provide for better evaluation and prioritization of the hazards.

The following hazards are presented in alphabetical order, and not by planning significance, for ease of reference. Additionally, man-made hazards are presented, again in alphabetical order, after natural hazards.

## 4.7 – Agricultural Infestation


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

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

### 4.7.1 –Location and Extent

The entire planning area may be affected by agricultural infestation. While rural areas within the region are more susceptible to crop and livestock infestation, urban and suburban areas are also at risk due to landscaping, urban gardens and parks, all of which add value to homes and communities, may be susceptible to damage or loss. The magnitude and severity of an agricultural infestation is relative to the type of infestation. A foreign animal disease like foot and mouth could potentially cause the economy to crumble, whereas an infestation of fleas would be manageable. The MPC has determined that the magnitude of this hazard in the planning area would be limited, as most infestations are manageable in scope.

**Animal Disease**

Of key concern regarding this hazard is the potential introduction of a rapid and economically devastating foreign animal disease, including Foot and Mouth disease and Bovine Spongiform Encephalopathy (BSE) disease. Because Kansas is a major cattle state, with cattle raised locally as well as imported into the state, the potential for highly contagious diseases such as these is a

continuing, significant threat. The loss of production, death of animals, and other lasting problems resulting from an outbreak could cause continual and severe economic losses, as well as widespread unemployment. It would affect not only farmers, ranchers, and butchers, but also support and related industries

Of particular concern are Confined Animal Feeding Operations (CAFO) facilities, defined as facilities with 300 or more animal units. The CAFO facilities are regulated by the Kansas Department of Health & Environment (KDHE), Bureau of Water, and Livestock Waste Management. The CAFO includes beef, dairy, sheep, swine, chicken, turkey, and horses. The following is a list of the number of CAFOs per county, using the latest available data from 2016, in Kansas Region K:

- Atchison County: 3
- Brown County: 14
- Doniphan County: 2
- Douglas County: 2
- Jackson County: 5
- Jefferson County: 1
- Marshall County: 16
- Nemaha County: 84
- Washington County: 69

Knowing where diseased and at-risk animals are, where they've been and when, is important to ensuring a rapid response when animal disease events take place. The Kansas Department of Agriculture (KDA), Division of Animal Health monitors and reports on animal reportable diseases. Producers are required by state law to report any of the reportable animal diseases.

**Crop Pests and Diseases**

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

Field crops in the region are also subject to various types of infestation. According to KDA, Plant Protection and Weed Control Division, the following are the highest risk crop pests to this region and the potentially impacted crop:

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

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

**Tree Pests**

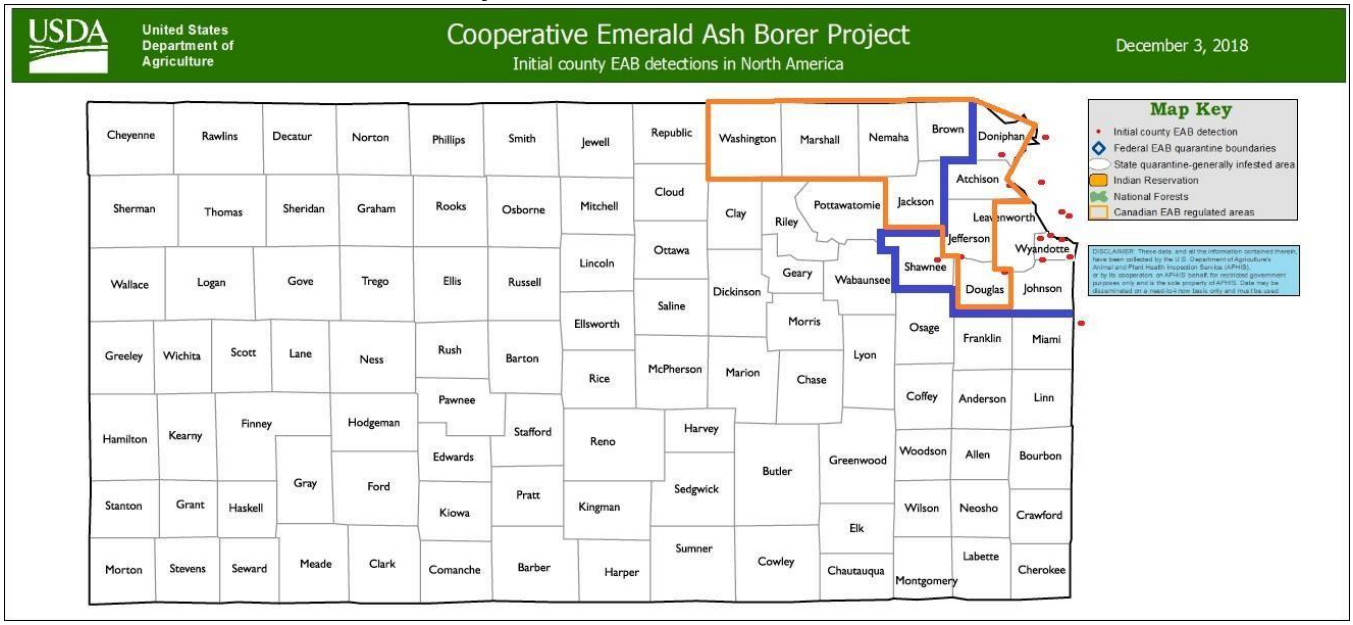
According to the KDA, Plant Protection and Weed Control Division, the following are the highest risk plant pests by host to Kansas Region K:

- Emerald Ash Borer (EAB): Ash Trees
- Asian Longhorned Beetle: Maple, Birch, Willow, Mimosa, Ash, Sycamore & Poplar Trees
- Thousand Cankers: Walnut Trees

As of this plan, neither the Asian Longhorned Beetle nor Thousand Cankers have been detected in Kansas.

As of this plan, the EAB has been discovered in numerous Kansas countries, including Atchison, Doniphan, Douglas and Jefferson in Region K. The following map from the USDA shows the Federal EAB Quarantine area for the State of Kansas in relation to Kansas Region K.

**Initial County EAB Detections, December 2018**




**Wildlife Pests**

The region's farmers also lose a significant amount of crops each year as a result of wildlife foraging. This can be particularly problematic in areas where natural habitat has been diminished

or in years where weather patterns such as early/late frost deep snow, or drought has caused the wild food sources to be limited. Also of concern are the following wildlife diseases:

- Chronic Wasting Disease (CWD), affecting deer and captive elk populations.
- Hemorrhagic Disease (HD), affecting white-tailed deer

There have been 48 positive cases of CWD found in Kansas since surveillance started in 1996 and regular occurrences of HD seasonally in late summer and fall. These diseases can seriously damage the populations of the captive deer and elk farms and the wild deer populations but also affect the annual $350 million-dollar regional and statewide hunting economy.

### 4.7.2 – Previous Occurrences

There have been no major reported or recorded agricultural infestations, above what is considered a normal level, for Kansas Region K.

Crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of agricultural infestation on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates 166 claims on 30,050 acres for $2,442,785.

**Table 4.5: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Agricultural Infestation**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 8 | 1,102 | $200,143 |
| Brown | 11 | 930 | $140,277 |
| Doniphan | 14 | 818 | $147,373 |
| Douglas | 19 | 1,922 | $296,327 |
| Jackson | 6 | 1,897 | $325,068 |
| Jefferson | 12 | 884 | $103,591 |
| Marshall | 21 | 4,454 | $471,481 |
| Nemaha | 15 | 2,121 | $257,252 |
| Washington | 48 | 5,461 | $373,461 |

Source: USDA Farm Service Agency

### 4.7.3 – Hazard Probability Analysis

Kansas Region K experiences agricultural losses every year because of insects, vermin or diseases that impact plants and livestock. Data from the UDSA Risk Management Agency indicates that there has been at least one claimed incident of agricultural infestation for Kansas Region K for the period 2015 through 2018. Using the binomial probability equation (number of years with an event divided by total number of years in reporting period) we derive a probability 100% of a reportable

agricultural infestation event in a given year. However, the large majority of events are expected to be small and limited in scope.

### 4.7.4 – Vulnerability Assessment

Regional populations and facilities are not directly vulnerable to losses as a result of agricultural infestation. The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. The USDA Risk Management Agency provides information on insured crop losses related to identified hazards, with data from the ten-year period of 2009 to 2018 (with 2009 and 2018 being full data set years) used for analysis. The higher the percentage loss, the higher the vulnerability the county has to agricultural infestation events.

**Table 4.6: Agricultural Infestation Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 110 | 0.06% | $66,913,000 | $20,014 | 0.03% |
| Brown | 258,601 | 93 | 0.04% | $112,057,000 | $14,028 | 0.01% |
| Doniphan | 144,927 | 82 | 0.06% | $76,581,000 | $14,737 | 0.02% |
| Douglas | 159,261 | 192 | 0.12% | $65,867,000 | $29,633 | 0.04% |
| Jackson | 168,682 | 190 | 0.11% | $40,215,000 | $32,507 | 0.08% |
| Jefferson | 153,276 | 88 | 0.06% | $44,922,000 | $10,359 | 0.02% |
| Marshall | 361,473 | 445 | 0.12% | $92,882,000 | $47,148 | 0.05% |
| Nemaha | 268,088 | 212 | 0.08% | $76,127,000 | $25,725 | 0.03% |
| Washington | 336,673 | 546 | 0.16% | $87,087,000 | $37,346 | 0.04% |

Source: USDA

This table only reflects insured losses that were claimed. According to the 2017 Kansas Crop Insurance Profile Report issued by the USDA Risk Management Agency, 75-94% percent of major Kansas row crops were insured. Data regarding the number or value of livestock and wildlife lost to disease or infestation was not available for this planning effort.

In addition, threats have been identified which, while currently not impacting Kansas, may present a future risk. According to the KDA, Plant Protection and Weed Control Division the following table lists the highest risk plant pests to Kansas.

**Table 4.7: Potential High-Risk Plant Pests**

| Pest (Disease Insect, or weed) | Crop or Host Plant | Current Distribution | Type of Loss |
|---|---|---|---|
| Rust, Austro-Asian | Soybean | Australia, Japan, Pacific, Gulf of Mexico | Direct Loss to production |
| Aspergillus ear rot (Alfatoxin) | Corn | Worldwide, endemic to Kansas | Toxin renders the grain unusable |
| Black Stem Rust UG99 strain | Wheat | Africa, Asia | Direct Loss to production |
| Blast – South American strains | Wheat | South America | Direct Loss to production |
| Stripe Rust (new races) | Wheat | North America | Direct Loss to production |
| Leaf Rust (new races) | Wheat | North America | Direct Loss to production |
| Karnal Bunt | Wheat | Asia, Mexico, Arizona | International export quarantines, degradation of flour quality |
| Thousand Cankers | Walnut | Western US states and PA, VA, Tenn | Death of municipal trees, loss of nut crop, loss of timber |

**Table 4.7: Potential High-Risk Plant Pests**

| Pest (Disease Insect, or weed) | Crop or Host Plant | Current Distribution | Type of Loss |
|---|---|---|---|
| Emerald Ash Borer | Ash | North Central and North Eastern U.S., including Kansas (Wyandotte County) | Death of trees. Cost of removal and re-vegetation. |
| Asian Longhorned Beetle | Maples, Birches, Willows, Mimosa, Ash, Sycamore, Poplar trees | Small parts of Ohio, New York, and Massachusetts | Death of trees. Cost of removal and re-vegetation. |
| Hydrilla | Water Bodies | Southern U.S. and one park pond in Olathe | Economic and environmental. |

## 4.7.5 – Impact and Consequence Analysis

As per EMAP standards, the information in the following table provides the Consequence Analysis.

**Table 4.8: Agricultural Infestation Consequence Analysis**

| Subject | Impacts of Agricultural Infestation |
|---|---|
| Health and Safety of the Public | Impact in the area would be minimal. If the infestation is unrecognized, then there is the potential for the food supply to be contaminated. |
| Health and Safety of Responders | Impact would be minimal with protective clothing, gloves, etc as these diseases cause no risk to humans. |

| | |
|---|---|
| Continuity of Operations | Minimal expectation of execution of the COOP. |
| Property, Facilities, and Infrastructure | Localized impact to facilities and infrastructure in the incident area is minimal to non-existent. |
| Environment | Impact could be severe to the incident area, specifically, plants, trees, bushes, and crops. |
| Economic Conditions | Impacts to the economy will depend on the severity of the infestation. The potential for economic loss to the community and state could be severe if the infestation is hard to contain, eliminate, or reduce. Impact could be minimized due to crop insurance. |
| Public Confidence in the Jurisdiction's Governance | Confidence could be in question depending on timeliness and steps taken to warn the producers and public, and treat/eradicate the infestation. |

## 4.8 – Dam and Levee Failure

A dam is a barrier across flowing water that obstructs, directs or slows down the flow, often creating a reservoir, lake or impoundments. Common reasons for dam failure include:

- Flooding
- Sub-standard construction materials/techniques
- Spillway design error
- Geological instability caused by changes to water levels during filling or poor surveying
- Sliding of a mountain into the reservoir
- Poor maintenance, especially of outlet pipes
- Human, computer or design error
- Internal erosion, especially in earthen dams
- Earthquakes

A levee is an artificial barrier, usually an earthen embankment, constructed along rivers to protect adjacent lands from flooding. Common reasons for levee failure include:

- Surface erosion due to water velocities
- Subsurface actions
- Flood waters exceeding the design capacity of the structure

### 4.8.1 – Dam Location and Extent

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

- *any artificial barrier including appurtenant works with the ability to impound water, waste water or other liquids that has a height of 25 feet or more; or has a height of six feet or greater and also has the capacity to impound 50 or more acre feet. The height of a dam or barrier shall be determined as follows: (1) A barrier or dam that extends across the natural bed of a stream or watercourse shall be measured from the downstream toe of the barrier or dam to the top of the barrier or dam; or (2) a barrier or dam that does not extend across a stream or watercourse shall be measured from the lowest elevation of the outside limit of the barrier or dam to the top of the barrier or dam.*

The KDA Division of Water Resources (KDA-DWR) is the State agency responsible for regulation of jurisdictional dams. Within the DWR, the Water Structures Program has the following responsibilities:

- Reviewing and approving of plans for constructing new dams and for modifying existing dams
- Ensuring quality control during construction,
- Monitoring dams that, if they failed, could cause loss of life, or interrupt public utilities or services

The KDA-DWR uses a three-tiered classification system to describe the potential risk and severity associated with dam failure, with the tiers relating to potential downstream impact rather than the physical condition of the dam.

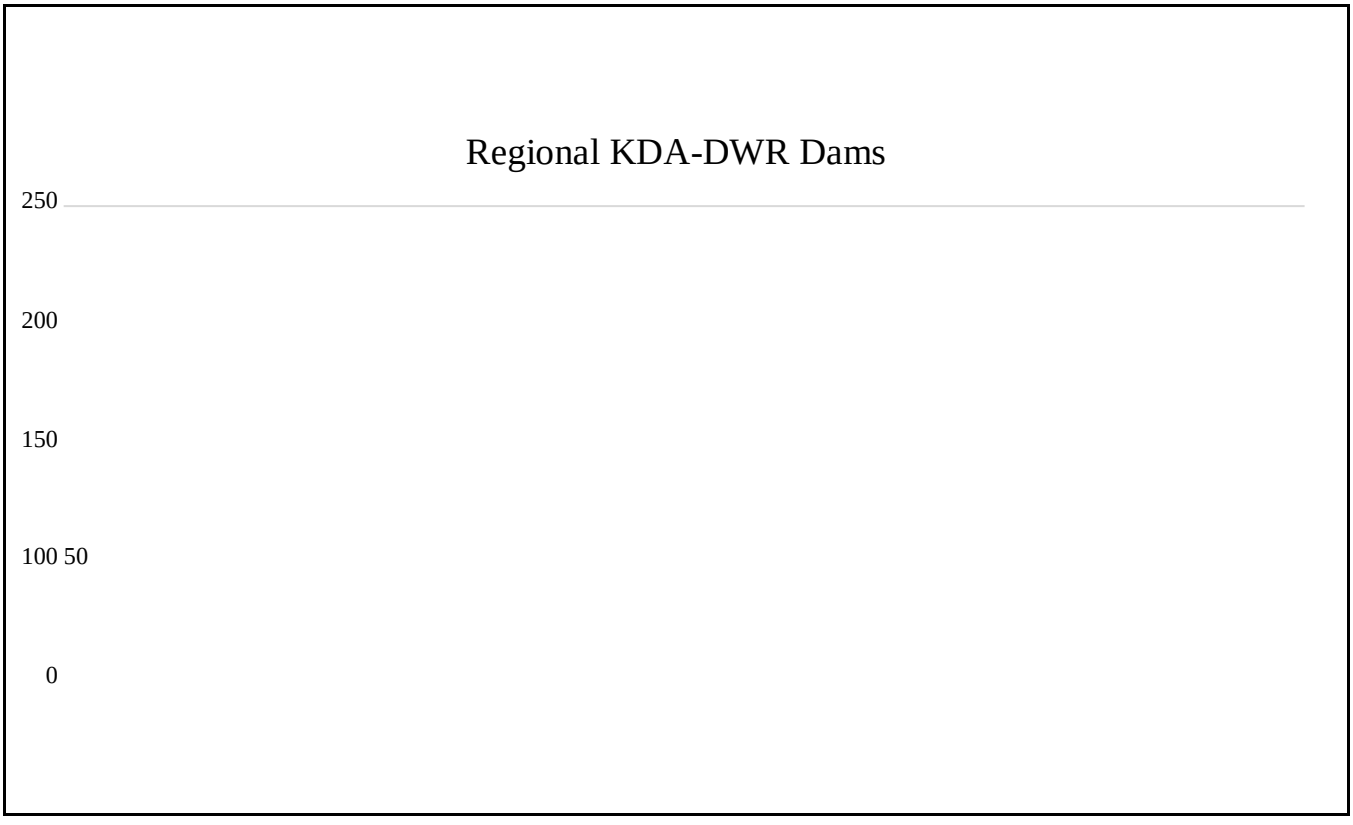
- **High Hazard (Class C):** Dams assigned the high hazard-potential classification are those where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high-volume roads that meet the requirements for hazard class C dams or a high-volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described in hazard class B. Emergency Action Plans (EAPs) are required for all High Hazard Dams.
- **Significant Hazard (Class B):** Dams assigned the significant hazard-potential classification are those dams where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet the requirements for hazard class B dams, damage low-volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation facilities, including campground areas intermittently used for sleeping and serving a relatively small number of persons.
- **Low Hazard (Class A):** Dams assigned the low hazard-potential classification are those where failure could damage only farm or other uninhabited buildings, agricultural or undeveloped land including hiking trails, or traffic on low-volume roads that meet the requirements for hazard class A dams.

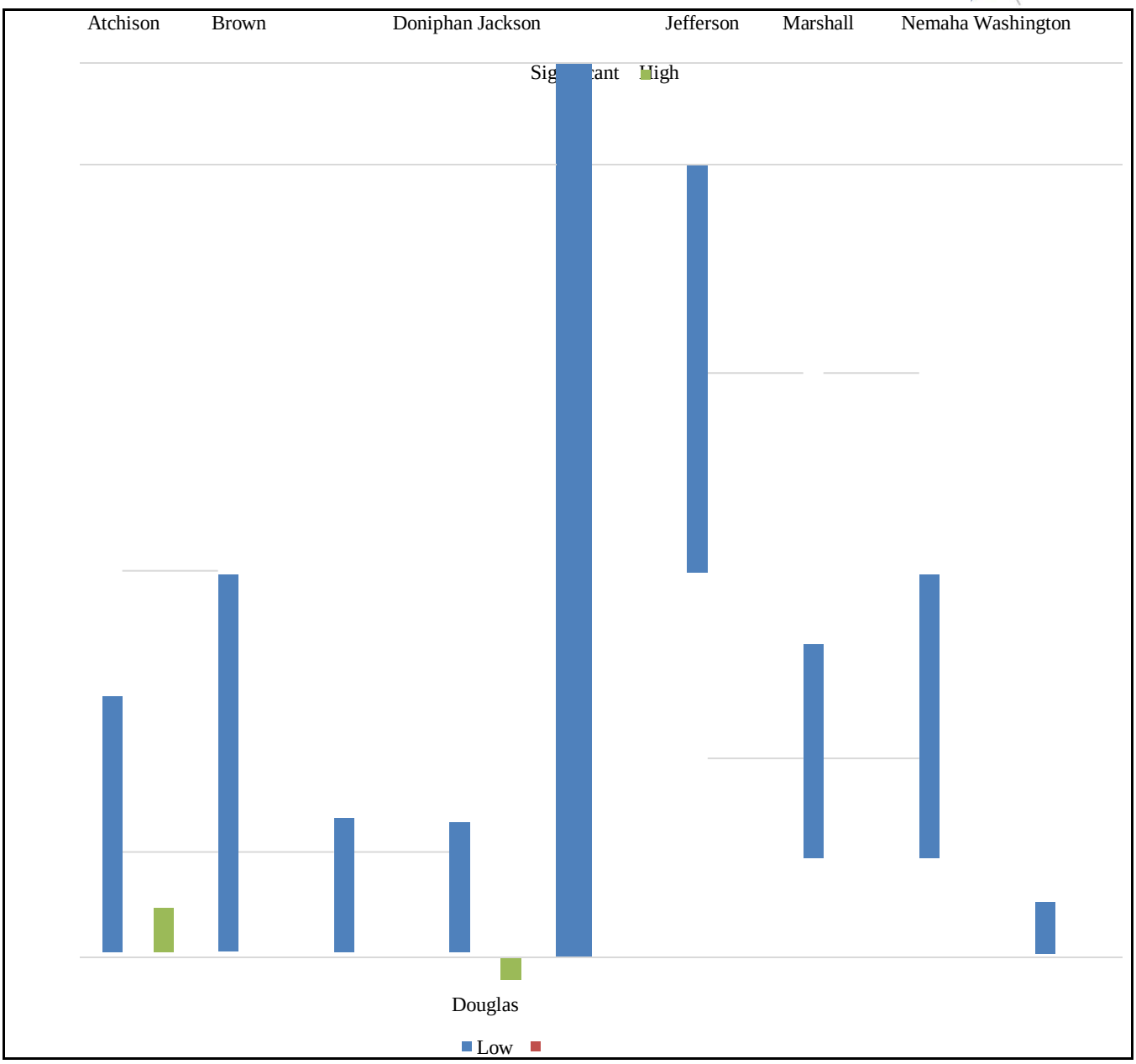
According to the KDA-DWR, there are 476 jurisdictional dams in Kansas Region K. These dams are classified as follows.

**Table 4.9: Kansas Region K KDA-DWR Jurisdictional Dams**

| County | Low | Significant | High | High Hazard Without EAP |
|---|---|---|---|---|
| Atchison | 128 | 3 | 22 | 0 |
| Brown | 189 | 8 | 5 | 0 |
| Doniphan | 67 | 1 | 0 | 0 |
| Douglas | 65 | 2 | 11 | 0 |
| Jackson | 201 | 6 | 3 | 0 |
| Jefferson | 204 | 3 | 2 | 0 |
| Marshall | 107 | 3 | 5 | 0 |
| Nemaha | 142 | 3 | 1 | 0 |
| Washington | 26 | 1 | 0 | 0 |

Source: KDA-DWR





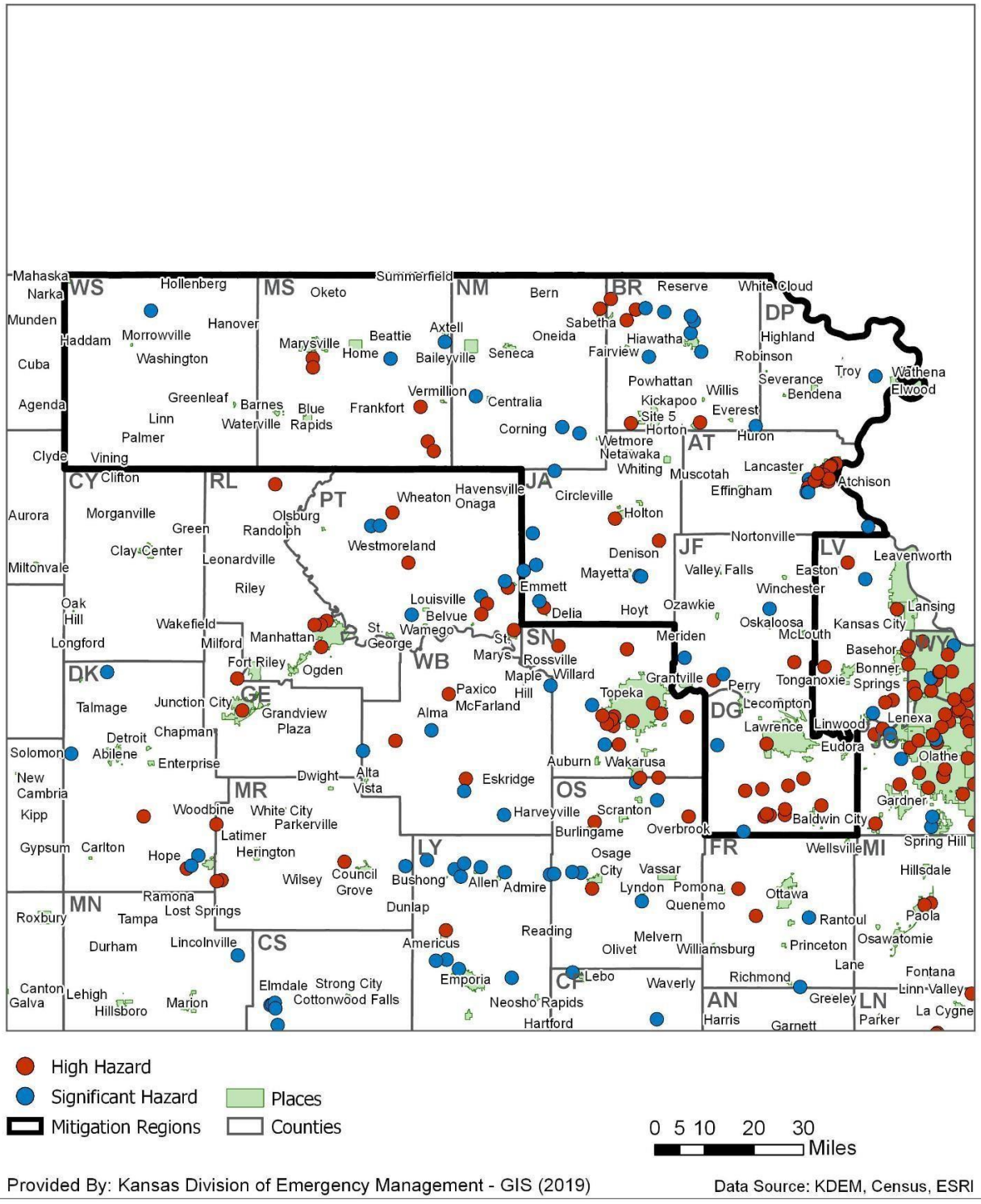

The following is a discussion of select high hazard dams within the region. It is worth noting that a many of these dams did not have inundation data completed, or the information is considered classified.

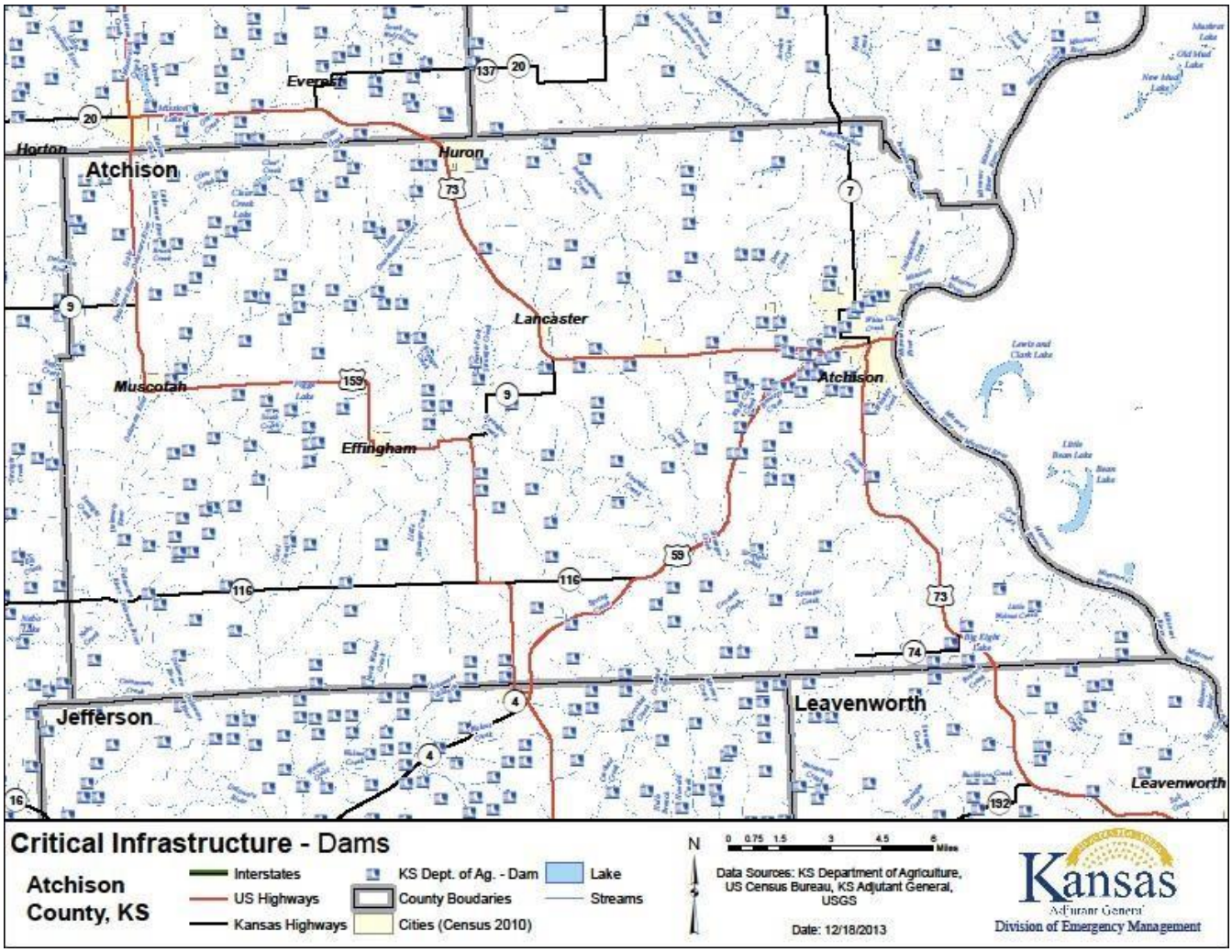
The following maps show all identified dams within Kansas Region K with a Significant or High classification, and available inundation and location mapping.

# Kansas Region K Significant and High Hazard Dams

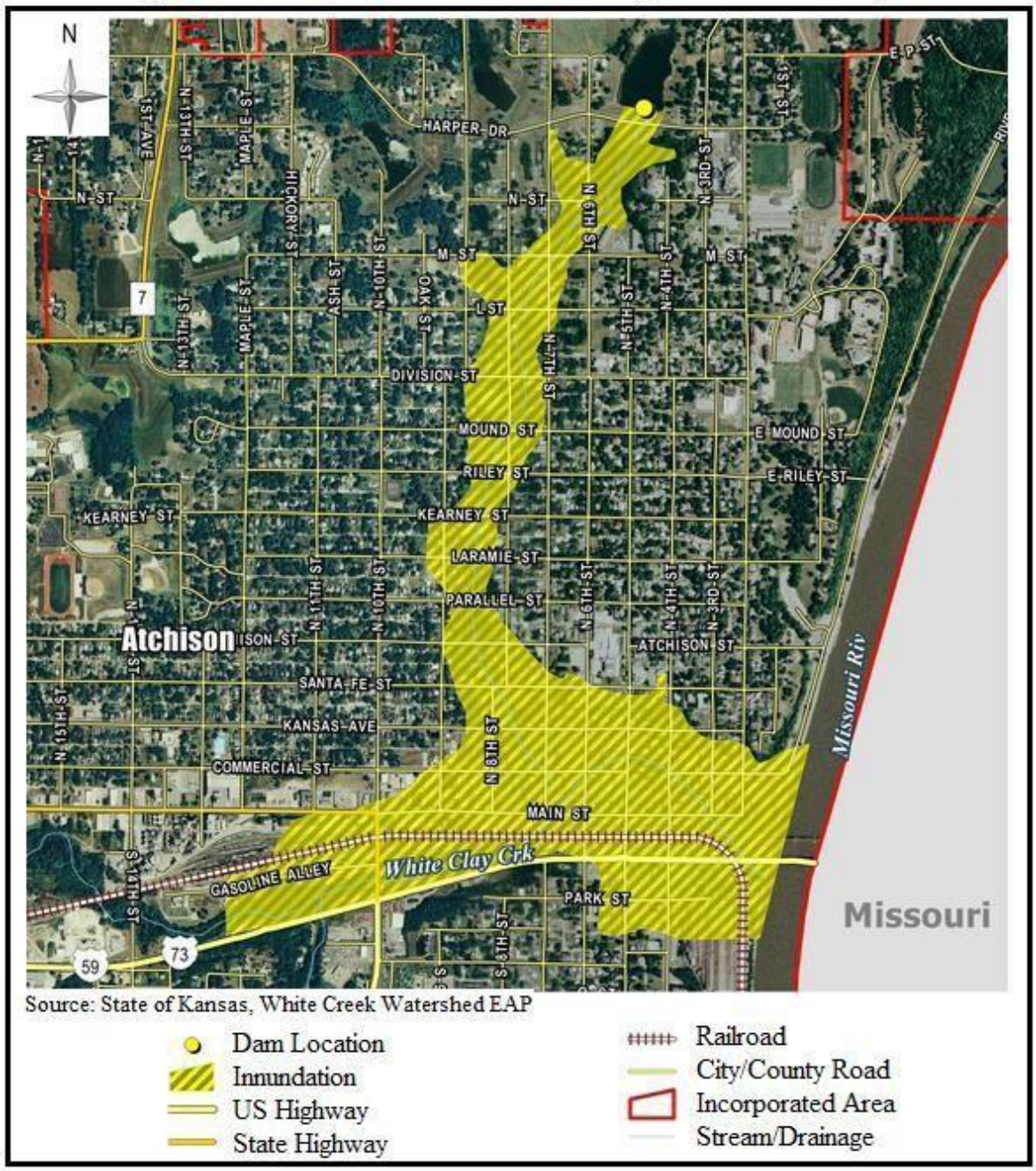
# Significant & High Hazard Dams in Kansas

*Region: k*




Everest
Horton
Atchison
Huron
Lancaster
Muscotah
Effingham
Atchison
Jefferson
Leavenworth
Leavenworth
Critical Infrastructure - Dams
Atchison County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
0 0.75 1.5 3 4.5 6 Miles
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

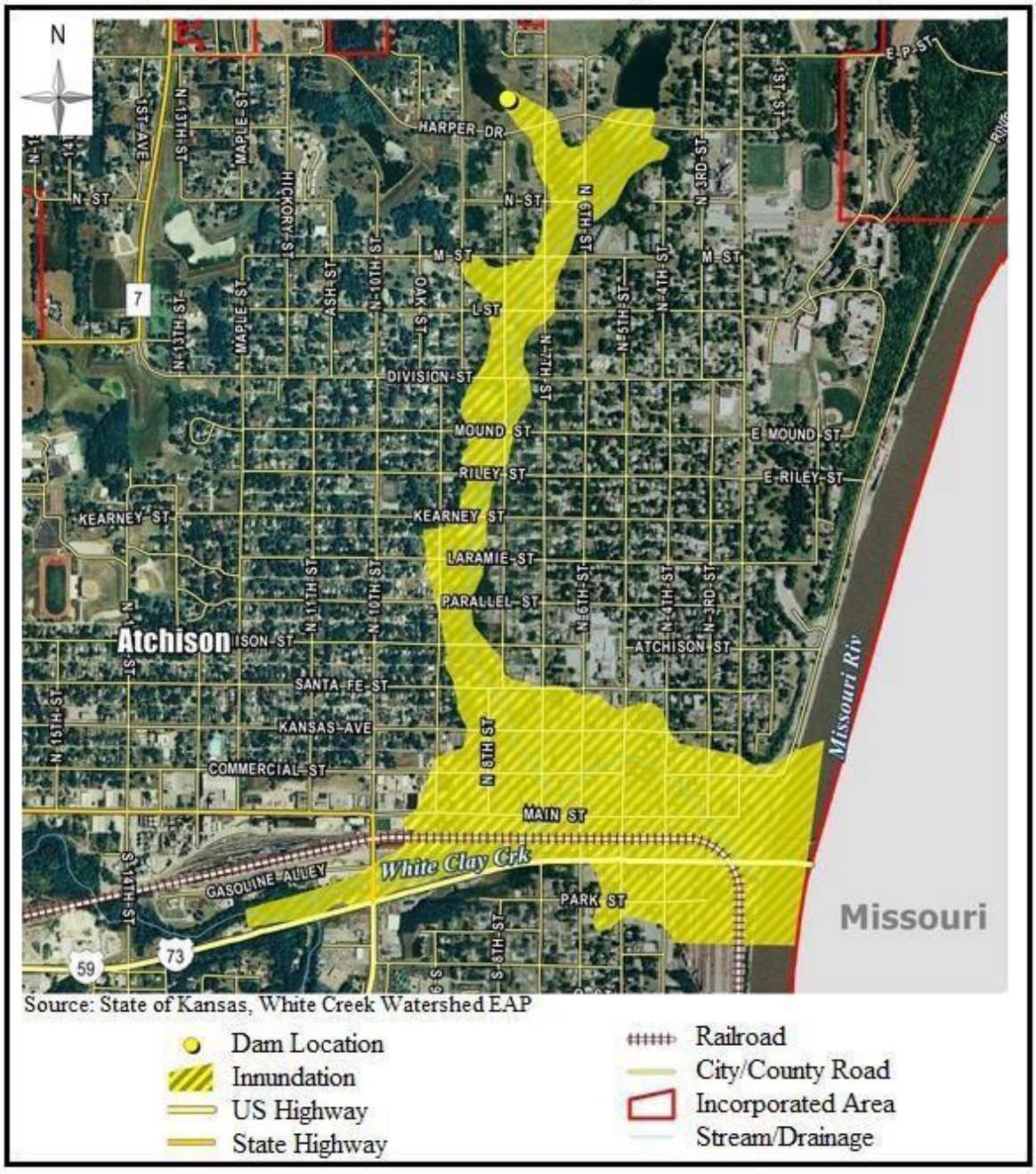
City of Atchison Dam #1 Inundation Map, Atchison County



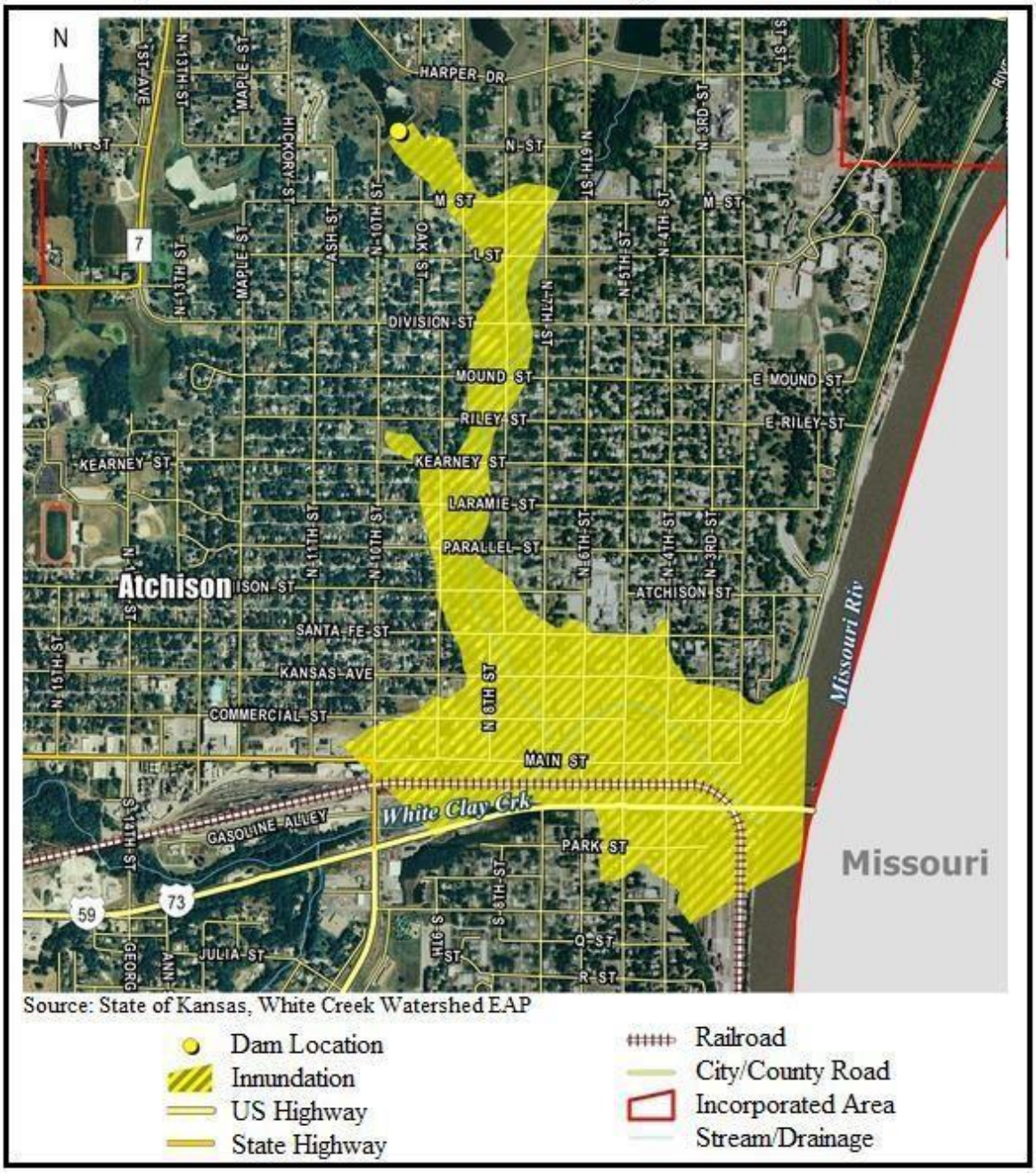

Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Inundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

City of Atchison Dam #2 Inundation Map, Atchison County



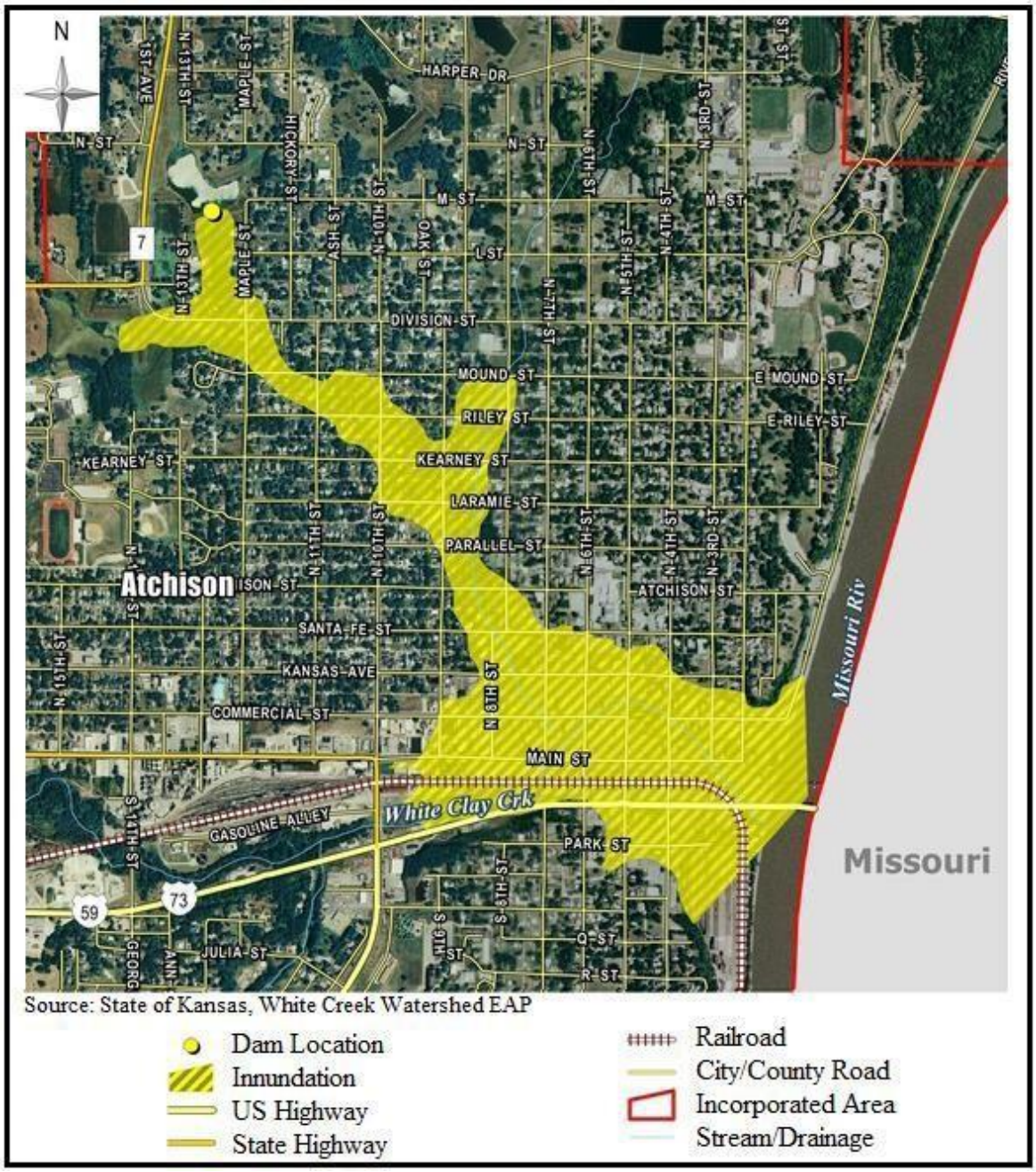
City of Atchison Dam #3 Inundation Map, Atchison County




Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Innundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

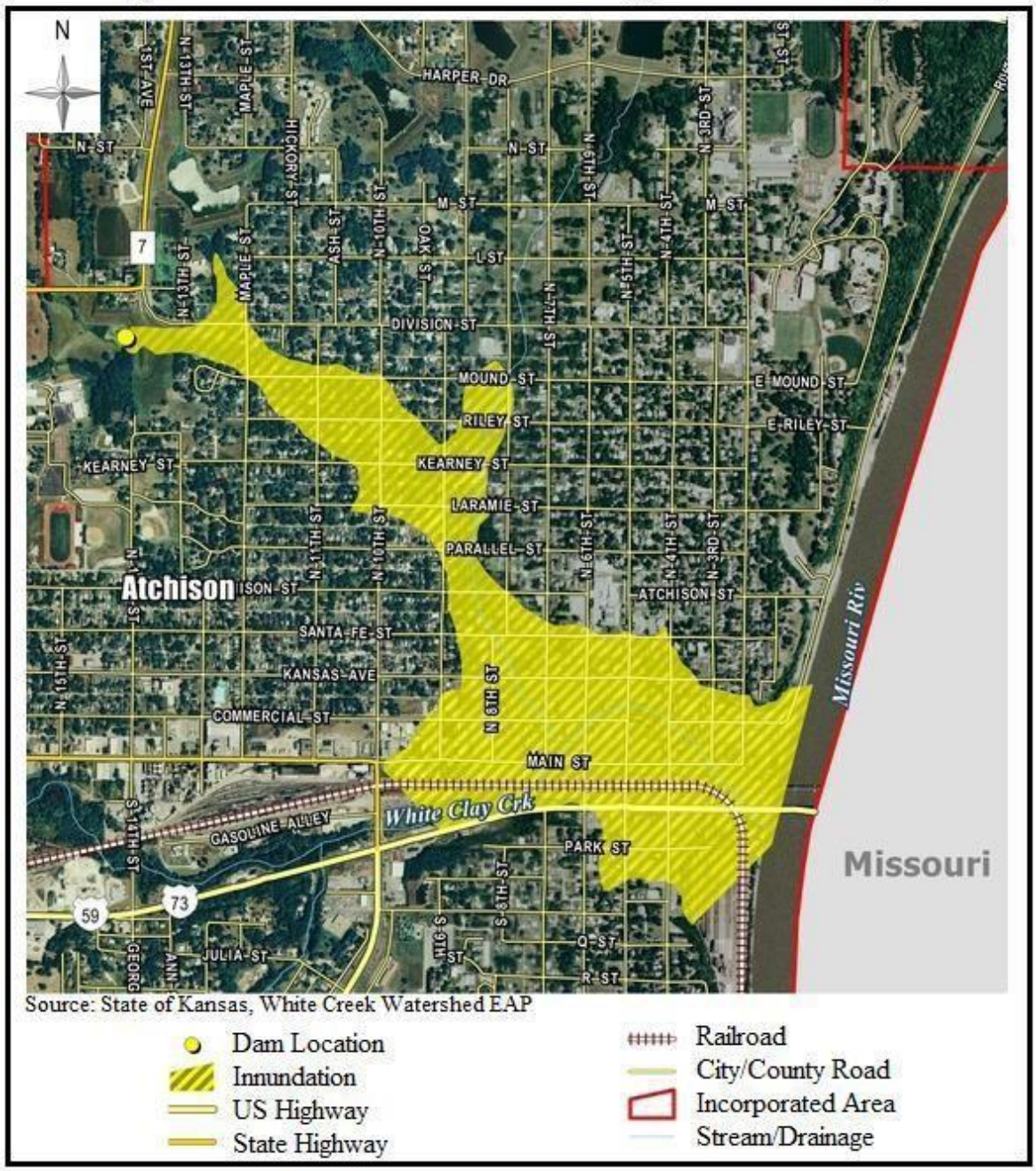
City of Atchison Dam #4 Inundation Map, Atchison County



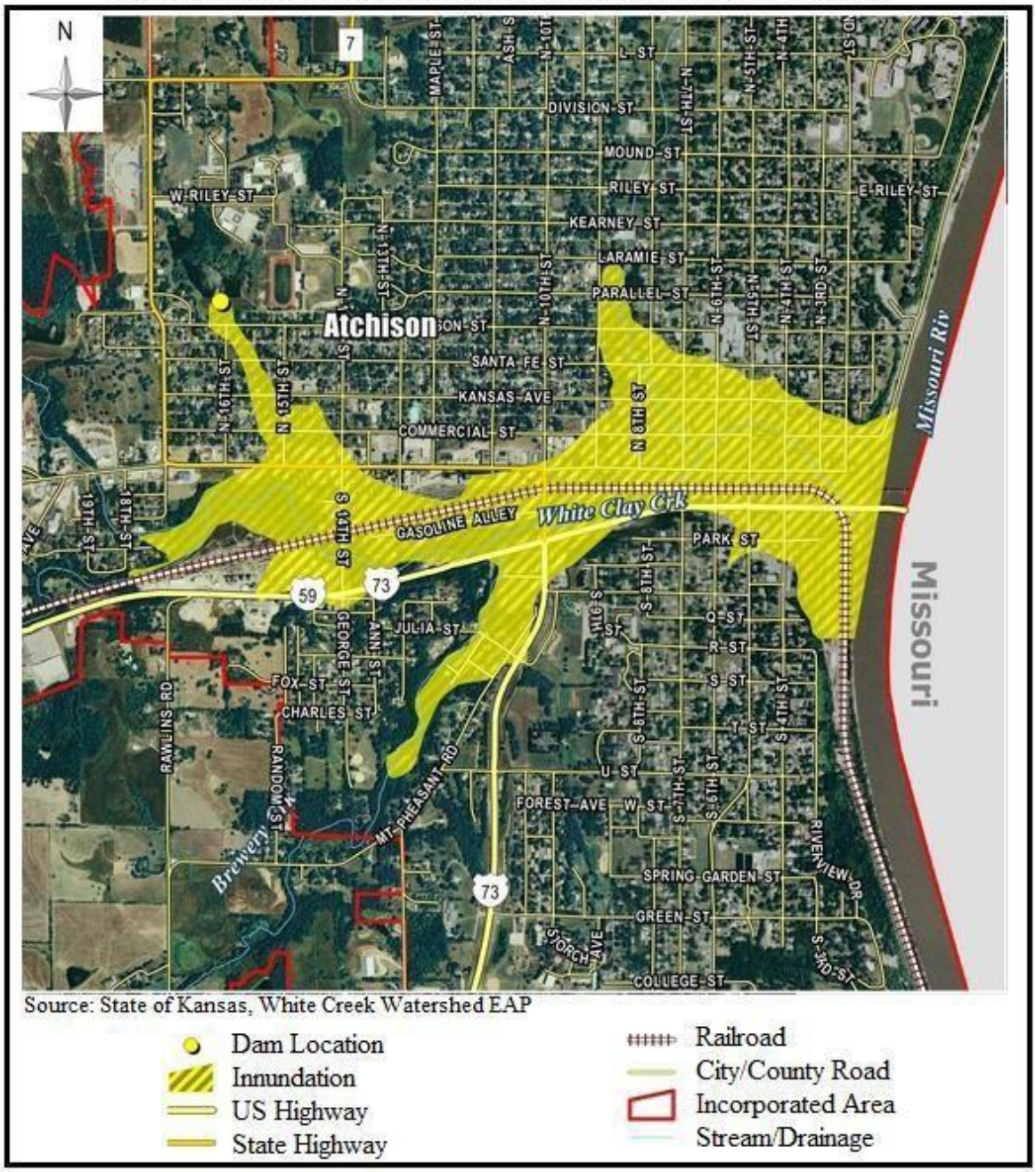

Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Innundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

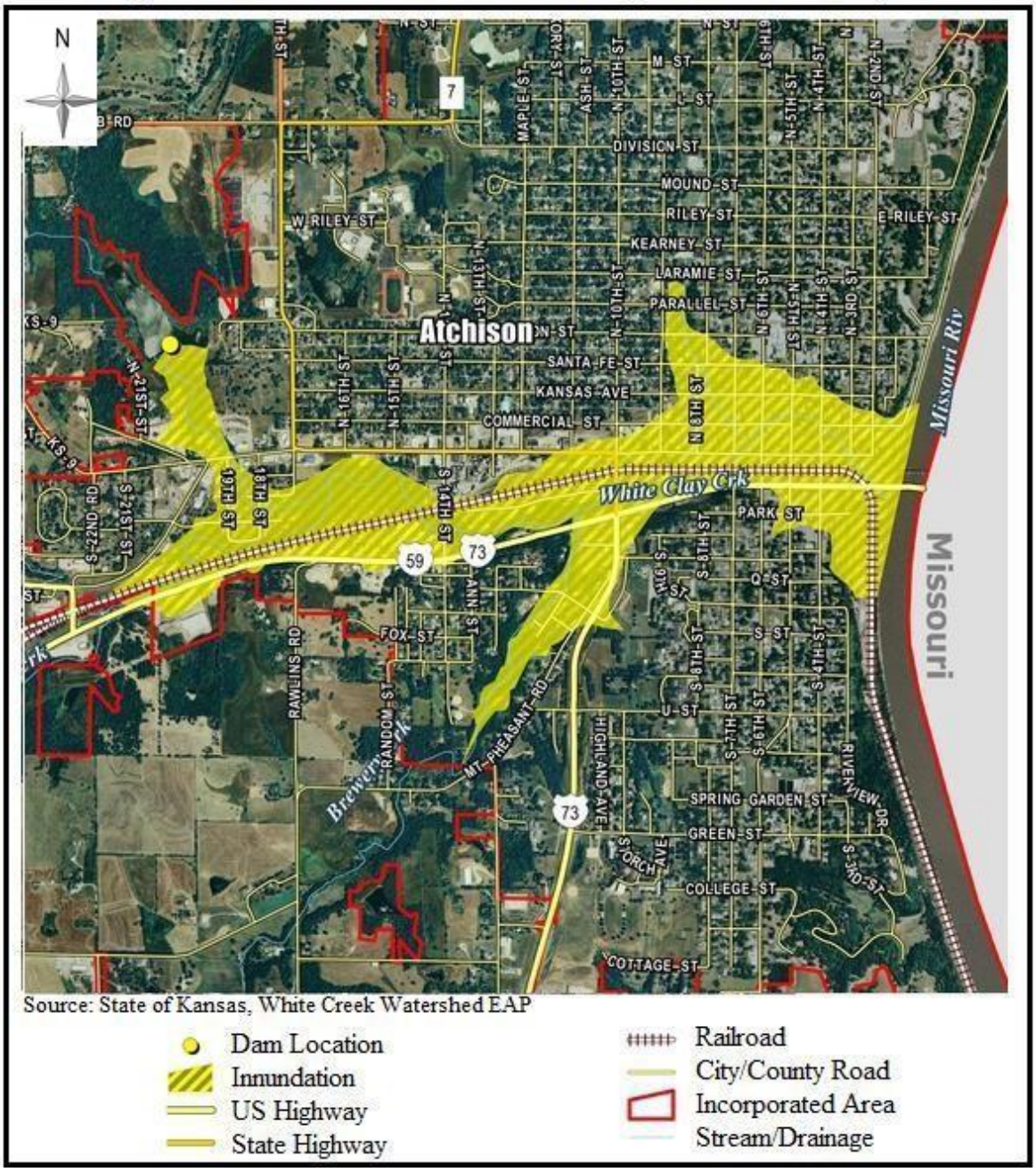
City of Atchison Dam #5 Inundation Map, Atchison County



## City of Atchison Dam #6 Inundation Map, Atchison County



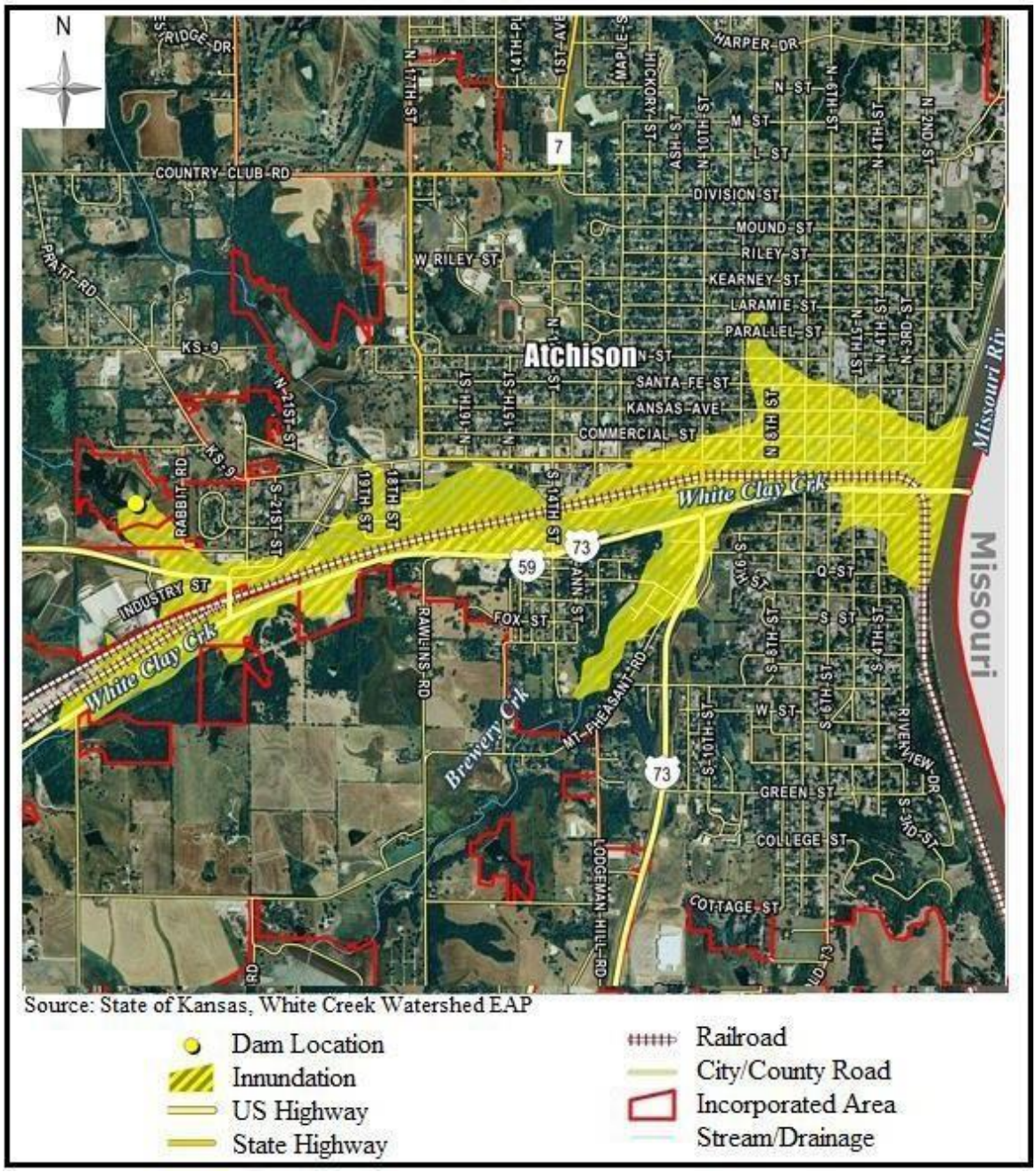
City of Atchison Dam #7 Inundation Map, Atchison County



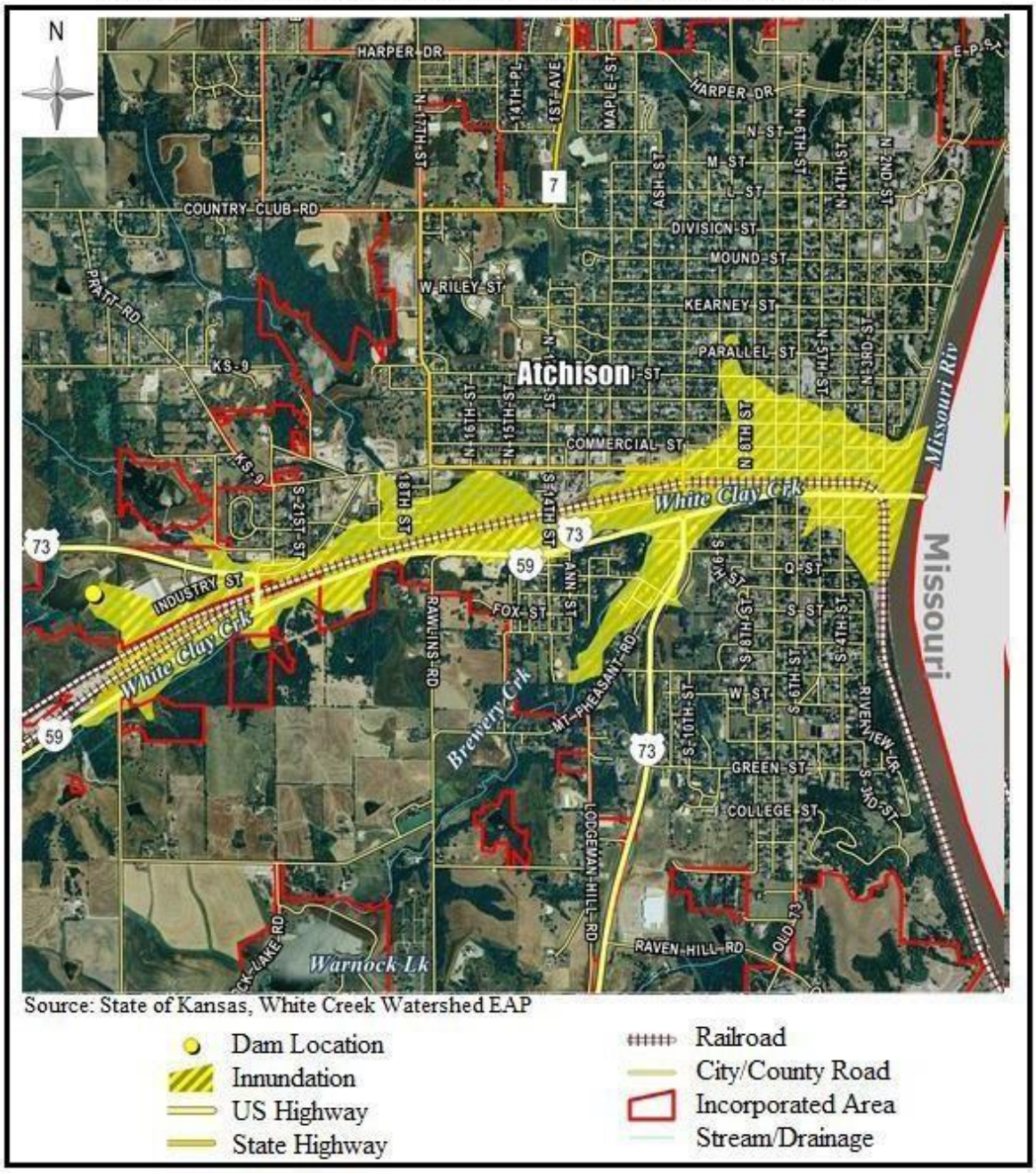

Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Inundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

## City of Atchison Dam #8 Inundation Map, Atchison County



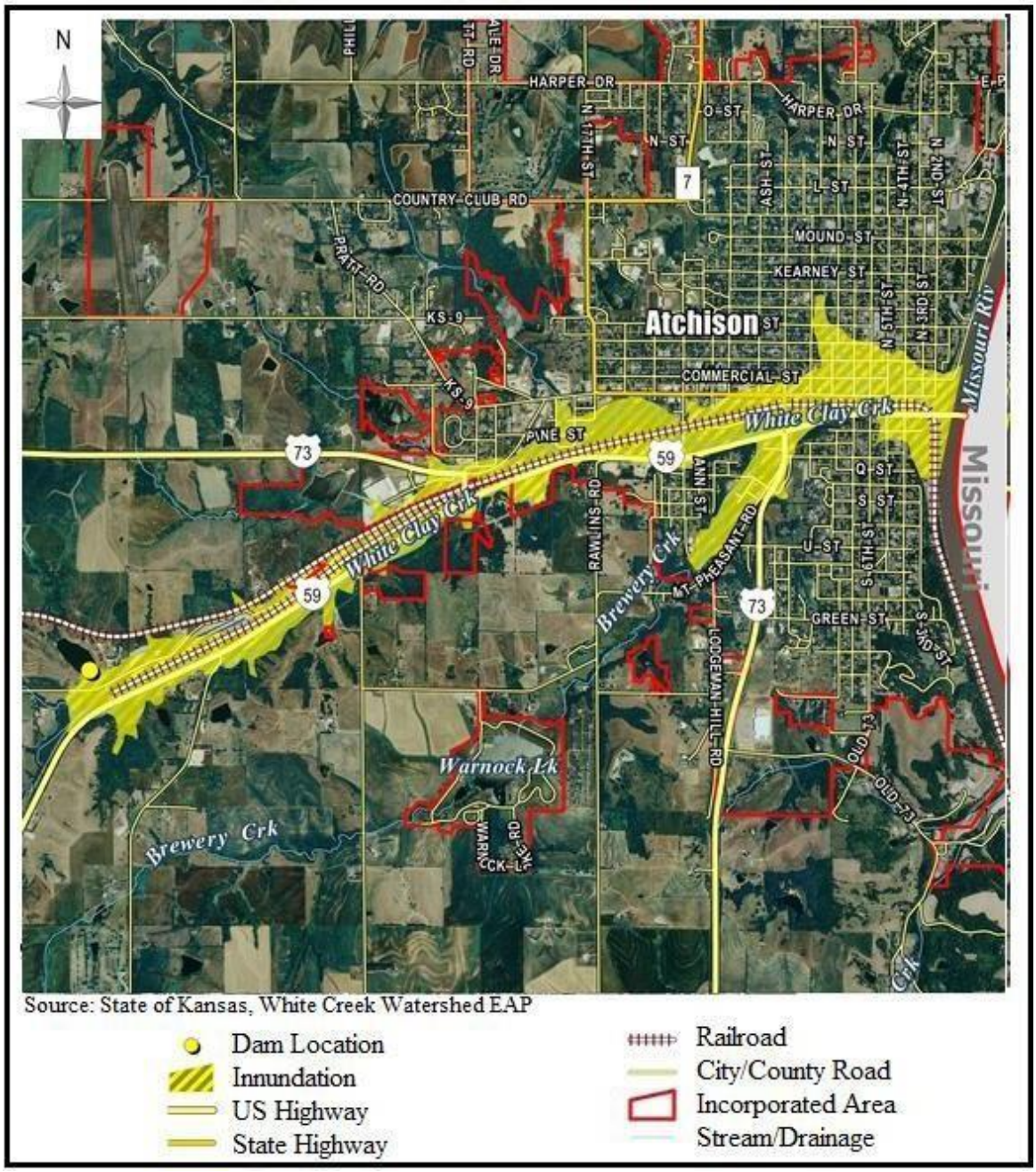
City of Atchison Dam #9 Inundation Map, Atchison County



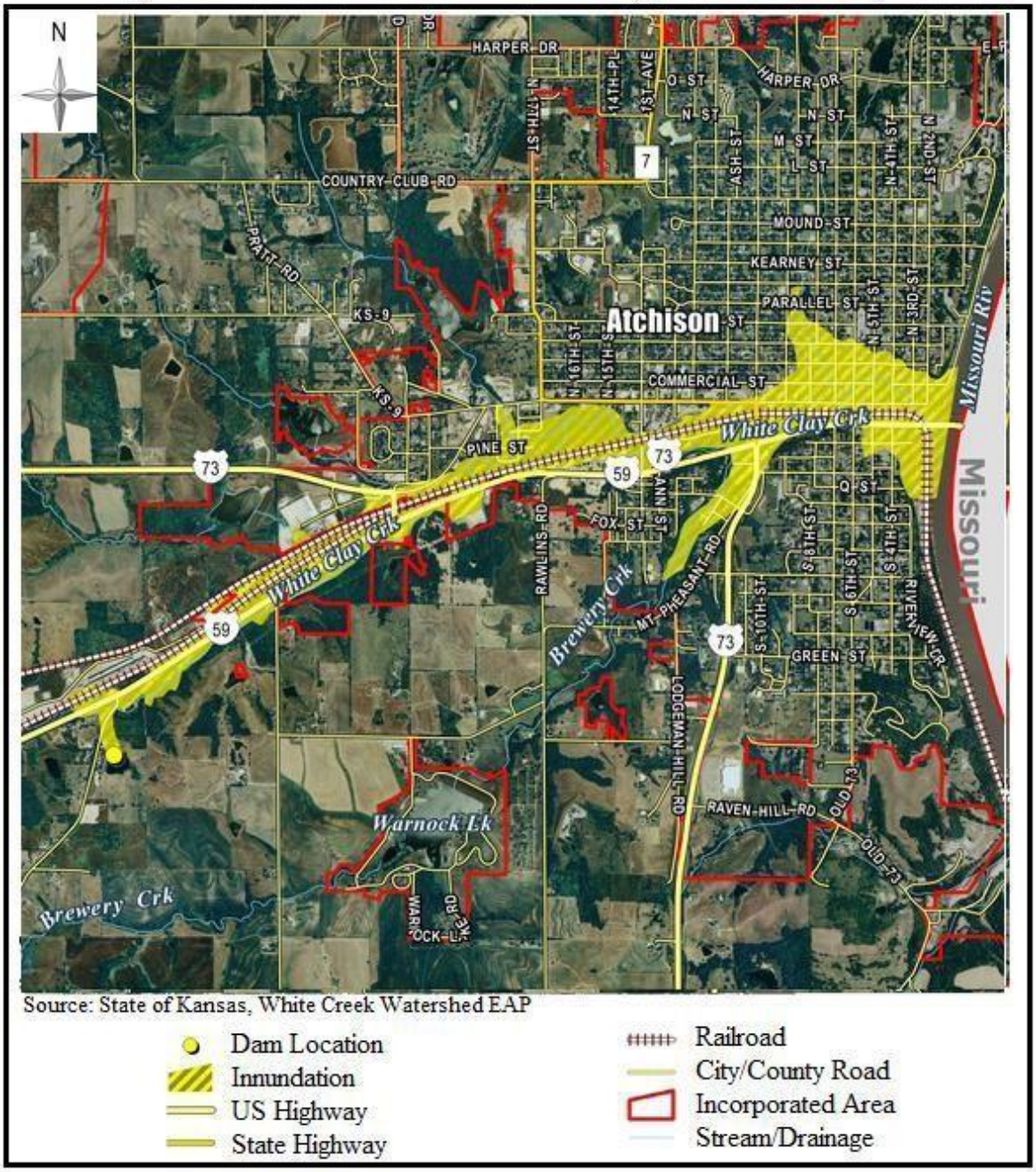

Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Inundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

City of Atchison Dam#10 Inundation Map, Atchison County



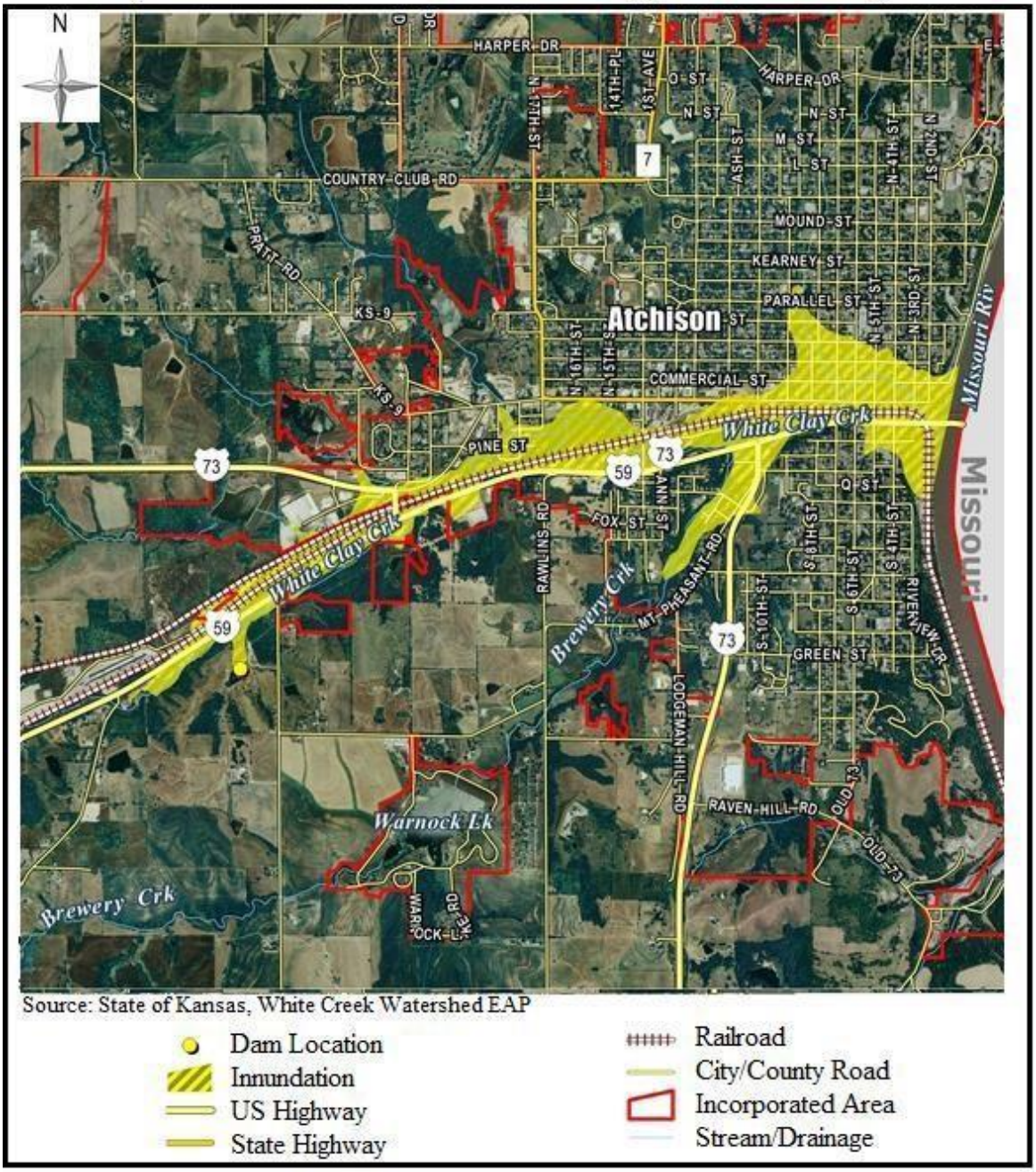
City of Atchison Dam#19 Inundation Map, Atchison County



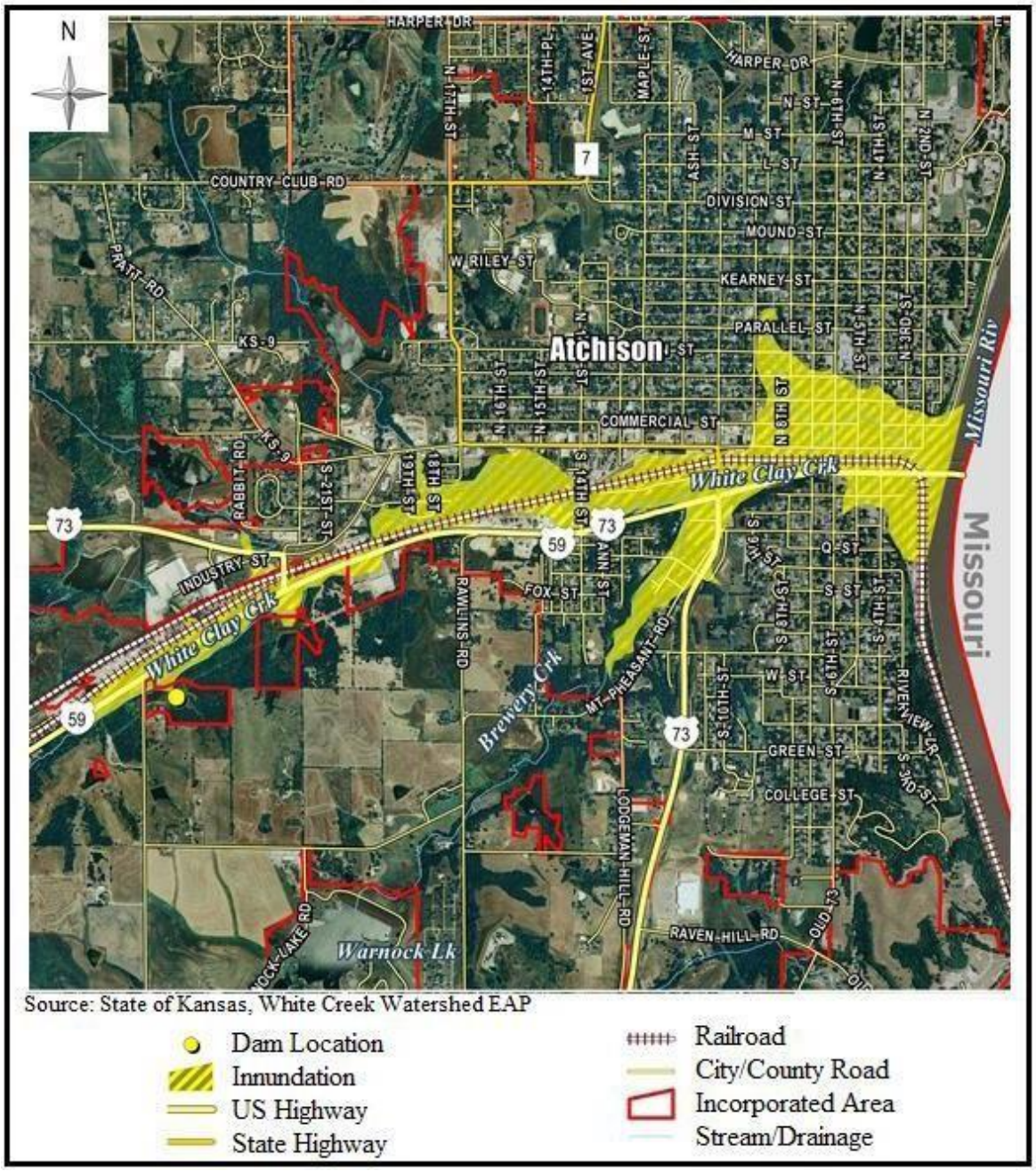

Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Innundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

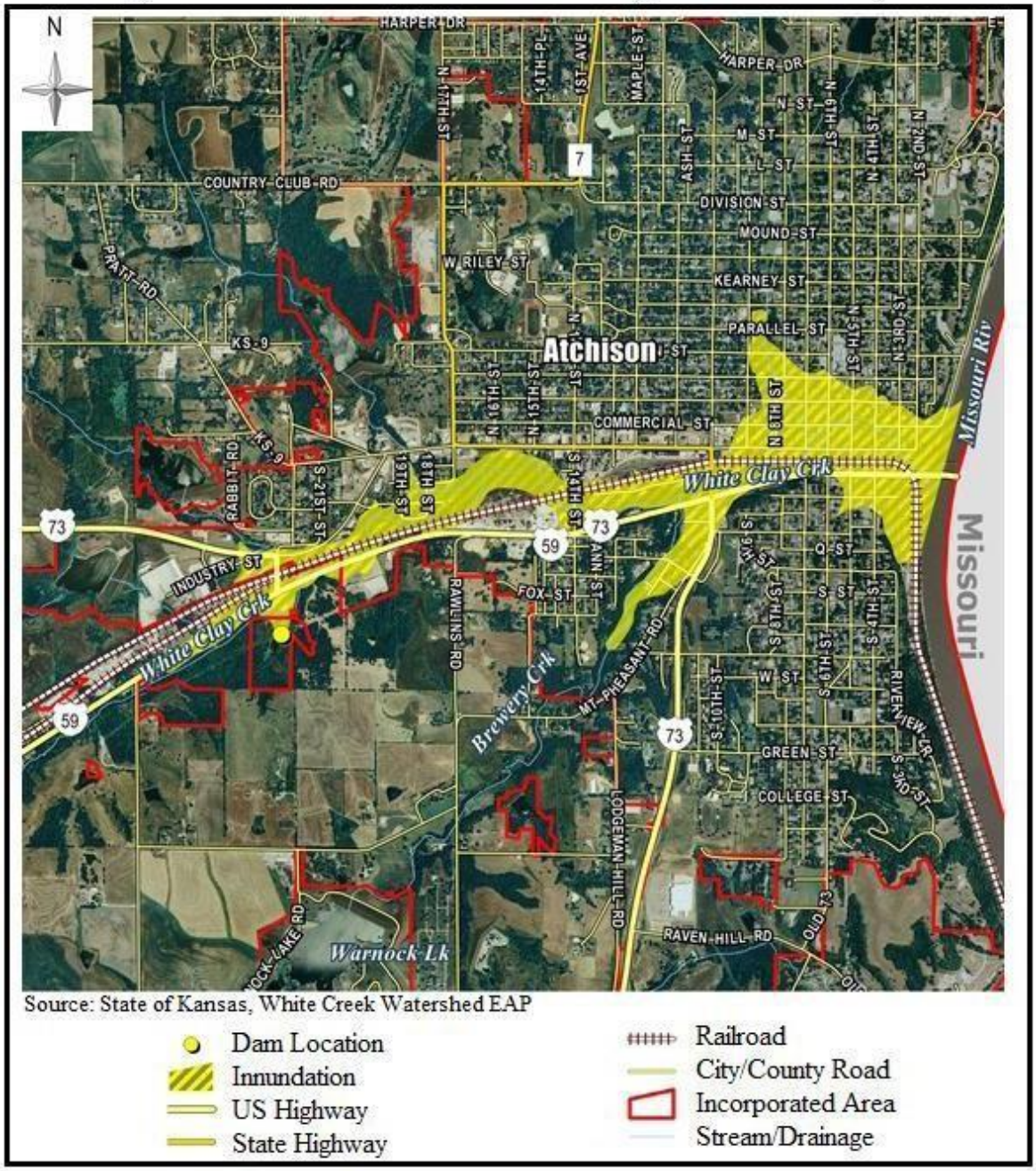
City of Atchison Dam#20 Inundation Map, Atchison County



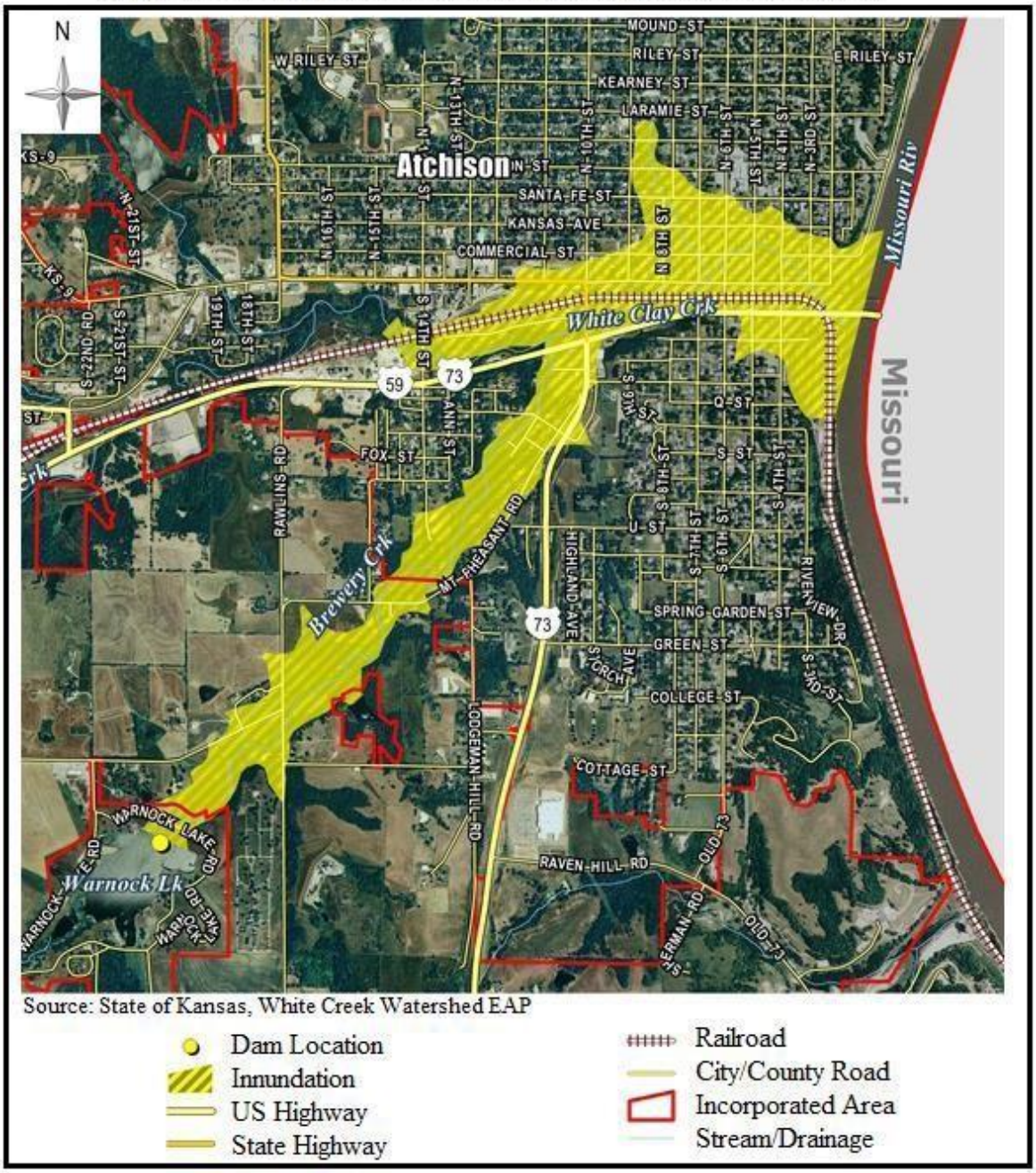
City of Atchison Dam#21 Inundation Map, Atchison County



City of Atchison Dam#22 Inundation Map, Atchison County



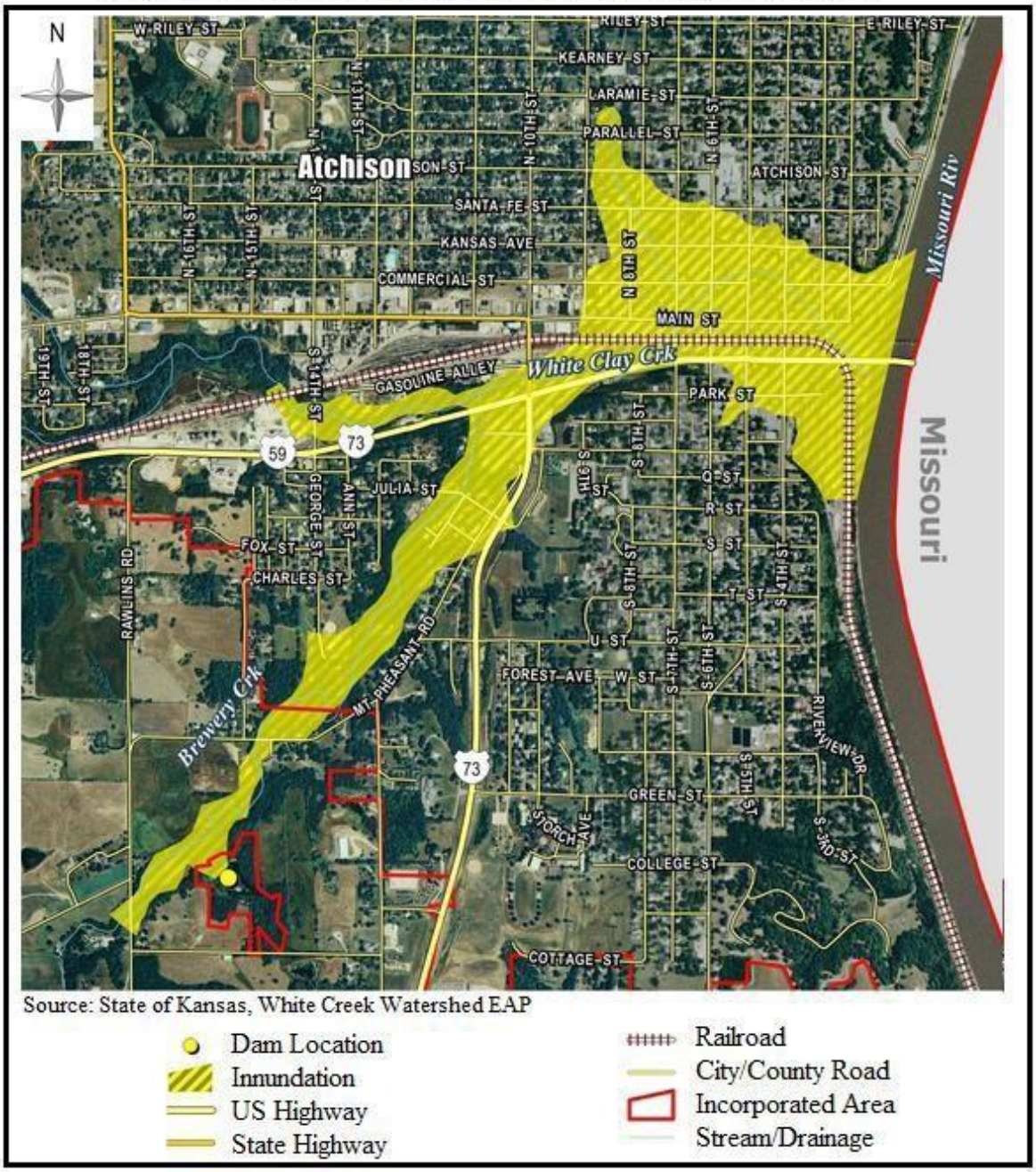
City of Atchison Dam#23 Inundation Map, Atchison County




Source: State of Kansas, White Creek Watershed EAP

- Dam Location
- Inundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

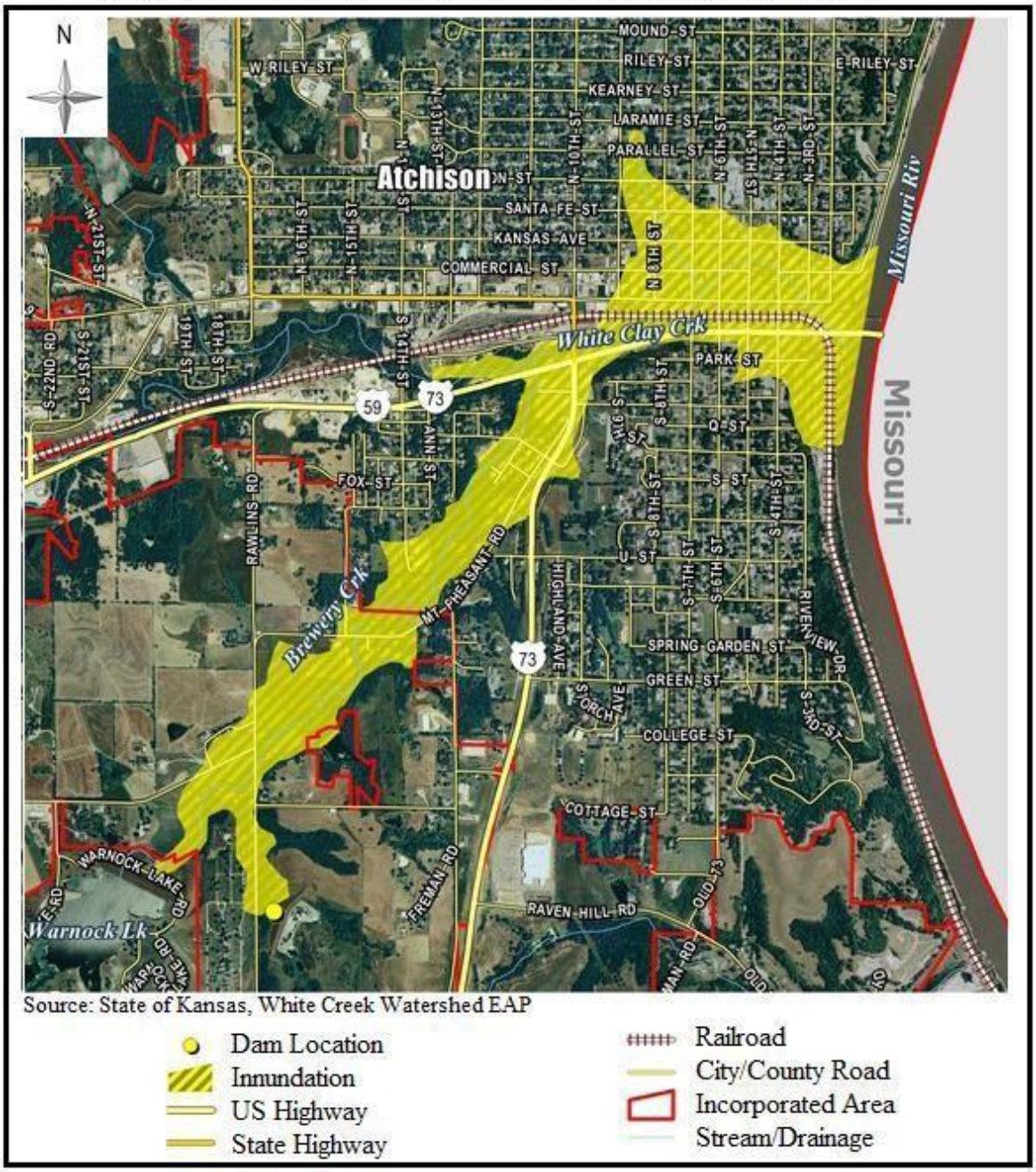
City of Atchison Dam #24 Inundation Map, Atchison County

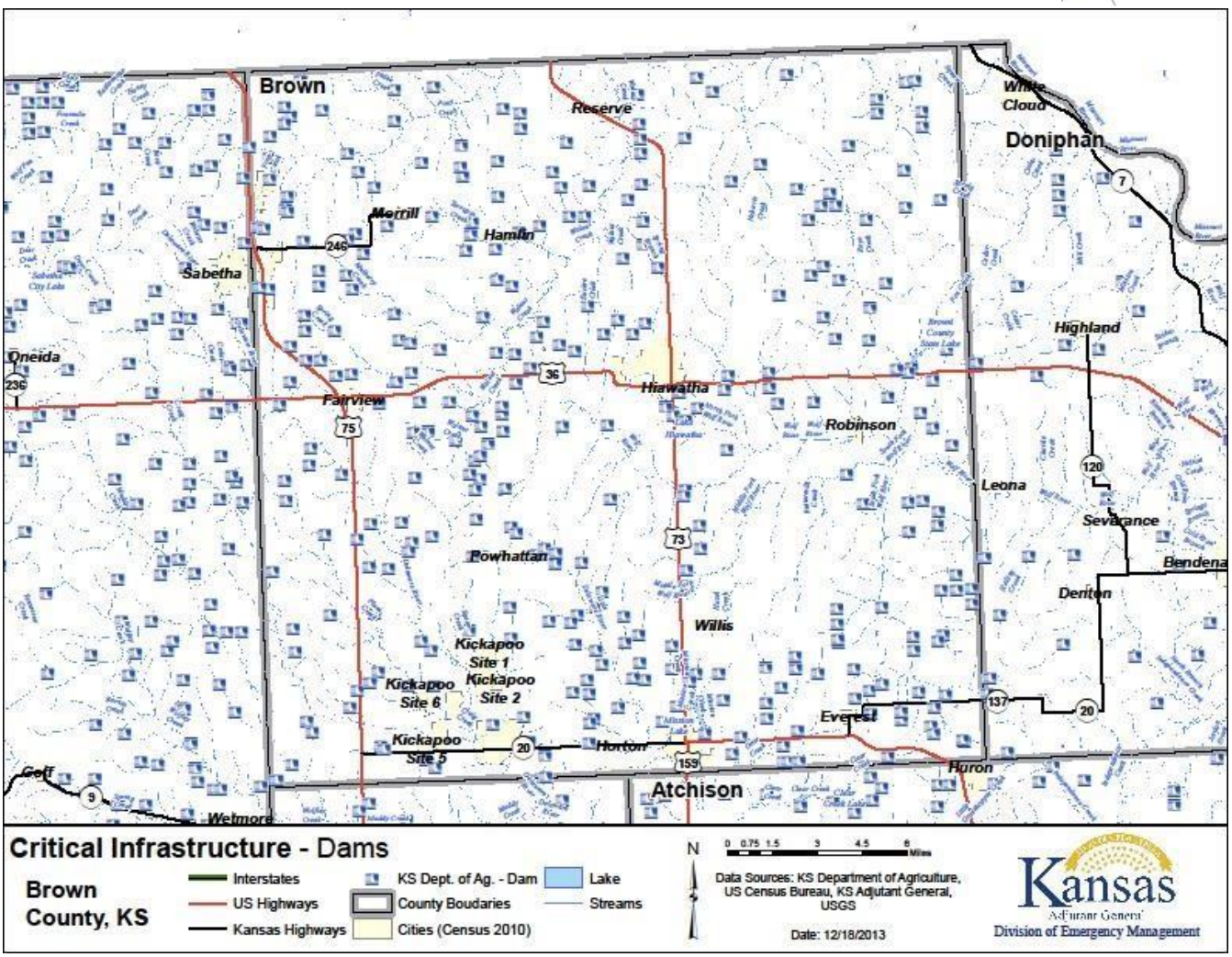



Source: State of Kansas, White Creek Watershed EAP

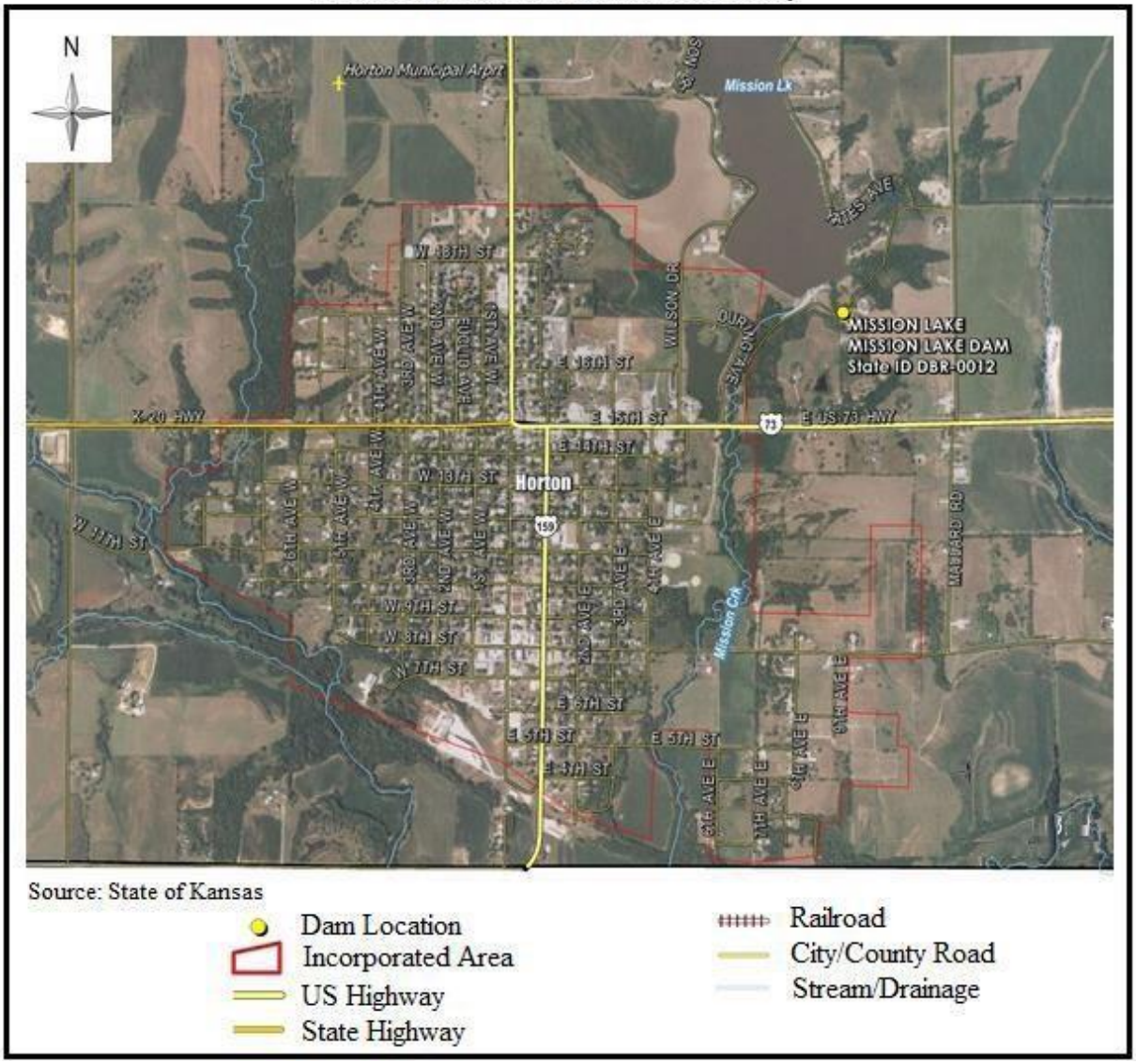
- Dam Location
- Inundation
- US Highway
- State Highway
- Railroad
- City/County Road
- Incorporated Area
- Stream/Drainage

City of Atchison Dam#25 Inundation Map, Atchison County

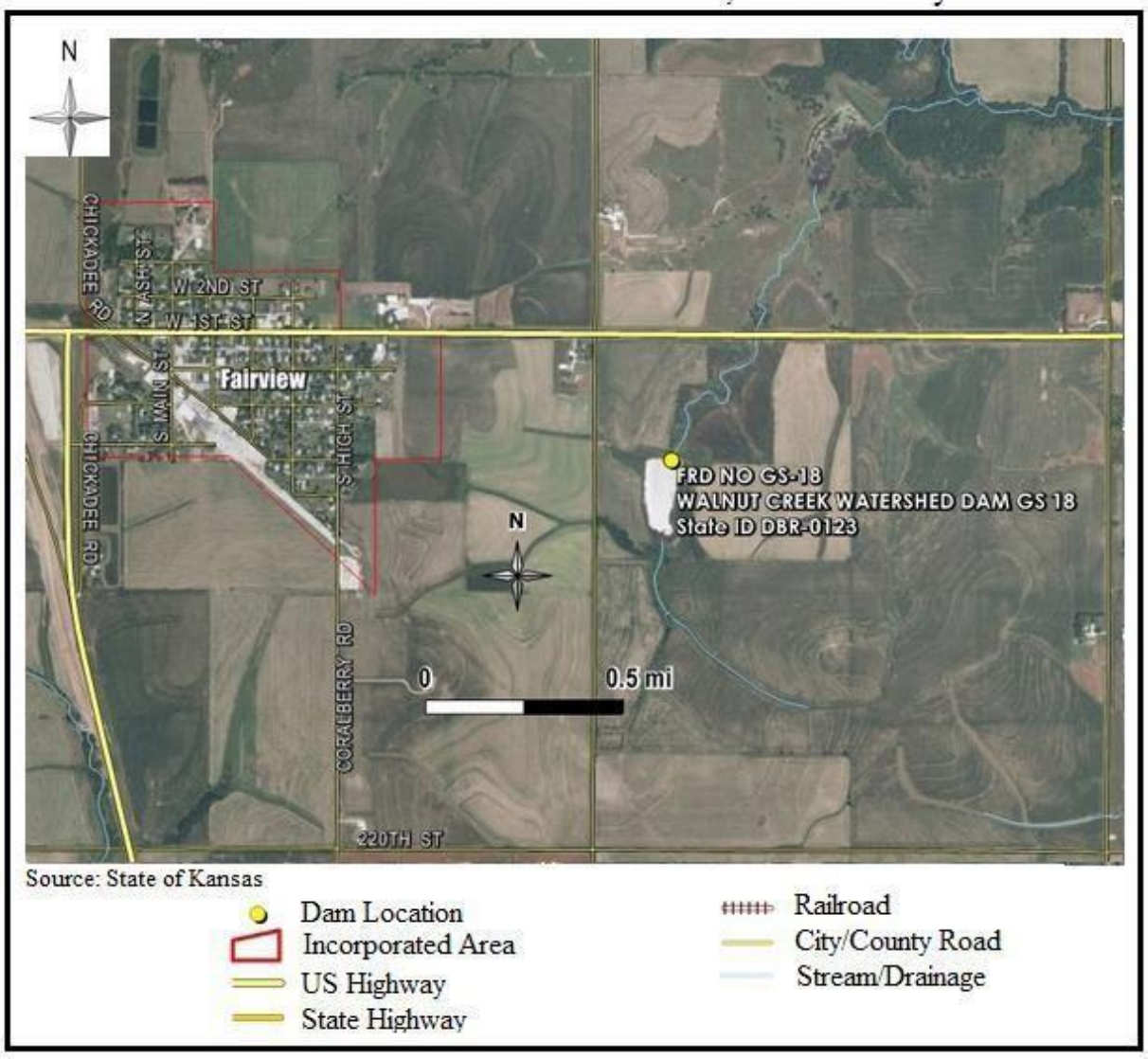



Brown
Reserve
White Cloud
Doniphan
Merrill
Hamlin
Sabetha
Oneida
Highland
Hiawatha
Fairview
Robinson
Leona
Sevarance
Bendena
Powhattan
Denton
Willis
Kickapoo Site 1
Kickapoo Site 6
Kickapoo Site 2
Kickapoo Site 5
Everest
Horton
Huron
Atchison
Wetmore
Critical Infrastructure - Dams
Brown County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

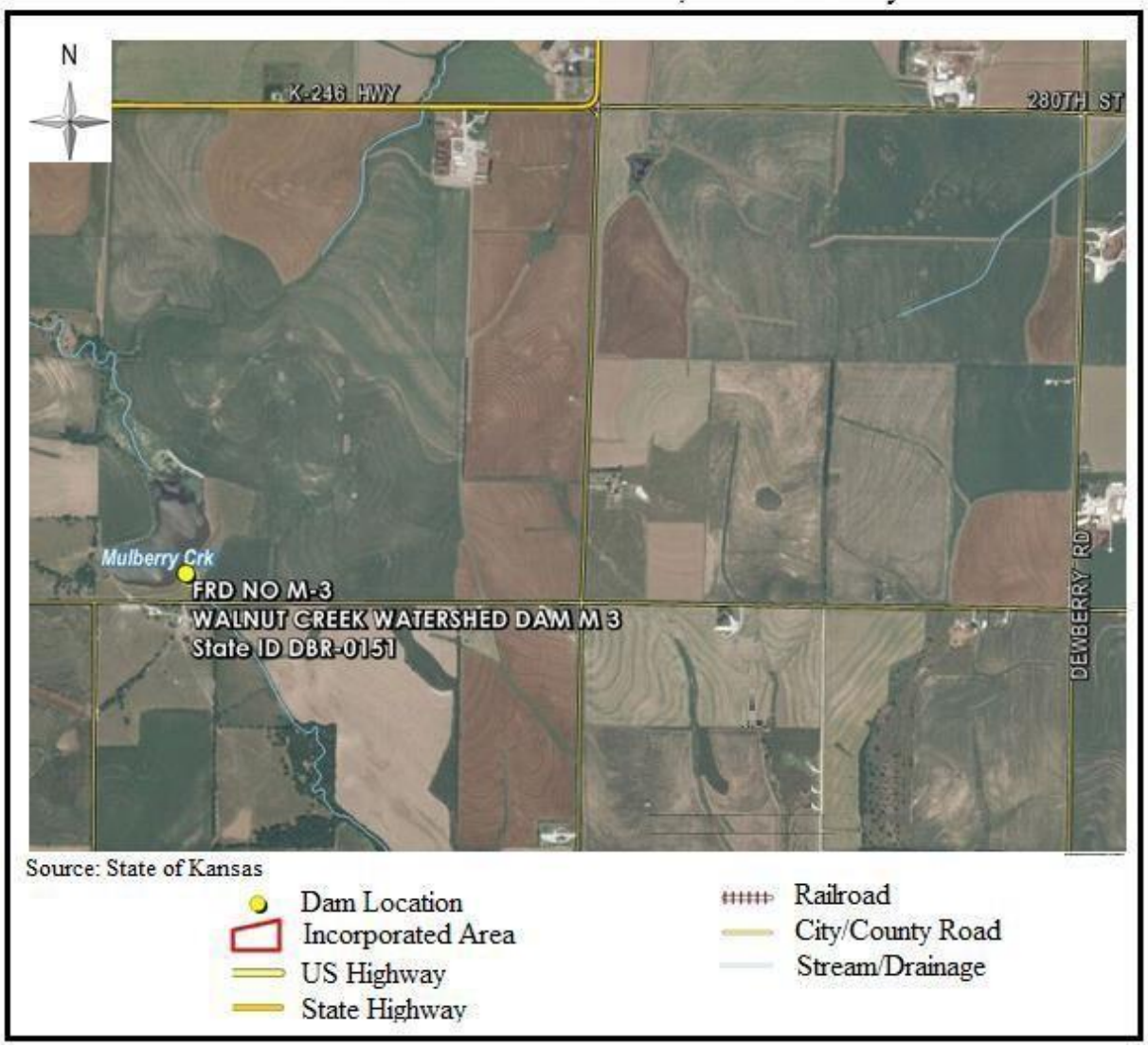
## Mission Lake Dam, Brown County



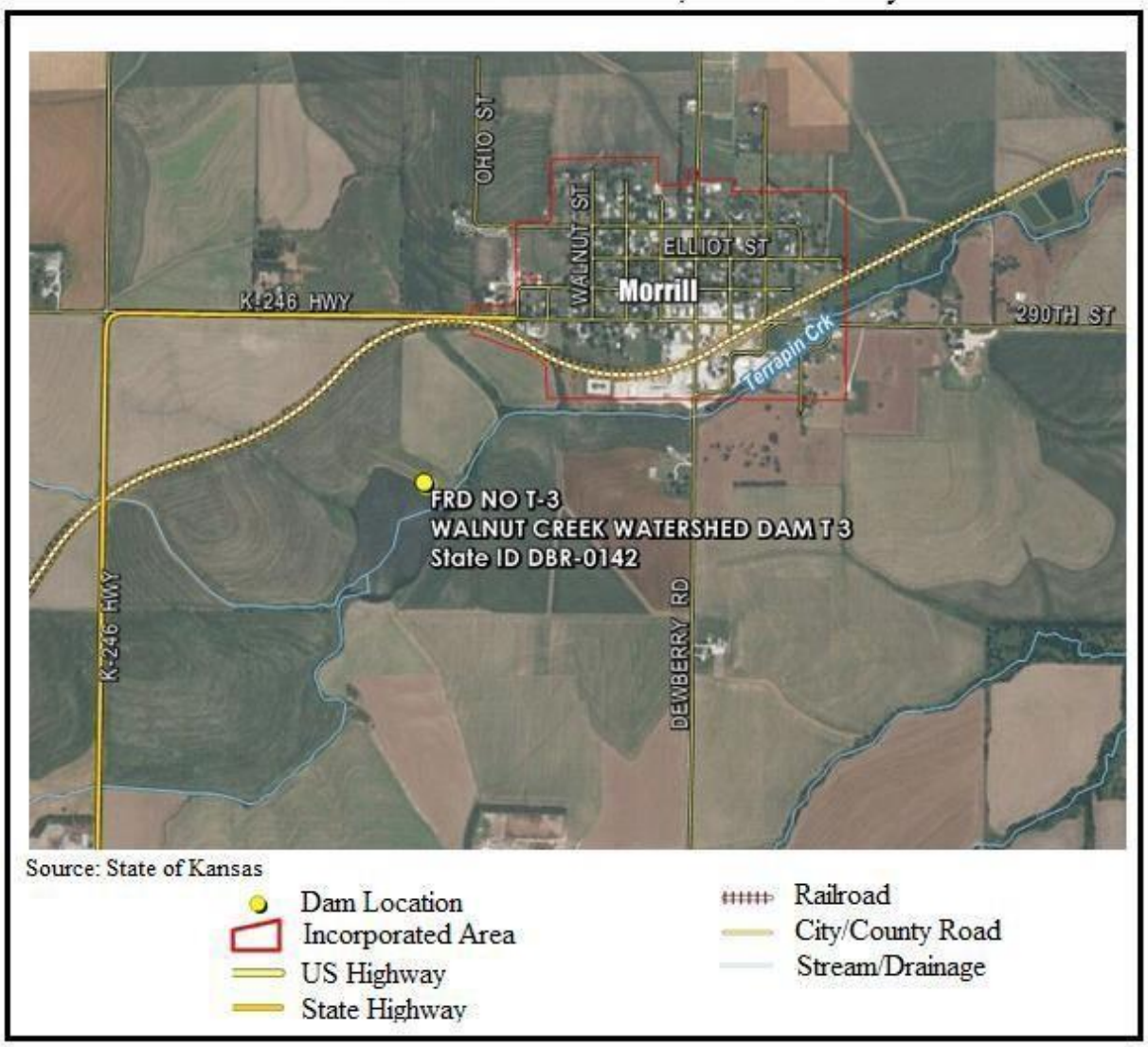
Walnut Creek Watershed Dam GS-18, Brown County

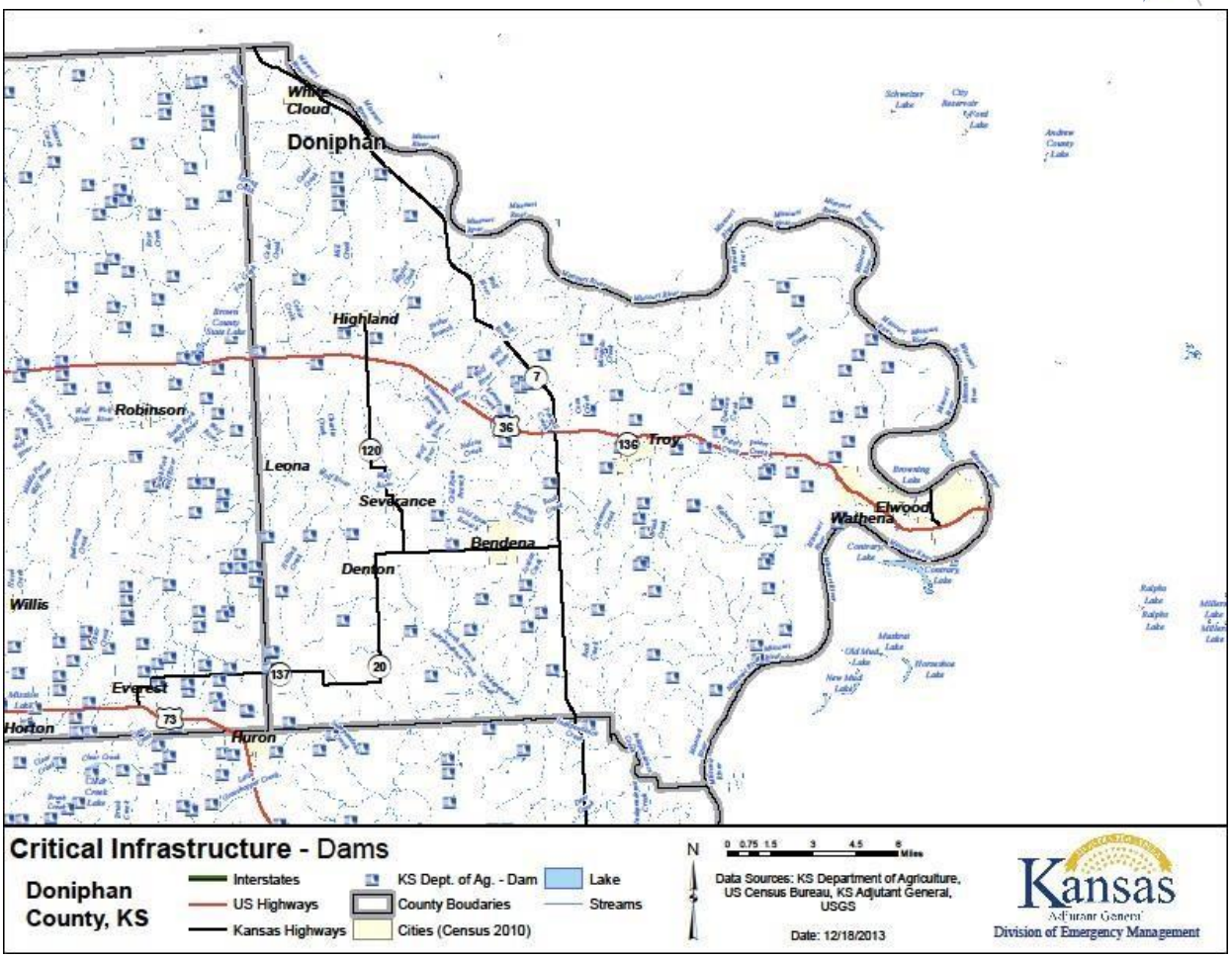


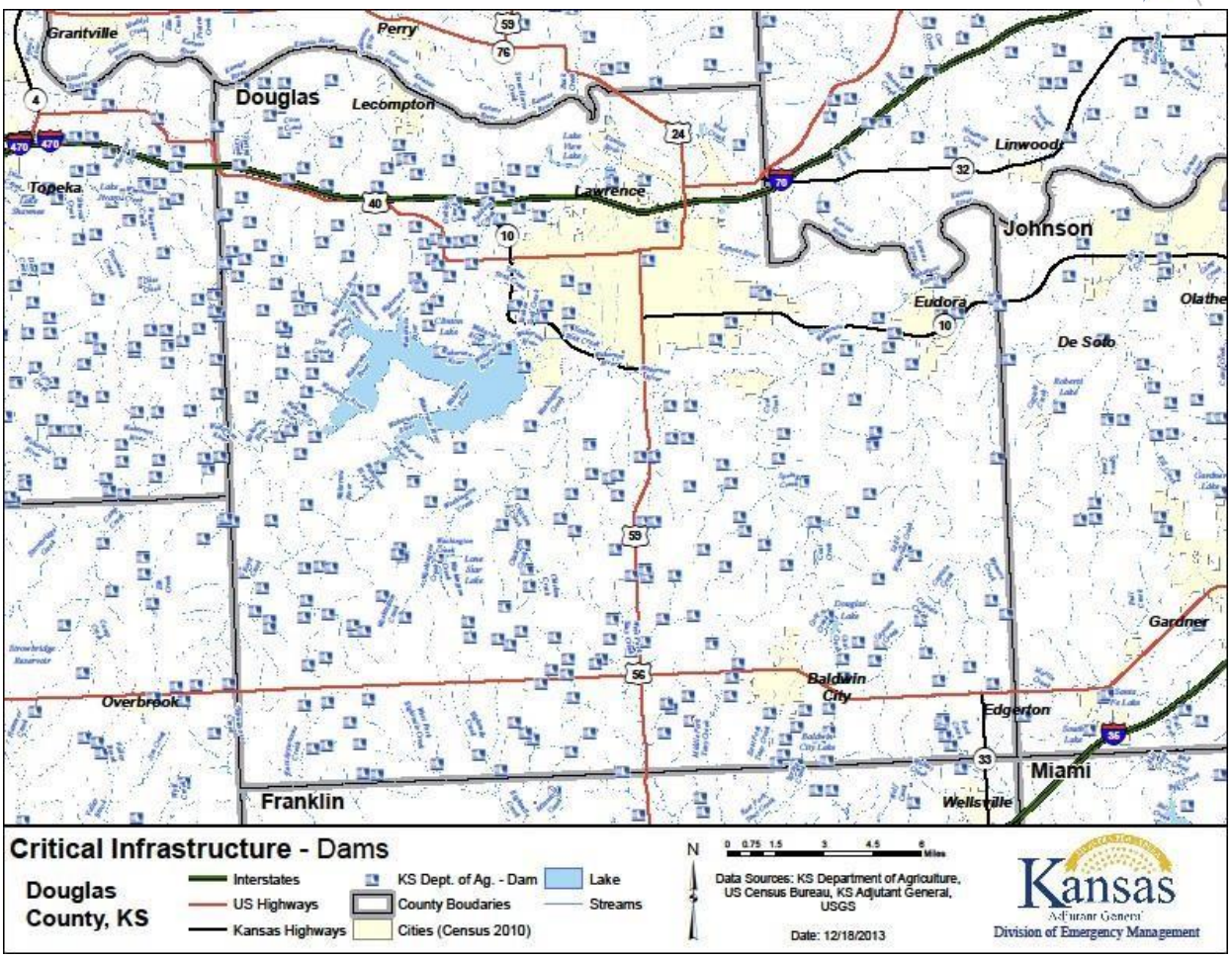
Walnut Creek Watershed Dam M-3, Brown County



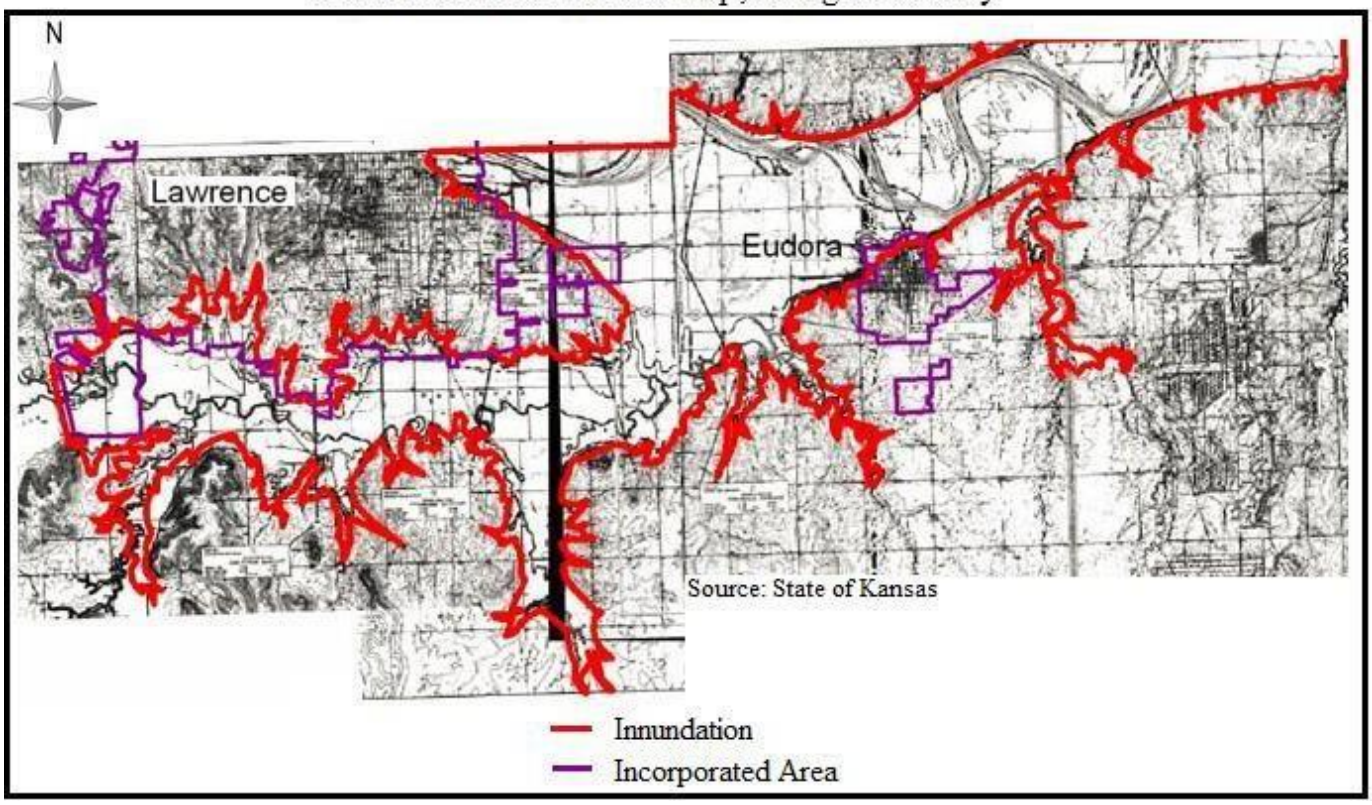
Walnut Creek Watershed Dam T-3, Brown County




White Cloud
Doniphan
Highland
Robinson
Leona
Severance
Bendena
Denton
Willis
Everest
Horton
Huron
Troy
Elwood
Wathena
7
36
120
136
137
20
73
Critical Infrastructure - Dams
Doniphan County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
0 0.75 1.5 3 4.5 6 Miles
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

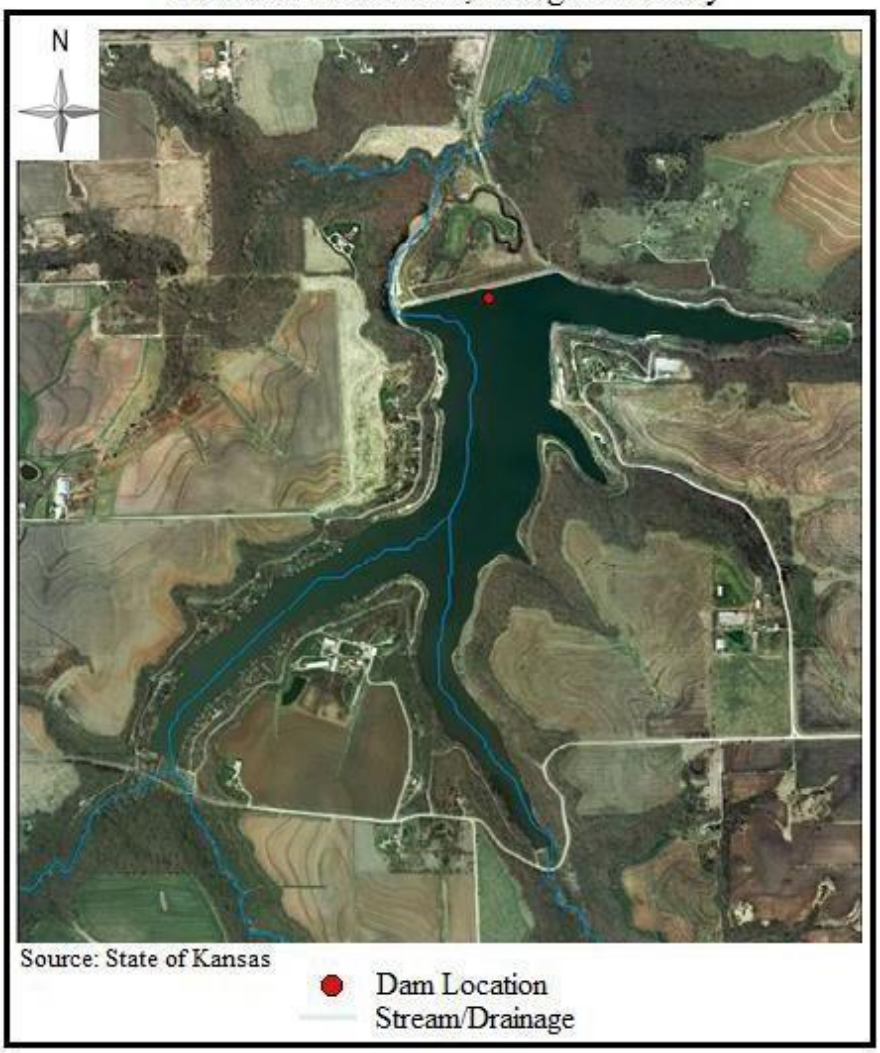

Granitville
Perry
Douglas
Lecompton
Topeka
Lawrence
Linwood
Johnson
Eudora
Olathe
De Soto
Gardner
Baldwin City
Overbrook
Edgerton
Miami
Franklin
Wellsville
Critical Infrastructure - Dams
Douglas County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

Clinton Dam Inundation Map, Douglas County

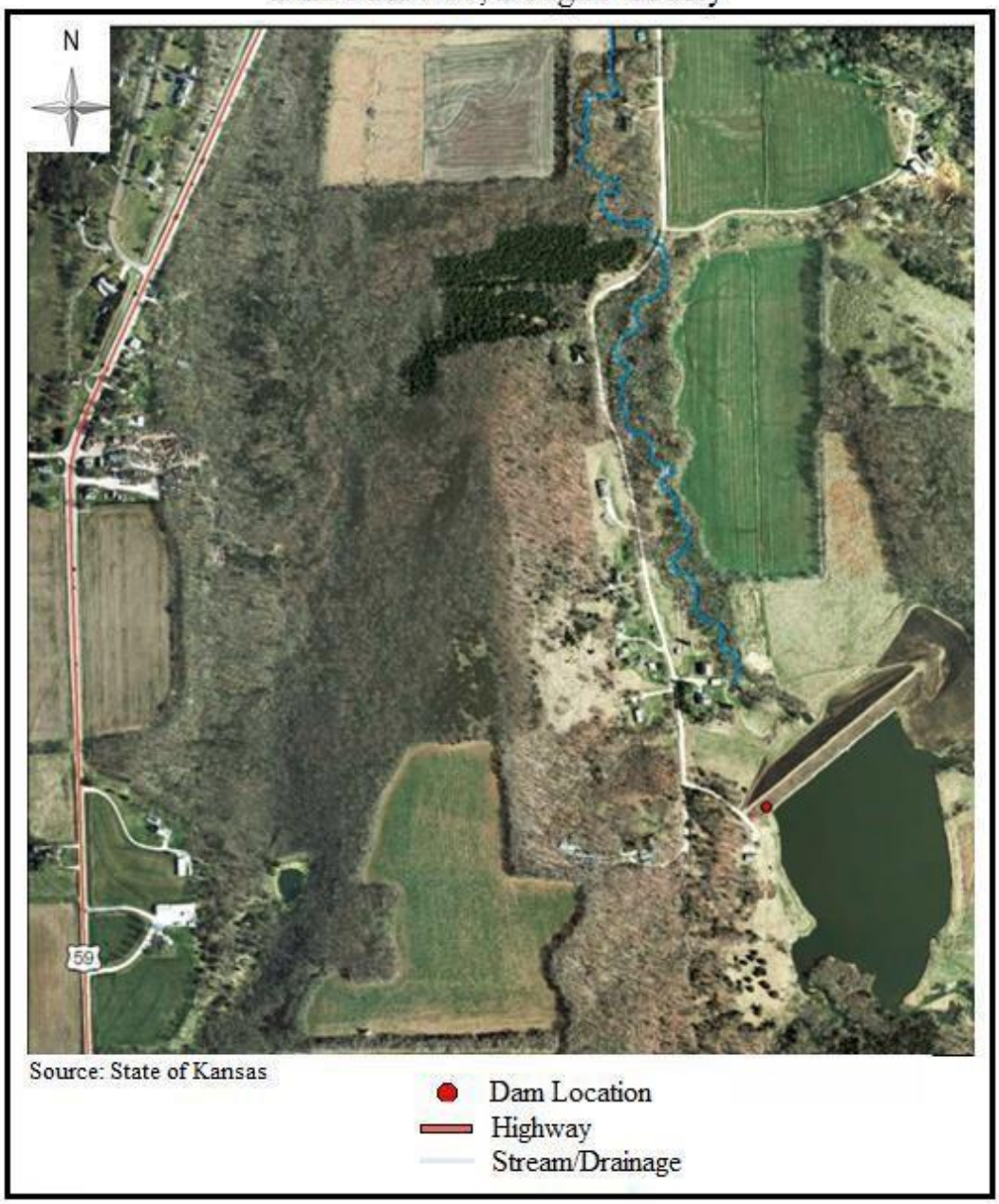


Dam FRD #24, Douglas County

Lonestar Lake Dam, Douglas County

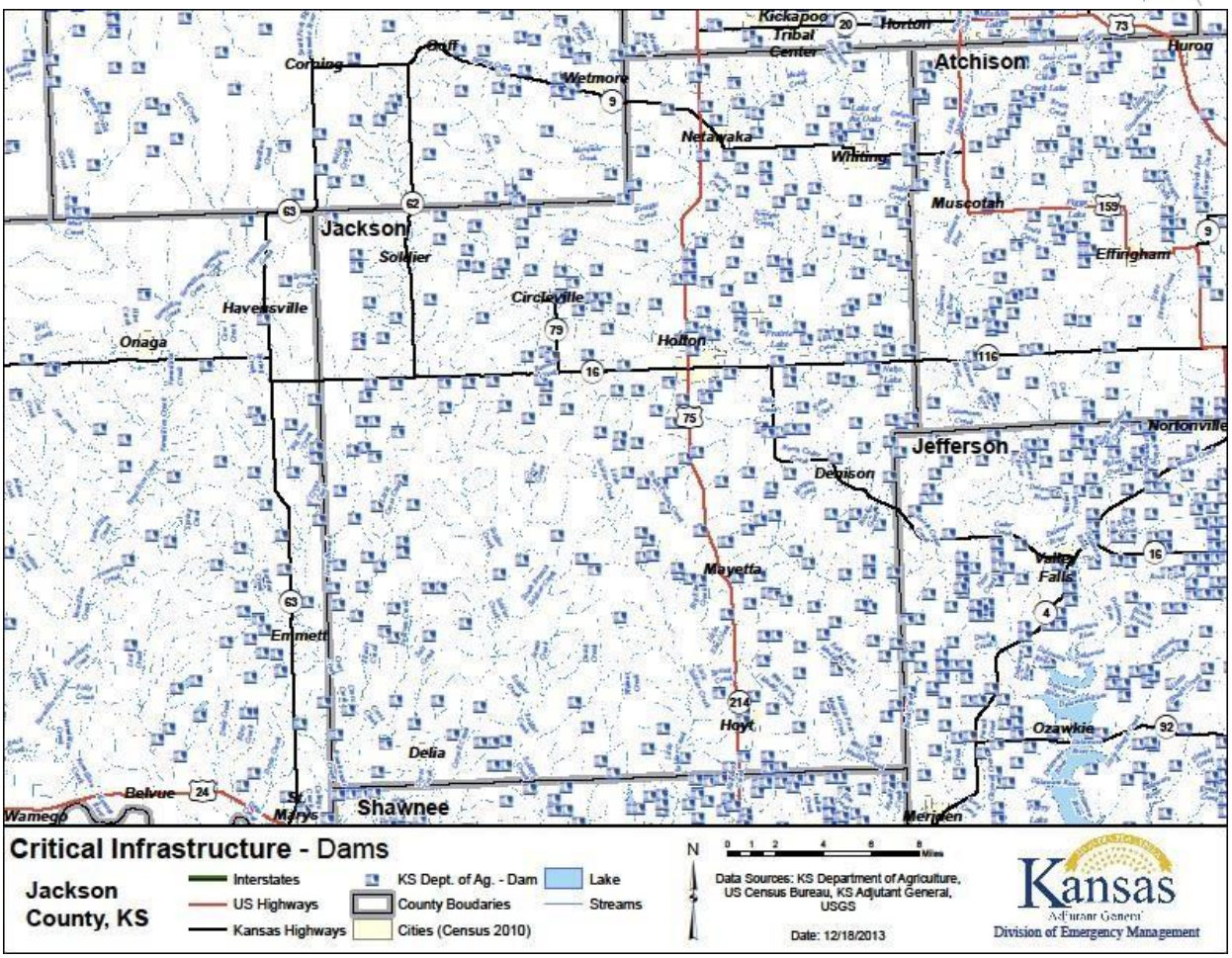


Dam FRD #31, Douglas County

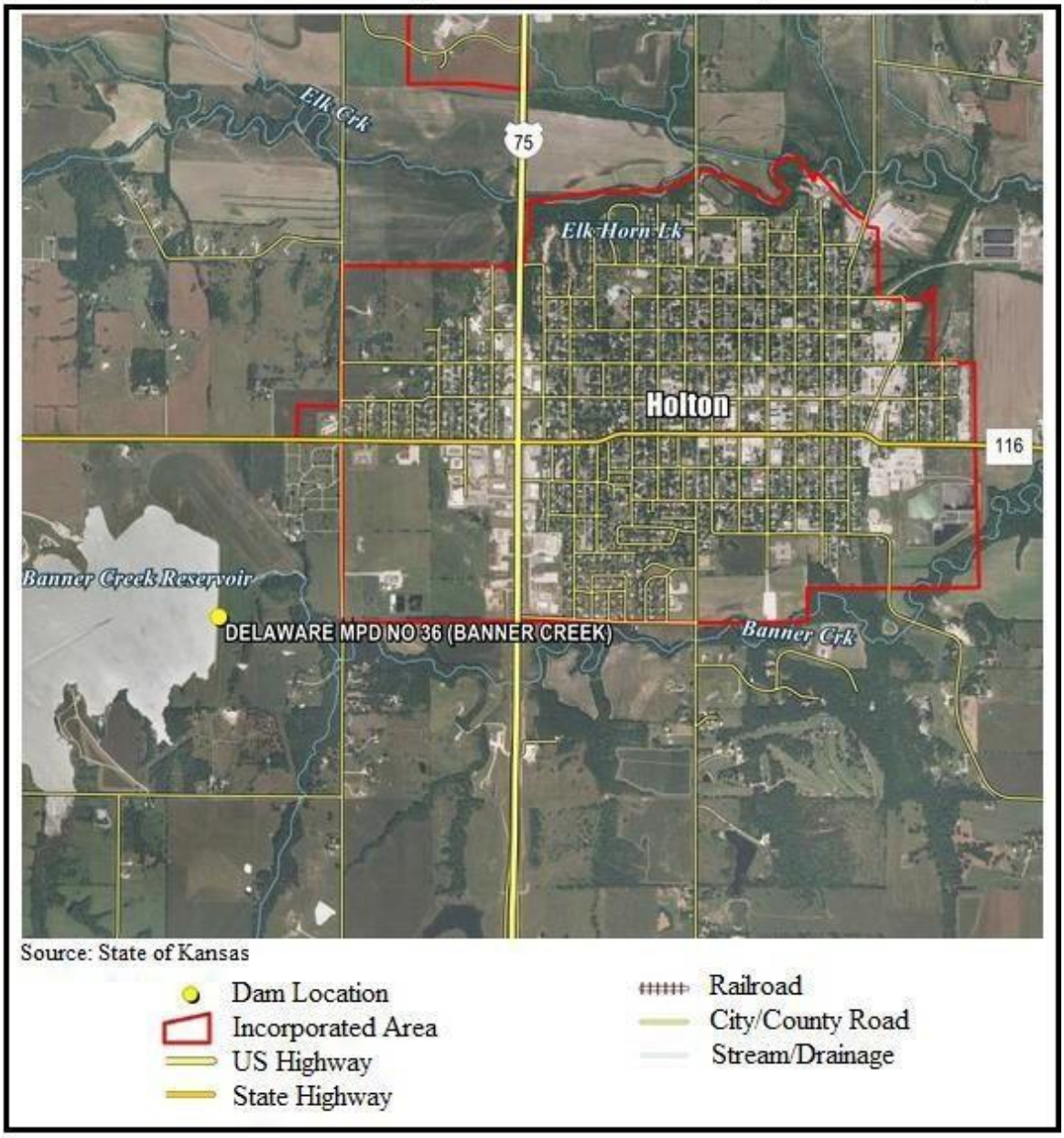


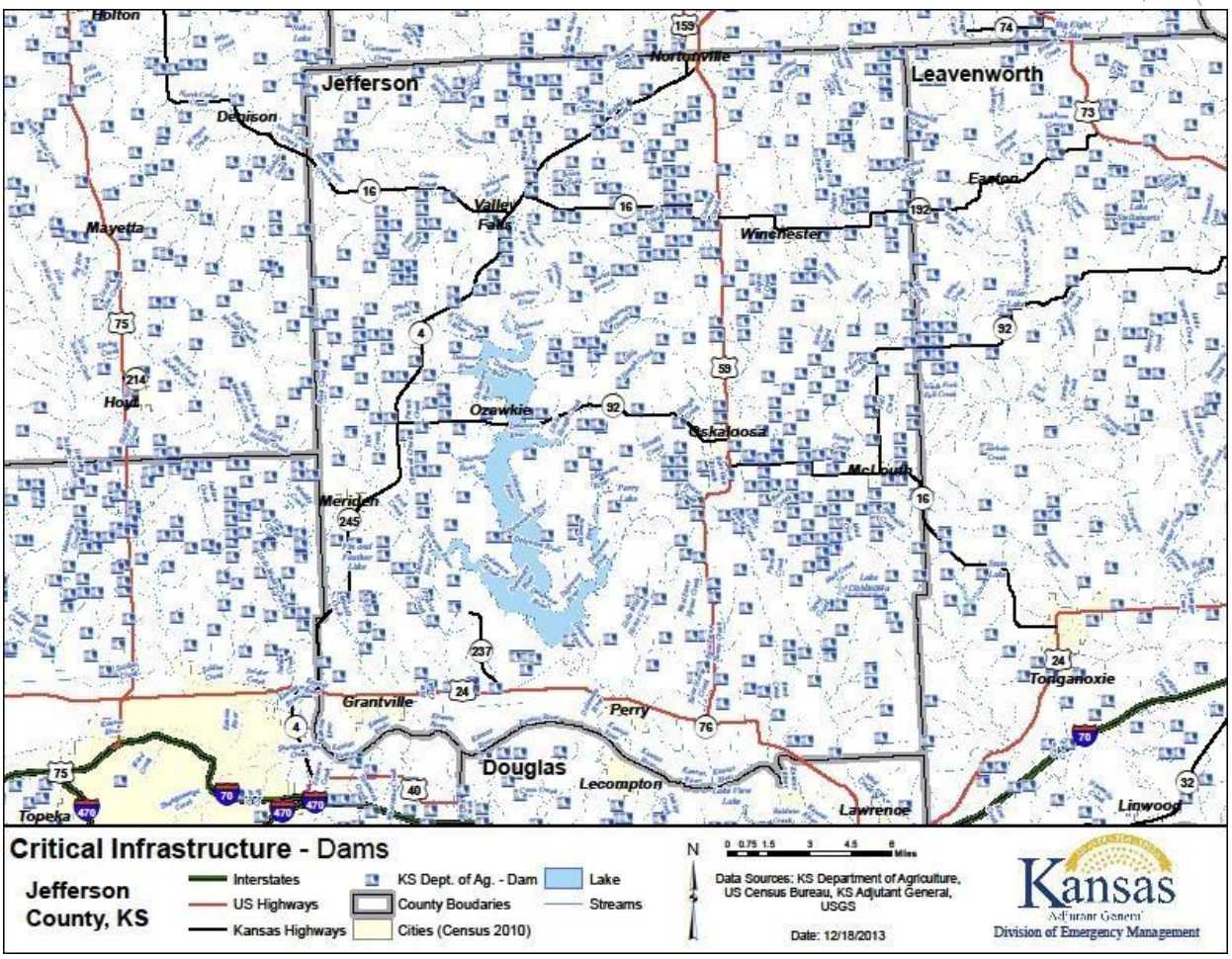
Dam DD #7-35, Douglas County

Dam FRD #26, Douglas County


Kickapoo Tribal Center
Horton
Atchison
Huron
Corning
Wetmore
Netawaka
Whiting
Muscotah
Effingham
Jackson
Soldier
Circleville
Havensville
Onaga
Holton
Jefferson
Nortonville
Denison
Mayetta
Valley Falls
Emmett
Hoyt
Ozawkie
Delia
Belvue
Wamego
St. Marys
Shawnee
Meriden
Critical Infrastructure - Dams
Jackson County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

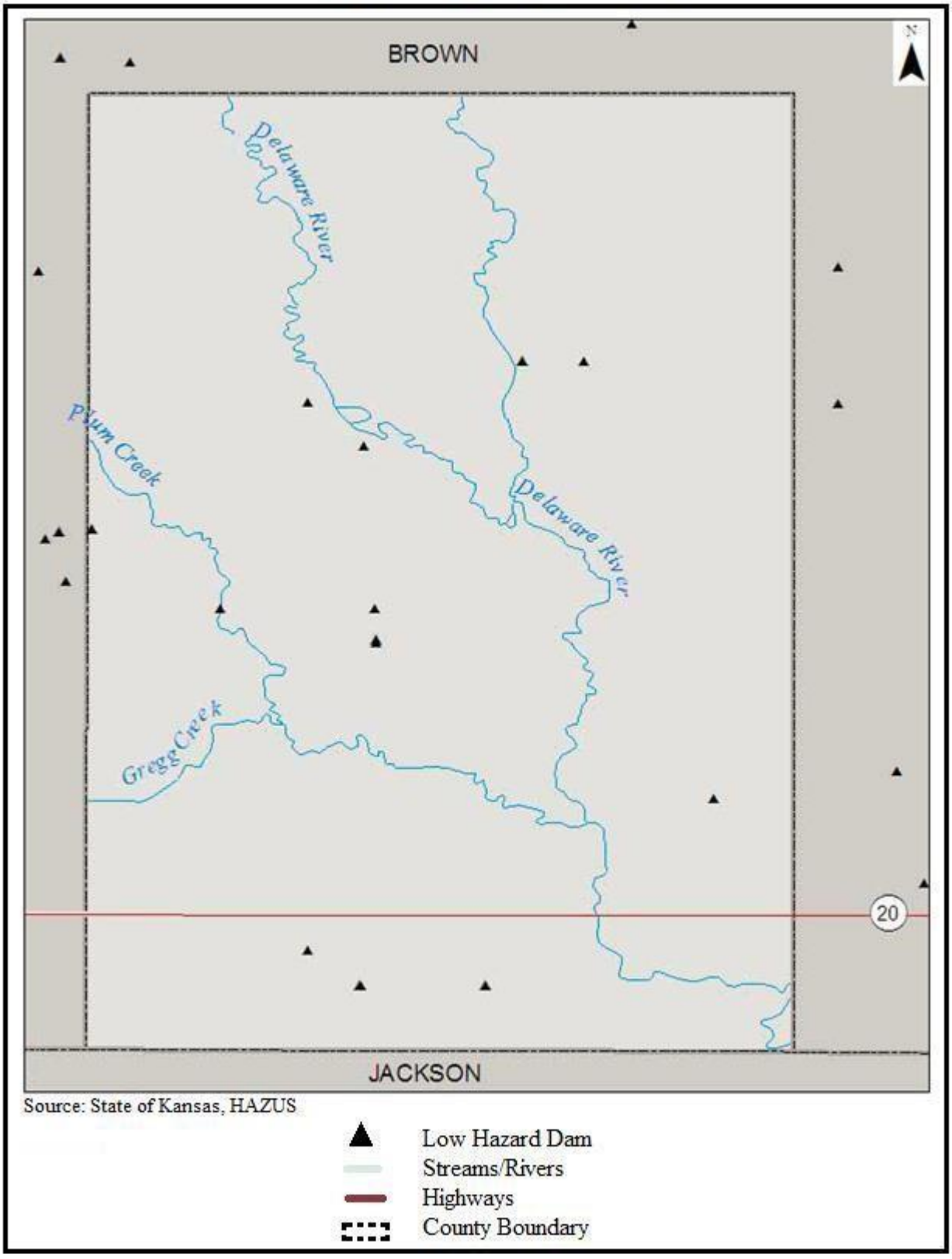
Delaware MPD #36 Dam, Banner Creek Reservoir, Jackson County

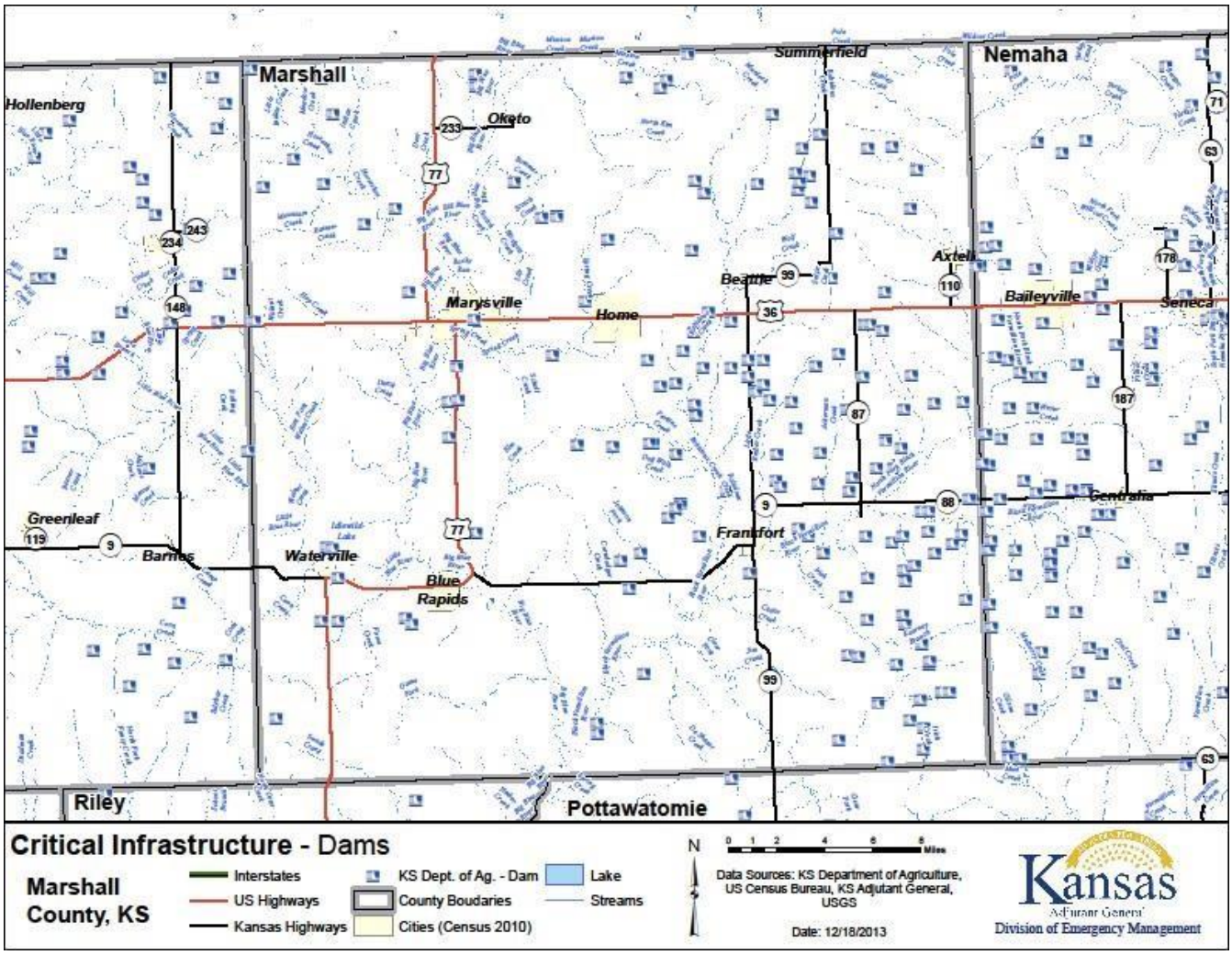



Holton
Jefferson
Nortonville
Leavenworth
Denison
Mayetta
Valley Falls
Winchester
Easton
Hoyt
Ozawkie
Oskaloosa
McLouth
Meriden
Grantville
Perry
Tonganoxie
Douglas
Lecompton
Lawrence
Topeka
Linwood
Critical Infrastructure - Dams
Jefferson County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

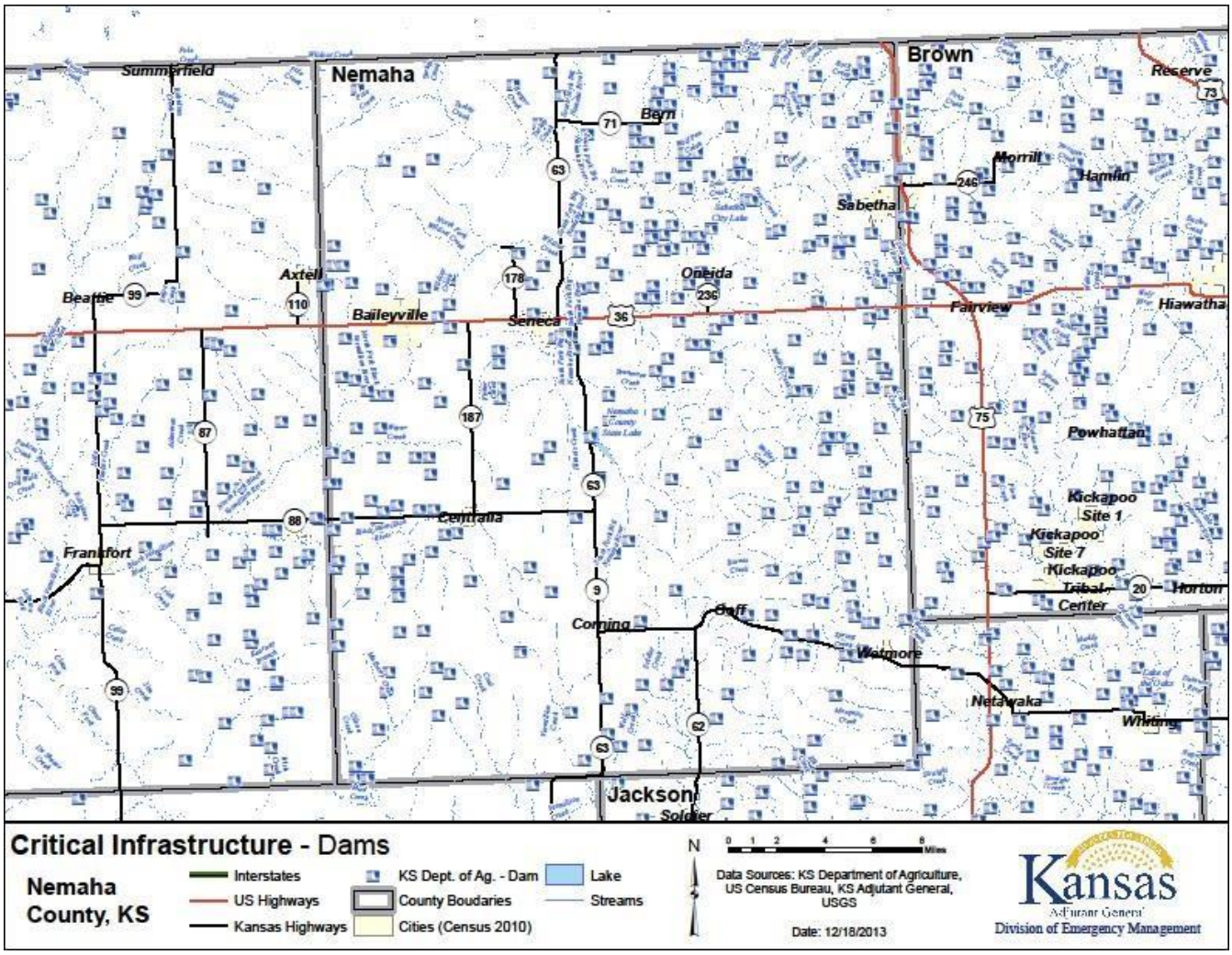
Perry Dam, Jefferson County

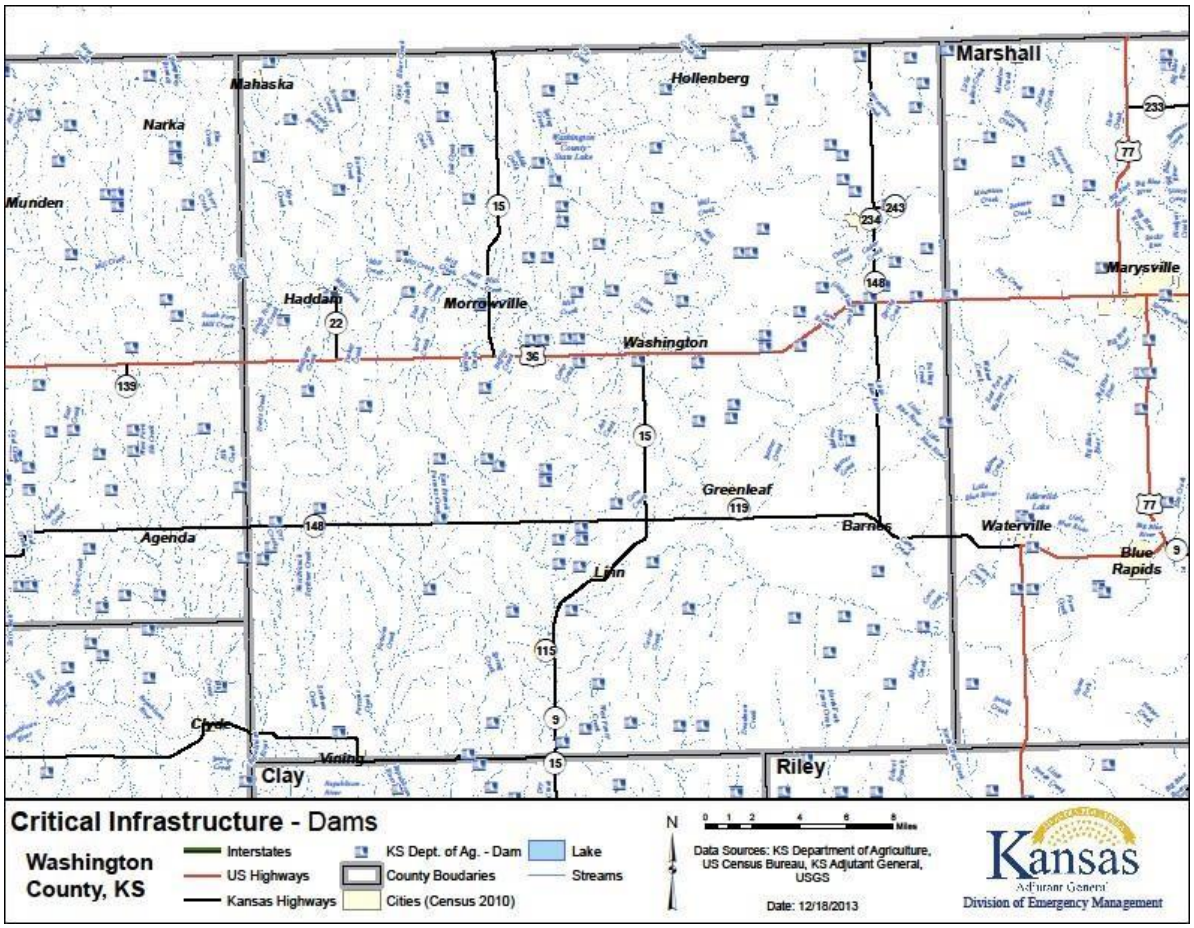
## Kickapoo Tribe Dam Location Map




Marshall
Nemaha
Riley
Pottawatomie
Hollenberg
Oketo
Summerfield
Beattie
Axtell
Baileyville
Seneca
Marysville
Home
Greenleaf
Barnes
Waterville
Blue Rapids
Frankfort
Centralia
Critical Infrastructure - Dams
Marshall County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management

Dam FRD #68, Marshall County


Nemaha
Brown
Summerfield
Reserve
Bern
Morrill
Hamlin
Sabetha
Axtell
Beattie
Baileyville
Seneca
Oneida
Fairview
Hiawatha
Powhattan
Kickapoo Site 1
Kickapoo Site 7
Kickapoo Tribal Center
Horton
Centralia
Frankfort
Corning
Goff
Wetmore
Netawaka
Whiting
Jackson
Soldier
Critical Infrastructure - Dams
Nemaha County, KS
Interstates
US Highways
Kansas Highways
KS Dept. of Ag. - Dam
County Boudaries
Cities (Census 2010)
Lake
Streams
N
Data Sources: KS Department of Agriculture, US Census Bureau, KS Adjutant General, USGS
Date: 12/18/2013
Kansas
Adjutant General
Division of Emergency Management




In addition, the KDA-DWR indicates that there are three dams within the state that are operated by Federal Government agencies.

**Table 4.10: Kansas Region K Federally Operated Dams**

| County | Federal Reservoir Name | Operating Agency |
|---|---|---|
| Douglas | Clinton | United States Army Corps of Engineers (USACE) |
| Jefferson | Perry | USACE |

Source: KDA-DWR

Of additional potential concern are high hazard dams in neighboring Nebraska counties. These dams, and the relevant county they are in, are as follows:

- Gage County - Little Indian Creek 15A Dam
- Gage County - Upper Big Nemaha 25C Dam
- Gage County - Mud Creek 2A Dam

- Gage County - Big Indian Creek 14B Dam
- Richardson County-Long Branch 21 Dam
- Thayer County - Hebron Dam

### 4.8.2 – Levee Location and Extent

As there is no one, comprehensive list of all levees within the region, two sources of data were reviewed to determine a list of all known levees. These sources are:

 The U.S. Army Corps of Engineers (USACE) Integrated National Levee Database (NLD), containing levees enrolled in the USACE National Levee Safety Program (NLSP).  The FEMA National Levee Inventory Report (NLIR)

According the USACE Integrated NLD, there are 63 levees in the NLSP in Kansas Region K. The following table provides available information on these levees.

**Table 4.11: Kansas Region K USACE NLD Levees**

| County(ies) | Jurisdiction(s) | Name | Waterway | Segments | Levee Miles | Leveed Area in Square Miles | Inspection Rating Description | Sponsors |
|---|---|---|---|---|---|---|---|---|
| Atchison | Atchison County | Henry Pohl Levee | Missouri River | 1 | 3.96 | 1.07 | - | Henry Pohl Levee |
| Atchison | Atchison Count | Henry Pohl Levee | Cedar River | 1 | 0.50 | 0.96 | - | Henry Pohl Levee District |
| Atchison | Denison, | LAT-0001 | - | 1 | 0.73 | 0.14 | - | - |
| Atchison | Muscotah | LAT-0002 | - | 1 | 1.02 | 0.21 | - | - |
| Atchison | Denison | LAT-0003-C | - | 1 | 1.44 | 0.42 | - | - |
| Atchison | Muscotah | LAT-0006-C | - | 1 | 0.56 | 0.23 | - | - |
| Atchison | Muscotah | LAT-0007-C | - | 1 | 0.25 | 0.18 | - | - |
| Atchison | Muscotah | LAT-0008 | - | 1 | 0.12 | 0.06 | - | - |
| Atchison | Denison | LAT-0009 | - | 1 | 0.65 | 0.09 | - | - |
| Atchison | Atchison County | LAT-0013 | - | 1 | 3.08 | 0.94 | - | - |
| Atchison | Atchison County | LAT-0015 | - | 1 | 3.62 | 1.12 | - | - |
| Atchison | Muscotah | LAT-0028 | - | 1 | 0.37 | 0.13 | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Atchison, Doniphan | Atchison | MRLS 440-R | Missouri River | 1 | 10.57 | 6.88 | Minimally Acceptable | Drainage District No. 15-45 of Atchison and Doniphan Counties, Kansas |
| Atchison, Leavenworth | Leavenworth | Grape-Bollin-Schwartz Levee Association | Missouri River | 1 | 4.69 | 1.71 | - | Grape-Bollin-Schwartz Levee Association |

**Table 4.11: Kansas Region K USACE NLD Levees**

| County(ies) | Jurisdiction(s) | Name | Waterway | Segments | Levee Miles | Leveed Area in Square Miles | Inspection Rating Description | Sponsors |
|---|---|---|---|---|---|---|---|---|
| Brown | Leona | LBR-0006 | - | 1 | 0.92 | 0.19 | - | - |
| Brown, Iowa Tribal Reservation | Rulo | MRLS-512-513-R SE | Big Nemaha River | 1 | 5.76 | 3.57 | - | - |
| Buchanan, Doniphan | St. Joseph | MRLS 471-460-R | Missouri River | 1 | 13.80 | 20.64 | Minimally Acceptable | Elwood-Gladden Drainage District and St. Joseph Airport Levee District |
| Doniphan | Doniphan County | MRLS 482-R | Missouri River | 1 | 8.26 | 7.47 | Minimally Acceptable | Doniphan County - Burr Oak Drainage District #3 |
| Doniphan | Doniphan County | MRLS 482-R Doniphan-Burr Oak 1 | Missouri River Canal | 1 | 1.86 | 0.31 | - | - |
| Doniphan | Doniphan County | MRLS 482-R Doniphan-Burr Oak 2 | Missouri River Canal | 1 | 1.38 | 0.92 | - | - |
| Doniphan | Doniphan County | MRLS 500-R | Missouri River | 1 | 4.14 | 2.33 | Minimally Acceptable | Iowa Point Drainage District No. 4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Doniphan | Doniphan County | Old 471 front levee | Missouri River | 1 | 0.49 | 0.37 | - | - |
| Douglas | Lawrence | Douglas County Drainage District | Kansas River | 1 | 4.08 | 2.24 | - | Douglas County Drainage District |
| Douglas | Lawrence | LDG-0017 | - | 1 | 0.62 | 0.10 | - | - |
| Douglas, Jefferson, Leavenworth | Lawrence | Lawrence Unit | Kansas River | 1 | 15.81 | 13.38 | Minimally Acceptable | City of Lawrence, Kansas |
| Douglas, Johnson | Linwood | Johnson Kansas River 1 | Kansas River | 1 | 0.82 | 0.27 | - | - |
| Jackson | Muscotah | LJA-0004 | Missouri River | 1 | 9.15 | 6.77 | - | - |
| Jackson | Circleville | LJA-0013 | Straight Creek | 1 | 0.71 | 0.25 | - | Undefined |

**Table 4.11: Kansas Region K USACE NLD Levees**

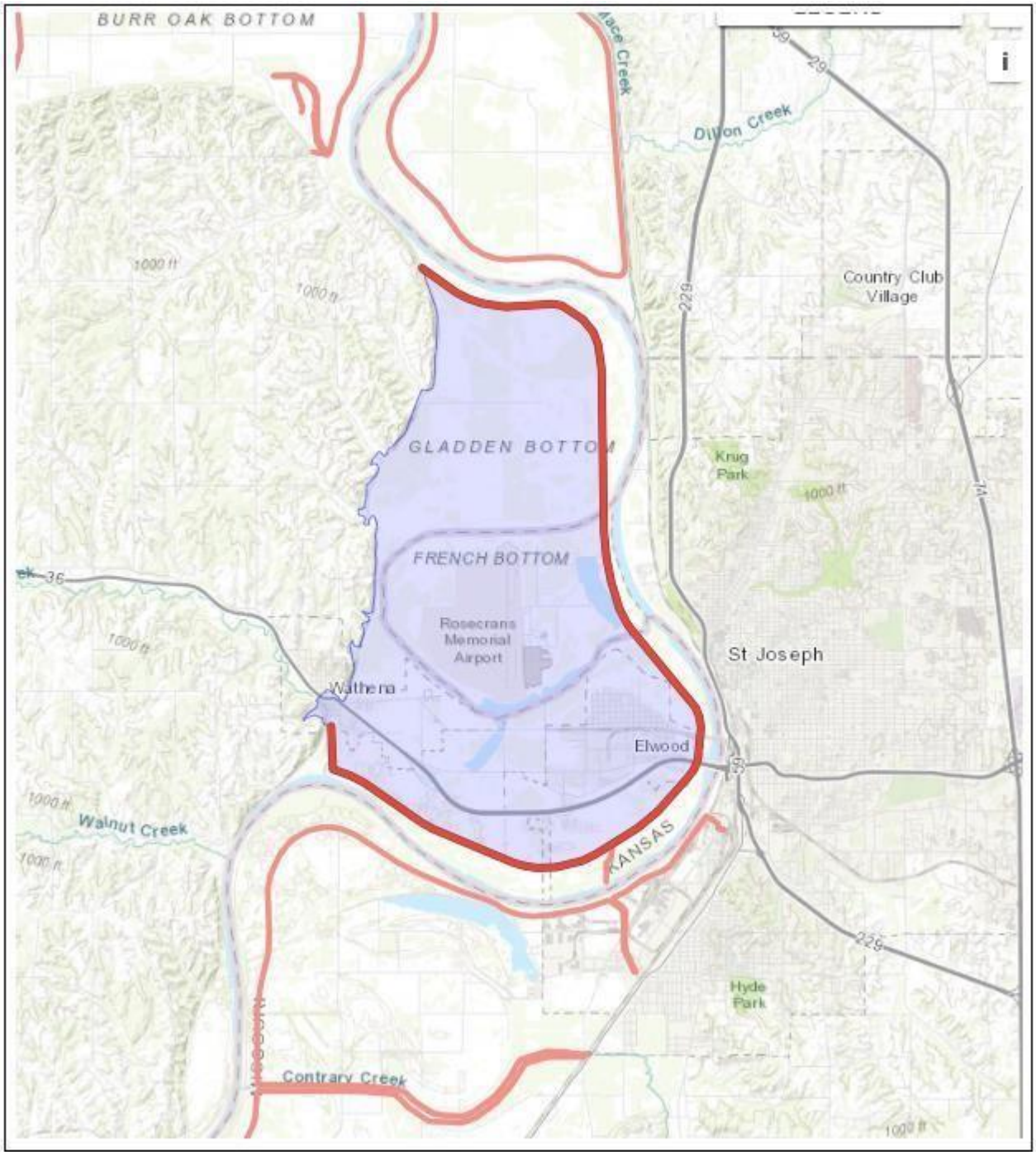
| County(ies) | Jurisdiction(s) | Name | Waterway | Segments | Levee Miles | Leveed Area in Square Miles | Inspection Rating Description | Sponsors |
|---|---|---|---|---|---|---|---|---|
| Jackson | Independence | Fire Prairie Creek Levee 1 | - | 1 | 0.28 | 0.12 | - | - |
| Jefferson | Grantville | LJF-0006 | - | 1 | 0.65 | 0.10 | - | - |
| Jefferson | Perry | LJF-0018 | - | 1 | 1.11 | 1.06 | - | - |
| Jefferson | Perry | Stonehouse Creek Drainage District No. 1 | Kansas River | 2 | 0.89 | 0.31 | Minimally Acceptable | Stonehouse Creek Drainage District No. 1, Stonehouse Creek RR embankment |
| Marshall | Frankfort | Frankfort, Kansas | Black Vermillion River | 1 | 3.24 | 0.60 | Minimally Acceptable | City of Frankfort, Kansas |
| Marshall | Vermillion | LMS-0007 | - | 1 | 0.50 | 0.06 | - | - |
| Marshall | Vermillion | LMS-0022 | - | 1 | 0.50 | 0.04 | - | - |
| Marshall | Vermillion | LMS-0032, LMS-0027 | | 1 | 0.72 | 0.15 | - | - |
| Marshall | Frankfort | LMS-0069, LMS-0056 | | 1 | 1.12 | 0.11 | - | - |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Marshall | Marysville | Marysville, Kansas | Big Blue River | 1 | 3.03 | 0.83 | - | Marysville, Kansas |
| Nemaha | Bern | LNM-0010-LMN-0012 | - | 1 | 0.49 | 0.078 | - | - |
| Washington | Barnes | LWS-0002 | - | 1 | 1.04 | 0.076 | - | - |
| Washington | Barnes | LWS-0009 | - | 1 | 0.42 | 0.067 | - | - |

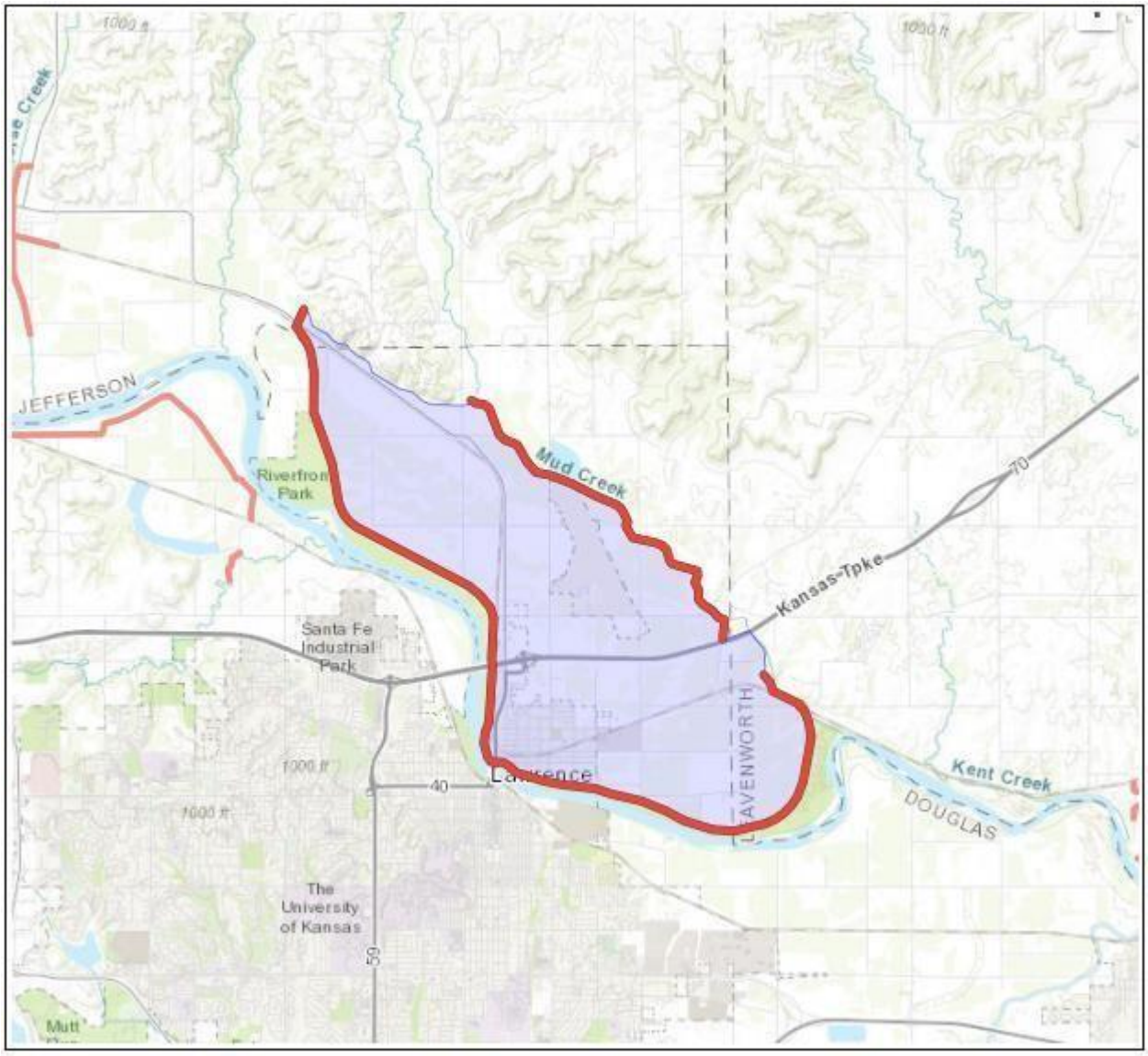
Source: USACE
-: Data unknown

The following maps detail select individual levees. Additional, both the county and jurisdiction for the levee are noted in parenthesis.

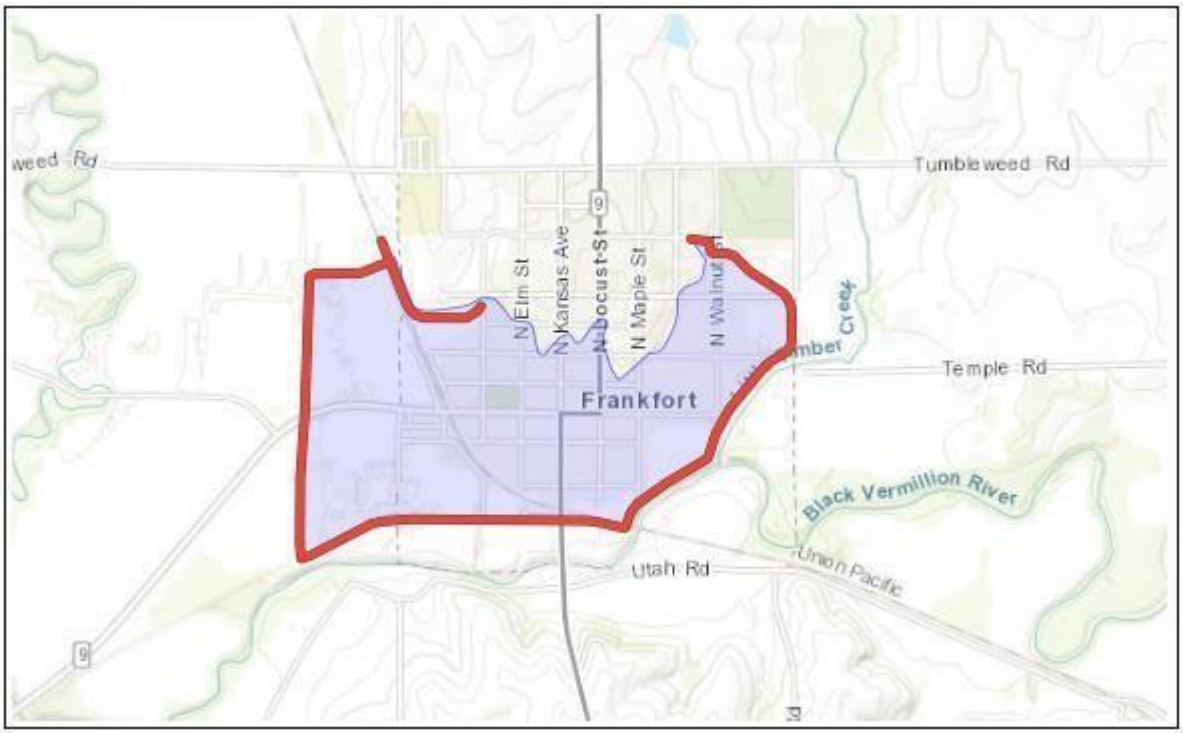
**MRLS 471-460-R (Doniphan County)**



## Lawrence Unit (Douglas County, Lawrence)



**Frankfort (Marshall County, Frankfort)**




## 4.8.3 – Previous Occurrences

Kansas Region K has been fortunate enough to not have any catastrophic dam failures. Below are the reported dam failures for the region for the 20-year period from 1999-2018.

**Table 4.12: Kansas Region K Dam Incidents**

| County | Dam Name | Incident Type | Failure | Incident Date | Deaths |
|---|---|---|---|---|---|
| Douglas | KS00310 | Erosion/Animal Burrows | No | 3/8/2001 | None Reported |
| Douglas | KS02540 | Cracking, Embankment Erosion | No | 8/15/2001 | None Reported |

Source: Stanford University National Performance of Dams Program

The following details notable or reported levee failures in Kansas Region K in the past 20 years.

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

- Ft. Leavenworth levee
- Kansas Department of Corrections Levee

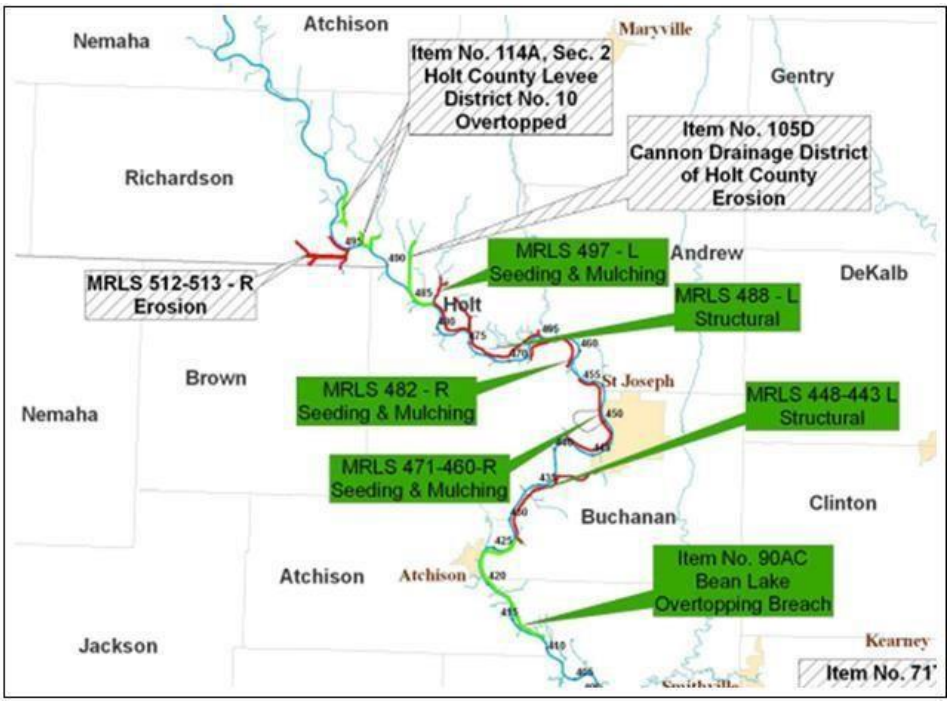
The Levee Repair Working Group of the Missouri River Flood Task Force, established in response to the Missouri River Basin flood of 2011, reported that the following federal and non-federal levees in Kansas were damaged by the flooding.

**Table 4.13: 2011 Damaged Levees**

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

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

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




## 4.8.4 – Hazard Probability Analysis

Due to the variability of the size and construction of the dams in Region K, estimating the probability of dam failure is difficult on any scale greater than a case-by-case basis. Historically, the limited available data indicates there have been three reported dam failure events in Kansas Region K over a 20-year period. Using the binomial probability equation (number of years with an event divided by total number of years in reporting period) we derive a probability 15% of a dam failure in a given year. However, it is worth noting that none of the historically reported event resulted in a catastrophic failure, had no loss of life, and no property damages.

Historically, the limited available data indicates there have been no reported levee failure events in Kansas Region K over a 20-year period. Using the binomial probability equation, we derive a probability of 0% for a levee failure in a given year. However, because past non-occurrence does not guarantee future non-occurrence, both federal and nonfederal levees may be damaged in future catastrophic regional flood events.

## 4.8.5 – Vulnerability Assessment, Dams

Following the metric established in the State of Kansas 2018 Hazard Mitigation Plan, an analysis of vulnerability to dam failure was completed by points being assigned to each type of dam and then aggregated for a total point score for each county. This analysis does not intend to demonstrate vulnerability in terms dam structures that are likely to fail, but rather provides a general overview of the

counties that have a high number of dams, with weighted consideration given to dams whose failure would result in greater damages. Points were assigned as follows:

- Low Hazard Dams: 1 point
- Significant Hazard Dams: 2 point
- High Hazard Dams: 3 points
- High Hazard Dams without an EAP: 2 points  Federal Reservoir Dams: 3 points.

Based on these categories, an awarded point total was determined for each participating county and a vulnerability rating assigned based on the following schedule.

**Table 4.14: Dam Vulnerability Rating Schedule**

| | Low | Medium-Low | Medium | Medium-High | High |
|---|---|---|---|---|---|
| Awarded Point Range | 0 – 26 | 27 – 50 | 51 – 100 | 101 – 200 | 201 - 327 |

The following table presents the dam failure vulnerability rating for each Kansas Region K participating county.

**Table 4.15: Kansas Region K County Vulnerability Assessment for Dam Failure**

| County | Low Hazard Dams | Significant Hazard Dams | High Hazard Dams | High Hazard Dams Without EAP | Federal Reservoirs | Vulnerability Rating | Vulnerability Level |
|---|---|---|---|---|---|---|---|
| Atchison | 128 | 3 | 22 | 0 | | 200 | Medium-High |
| Brown | 189 | 8 | 5 | 0 | | 220 | High |
| Doniphan | 67 | 1 | 0 | 0 | | 69 | Medium |
| Douglas | 65 | 2 | 11 | 0 | 1 | 105 | Medium-High |
| Jackson | 201 | 6 | 3 | 0 | | 222 | High |
| Jefferson | 204 | 3 | 2 | 0 | 1 | 219 | High |
| Marshall | 107 | 3 | 5 | 0 | | 128 | Medium-High |
| Nemaha | 142 | 3 | 1 | 0 | | 151 | Medium-High |
| Washington | 26 | 1 | 0 | 0 | | 28 | Low |

Source: Analysis by KDEM utilizing data from: Kansas Department of Agriculture, Division of Water Resources, Water Structures program; U.S. Army Corps of Engineers; Bureau of Reclamation; U.S. Army, U.S. Fish and Wildlife.

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.16: Kansas Region K Population Vulnerability Data for Dam Failure**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

### 4.8.6 – Vulnerability Assessment, Levees

Data was obtained from the USACE NLD to help determine the vulnerability of participating jurisdictions to potential levee failure. Available data includes:

- Number of people at risk
- Structures at risk
- Property value for structures at risk
- Levee safety action risk classification

Additionally, for the NFIP, FEMA will only recognize a levee system in its flood risk mapping effort that meet minimum design, operation, and maintenance standards as established by 44 CFR 65.10 – Mapping of Areas Protected by Levee Systems. In general, evaluated levees are assigned to one of these categories:

- **Accredited Levee:** Area behind the levee is mapped as a moderate-risk, with no mandatory flood insurance requirement.
- **To Be Accredited:** A levee system that has been approved for accreditation.
- **Provisionally Accredited Levee (PAL):** Area behind the levee is mapped as a moderate-risk, with no mandatory flood insurance requirement, for a two-year grace period while compliance with 44 CFR 65.10 is sought
- **Non-Accredited Levee:** Area behind the levee is mapped according to FEMA protocols, likely resulting in a high-risk area designation and associate flood insurance requirements
- **To Be Non-Accredited:** A levee system that no longer meets the requirements stipulated in 44 CFR 65.10 and is scheduled to lose accredited status

The following table presents the above information for each vulnerable jurisdiction.

**Table 4.17: Kansas Region K Levee Failure Vulnerability Data**

| County(ies) | Jurisdiction | Name | People at Risk | Structures at Risk | Property Value | Levee Safety Action Risk Classification | Levee System Status on Effective FIRM |
|---|---|---|---|---|---|---|---|
| Atchison | Atchison County | Henry Pohl Levee | 0 | 0 | $0 | Not Screened | Non-Accredited |
| Atchison | Atchison Count | Henry Pohl Levee | 0 | 0 | $1,140,000 | Low | Non-Accredited |
| Atchison | Denison, | LAT-0001 | 1 | 1 | $350,000 | Not Screened | - |
| Atchison | Muscotah | LAT-0002 | 4 | 1 | $350,000 | Not Screened | - |
| Atchison | Denison | LAT-0003-C | 0 | 0 | $0 | Not Screened | - |
| Atchison | Muscotah | LAT-0006-C | 10 | 4 | $1,120,000 | Not Screened | - |
| Atchison | Muscotah | LAT-0007-C | 0 | 0 | $0 | Not Screened | - |
| Atchison | Muscotah | LAT-0008 | 2 | 1 | $350,000 | Not Screened | - |
| Atchison | Denison | LAT-0009 | 0 | 0 | $0 | Not Screened | - |
| Atchison | Atchison County | LAT-0013 | 0 | 0 | $0 | Not Screened | - |
| Atchison | Atchison County | LAT-0015 | 0 | 0 | $0 | Not Screened | - |
| Atchison | Muscotah | LAT-0028 | 0 | 0 | $0 | Not Screened | - |
| Atchison, Doniphan | Atchison | MRLS 440-R | 1 | 0 | $71,600 | Low | Non-Accredited |
| Atchison, Leavenworth | Leavenworth | Grape-Bollin-Schwartz Levee Association | 13 | 7 | $186,000 | Low | Non-Accredited |
| Brown | Leona | LBR-0006 | 0 | 0 | $0 | Not Screened | - |

**Table 4.17: Kansas Region K Levee Failure Vulnerability Data**

| County(ies) | Jurisdiction | Name | People at Risk | Structures at Risk | Property Value | Levee Safety Action Risk Classification | Levee System Status on Effective FIRM |
|---|---|---|---|---|---|---|---|
| Brown, Iowa Tribal Reservation | Rulo | MRLS-512-513-R SE | 2 | 2 | $205,000 | Low | Non-Accredited |
| Doniphan | Doniphan County | MRLS 482-R | 7 | 36 | $1,560,000 | Low | Accredited |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Buchanan, Doniphan | St. Joseph | MRLS 471-460-R | 2,773 | 797 | $746,000,000 | Moderate | PAL |
| Doniphan | Doniphan County | MRLS 482-R DONIPHAN-BURR OAK 1 | 0 | 0 | $0 | Not Screened | Non-Accredited |
| Doniphan | Doniphan County | MRLS 482-R DONIPHAN-BURR OAK 2 | 0 | 0 | $0 | Not Screened | Non-Accredited |
| Doniphan | Doniphan County | MRLS 500-R | 0 | 0 | $2,050,000 | Low | Accredited |
| Doniphan | Doniphan County | Old 471 front levee | 0 | 0 | $0 | Not Screened | Non-Accredited |
| Douglas | Lawrence | Douglas County Drainage District | 16 | 24 | $4,870,000 | Low | Non-Accredited |
| Douglas | Lawrence | LDG-0017 | 0 | 0 | $0 | Not Screened | - |
| Douglas, Jefferson, Leavenworth | Lawrence | Lawrence Unit | 2,215 | 1,236 | $336,000,000 | Moderate | Accredited |
| Douglas, Johnson | Linwood | Johnson Kansas River 1 | 0 | 0 | $0 | Not Screened | Non-Accredited |
| Jackson | Muscotah | LJA-0004 | 0 | 0 | $0 | Not Screened | - |
| Jackson | Circleville | LJA-0013 | 0 | 1 | $360,000 | Not Screened | - |
| Jefferson | Grantville | LJF-0006 | 0 | 0 | $0 | Not Screened | - |
| Jefferson | Perry | LJF-0018 | 6 | 5 | $1,840,000 | Not Screened | - |
| Jefferson | Perry | Stonehouse Creek Drainage District No. 1 | 94 | 40 | $15,800,000 | Not Screened | Non-Accredited |
| Marshall | Frankfort | Frankfort, Kansas | 336 | 323 | $60,500,000 | Low | Accredited |
| Marshall | Vermillion | LMS-0007 | 0 | 0 | $0 | Not Screened | - |
| Marshall | Vermillion | LMS-0022 | 0 | 0 | $0 | Not Screened | - |
| Marshall | Vermillion | LMS-0032, LMS-0027 | 0 | 0 | $0 | Not Screened | - |

**Table 4.17: Kansas Region K Levee Failure Vulnerability Data**

| County(ies) | Jurisdiction | Name | People at Risk | Structures at Risk | Property Value | Levee Safety Action Risk Classification | Levee System Status on Effective FIRM |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Marshall | Frankfort | LMS-0069, LMS-0056 | 0 | 0 | $0 | Not Screened | - |
| Marshall | Marysville | Marysville, Kansas | 754 | 601 | $154,000,000 | Low | Accredited |
| Marshall | Blue Rapids | Tuttle Creek Dam | 243 | 113 | $26,700,000 | Not Screened | - |
| Nemaha | Bern | LNM-0010-LMN-0012 | 0 | 0 | $0 | Not Screened | - |
| Washington | Barnes | LWS-002 | 0 | 0 | $0 | Not Screened | - |
| | Barnes | LWS-0009 | 0 | 1 | $360,000 | Not Screened | - |

Source: USACE NLD

The following table indicates the total number of county structures and the associated percentage of the total number of county structures, and the total population and associated percentage of the total county population identified as at risk to levee failure.

**Table 4.18: Kansas Region K Population Vulnerability Data for Levee Failure**

| County | Structures Identified as at Risk to Levee Failure | Percentage of Structures Identified at Risk | Population Identified as at Risk to Levee Failure | Percentage of Population Identified at Risk |
|---|---|---|---|---|
| Atchison | 32 | 0.48% | 25 | 0.15% |
| Brown | 2 | 0.04% | 2 | 0.02% |
| Doniphan | 2,780 | 77.48% | 833 | 10.69% |
| Douglas | 2,231 | 4.54% | 1,260 | 7.06% |
| Jackson | 0 | 0.00% | 1 | 0.01% |
| Jefferson | 100 | 1.20% | 45 | 0.24% |
| Marshall | 1,333 | 27.26% | 1,037 | 10.52% |
| Nemaha | 0 | 0.00% | 0 | 0.00% |
| Washington | 0 | 0.00% | 1 | 0.02% |

Source: US Census Bureau and FEMA

## 4.8.7 – Impact and Consequence Analysis

As per EMAP standards, the information in the following table provides the Consequence Analysis.

**Table 4.19: Dam and Levee Failure Consequence Analysis**

| Subject | Impacts of Dam and Levee Failure |
|---|---|
| Health and Safety of the Public | In areas of inundation, the impact to the public is expected to be severe. Impacts to the public in adjacent or minimally impacted areas is expected to be minimal to moderate. |
| Health and Safety of Responders | Impact to responders is expected to be minimal with proper training. Impact could be severe if there is lack of training. |

| | |
|---|---|
| Continuity of Operations | Temporary relocation may be necessary if facilities or infrastructure is damaged. |

**Table 4.19: Dam and Levee Failure Consequence Analysis**

| Subject | Impacts of Dam and Levee Failure |
|---|---|
| Property, Facilities, and Infrastructure | In areas of inundation, impacts could be severe to facilities and infrastructure. . |
| Environment | In areas of inundation, impact to the environment are expected to be severe. Impact will lessen as distance increases. |
| Economic Conditions | In areas of inundation, impacts to the economy will depend on the scope of the inundation and the time it takes for the water to recede. |
| Public Confidence in the Jurisdiction's Governance | Perception of whether the failure could have been prevented, warning time, and response and recovery time will greatly impact the public's confidence. |

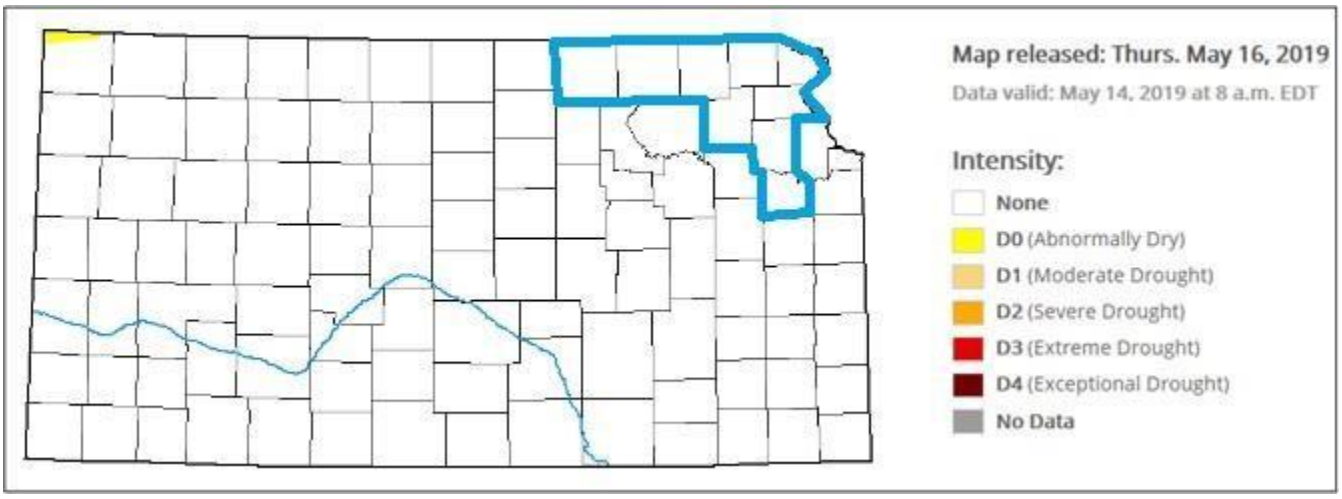
## 4.9 – Drought

Drought is an abnormally dry period lasting months or years when an area has a deficiency of water and precipitation in its surface and/or underground water supply. The hydrological imbalance can be grouped into the following non-exclusive categories.

- ***Agricultural:*** When the amount of moisture in the soil no longer meets the needs of previously grown crops.
- ***Hydrological:*** When surface and subsurface water levels are significantly below their normal levels.
- ***Meteorological:*** When there is a significant departure from the normal levels of precipitation.
- ***Socio-Economic:*** When the water deficiency begins to significantly affect the population.

### 4.9.1 – Location and Extent

While all of Kansas Region K is vulnerable to drought, it is most disastrous in the rural areas where the majority of agricultural businesses are located. The map below indicates the drought conditions for Kansas Region K through January 1, 2019.




### 4.9.2 – Previous Occurrences

One of the best indicators of historic drought periods is provided by the U.S. Drought Monitor, which lists weekly drought conditions for the State of Kansas. The following table details the U.S. Drought Monitor categories.

**Table 4.20: U.S. Drought Monitor Categories**

| Rating | Described Condition |
|---|---|
| None | No drought conditions |
| D0 | Abnormally Dry |
| D1 | Moderate Drought |
| D2 | Severe Drought |
| D3 | Extreme Drought |
| D4 | Exceptional Drought |

Source: U.S. Drought Monitor

Historical data was gathered from the U.S. Drought Monitor weekly reports from the 10-year period 2009 through 2018 (with 2009 and 2018 being full data set years). This data was compiled and aggregated to provide a yearly estimate of the percentage of the year Kansas Region K was in each Drought Monitor category.

**Table 4.21: Percentage of Kansas Region K in U.S. Drought Monitor Category, 2009-2018**

| Year | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|---|---|---|---|---|---|
| 2019* | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2018 | 25.3% | 74.7% | 52.2% | 15.9% | 3.1% | 0.0% |
| 2017 | 61.0% | 39.0% | 7.2% | 2.2% | 0.0% | 0.0% |
| 2016 | 84.6% | 15.4% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2015 | 72.9% | 27.1% | 6.3% | 0.0% | 0.0% | 0.0% |
| 2014 | 25.2% | 74.8% | 29.6% | 0.0% | 0.0% | 0.0% |
| 2013 | 44.4% | 55.6% | 34.0% | 28.5% | 0.0% | 0.0% |
| 2012 | 39.6% | 60.4% | 53.8% | 44.0% | 18.8% | 0.7% |
| 2011 | 56.0% | 44.0% | 5.4% | 0.0% | 0.0% | 0.0% |
| 2010 | 94.0% | 6.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 2009 | 92.4% | 7.6% | 0.0% | 0.0% | 0.0% | 0.0% |

Source: U.S. Drought Monitor *:
Data through March 16, 2019

Another good indicator of historical droughts is USDA Disaster Declarations. The following table details USDA Drought Declarations during the five-year period 2014 through 2018 (with 2014 and 2018 being full data set years) for Kansas Region K.

**Table 4.22: Kansas Region K Secretarial Drought Declarations, 2009 - 2018**

| Year | Number of Secretarial Drought Disaster Declarations |
|---|---|
| 2018 | 9 |
| 2017 | 1 |
| 2016 | 0 |

| | |
|---|---|
| 2015 | 0 |
| 2014 | 2 |

Source: USDA

Crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of drought on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates 1,491 claims on 2,043,328 acres for $133,428,420.

**Table 4.23: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Drought**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 70 | 101,673 | $19,936,990 |
| Brown | 89 | 196,222 | $29,904,396 |
| Doniphan | 65 | 75,157 | $10,298,687 |
| Douglas | 65 | 75,047 | $13,224,687 |
| Jackson | 100 | 114,692 | $18,222,727 |
| Jefferson | 80 | 95,162 | $17,487,729 |
| Marshall | 191 | 416,297 | $41,567,809 |
| Nemaha | 143 | 495,648 | $76,802,248 |
| Washington | 197 | 194,916 | $18,913,388 |

Source: USDA

## 4.9.3 – Hazard Probability Analysis

Reviewing historical data from the U.S. Drought Monitor weekly reports from the ten-year period of 2009 through 2018 (with 2009 and 2018 being full data set years) a yearly average can be created indicating the percentage of the region in each Drought Monitor category. This average can be used to extrapolate the potential likelihood of future drought conditions.

**Table 4.24: Kansas Region K Estimated Probability of Being in U.S. Drought Monitor Category**

| None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|---|---|---|---|---|
| 59.5% | 40.5% | 18.9% | 9.1% | 2.2% | 0.1% |

Source: U.S. Drought Monitor

Additionally, over the five-year period 2014 to 2018 three years recorded a USDA Declared Secretarial Drought Disaster, equating to 60% chance of occurrence.

Data was reviewed from the USDA Risk Management agency to determine vulnerability to drought. The following table summarizes drought event data for **Atchison County**

**Table 4.25: Atchison County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 70 |
| Average Number of Claims per Year | 7 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 101,673 |
| Average Number of Acres Damaged per Year | 10,167 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $19,936,990 |
| Average Crop Damage per Year | $1,993,699 |

Source: USDA

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to drought occurrences:

- Seven insurance claims
- 10,167 acres impacted
- $1,993,699 in insurance claims

The following table summarizes drought event data for **Brown County**.

**Table 4.26: Brown County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 89 |
| Average Number of Claims per Year | 9 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 196,222 |
| Average Number of Acres Damaged per Year | 19,622 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $29,904,396 |
| Average Crop Damage per Year | $2,990,440 |

Source: USDA

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to drought occurrences:

- Nine insurance claims
- 19,622 acres impacted
- $2,990,440 in insurance claims

The following table summarizes drought event data for **Doniphan County**.

**Table 4.27: Doniphan County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 89 |
| Average Number of Claims per Year | 9 |

| | |
|---|---|
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 75,157 |
| Average Number of Acres Damaged per Year | 7,516 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $10,298,687 |
| Average Crop Damage per Year | $1,029,869 |

Source: USDA

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to drought occurrences:

- Nine insurance claims
- 7,516acres impacted
- $1,029,869 in insurance claims

The following table summarizes drought event data for **Douglas County**.

**Table 4.28: Douglas County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 65 |
| Average Number of Claims per Year | 7 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 75,047 |
| Average Number of Acres Damaged per Year | 7,505 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $13,224,687 |
| Average Crop Damage per Year | $1,322,469 |

Source: USDA

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to drought occurrences:

- Seven insurance claims
- 7,505 acres impacted
- $1,322,469 in insurance claims

The following table summarizes drought event data for **Jackson County**.

**Table 4.29: Jackson County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 100 |
| Average Number of Claims per Year | 10 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 114,692 |
| Average Number of Acres Damaged per Year | 11,469 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $18,222,727 |
| Average Crop Damage per Year | $1,822,273 |

Source: USDA

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to drought occurrences:

- 10 insurance claims
- 11,469 acres impacted
- $1,822,273 in insurance claims

The following table summarizes drought event data for **Jefferson County**.

**Table 4.30: Jefferson County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 80 |
| Average Number of Claims per Year | 8 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 95,162 |
| Average Number of Acres Damaged per Year | 9,516 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $17,487,729 |
| Average Crop Damage per Year | $1,748,773 |

Source: USDA

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to drought occurrences:

- Eight insurance claims
- 9,516 acres impacted
- $1,748,773 in insurance claims

The following table summarizes drought event data for **Marshall County**.

**Table 4.31: Marshall County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 191 |
| Average Number of Claims per Year | 19 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 416,297 |
| Average Number of Acres Damaged per Year | 41,630 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $41,567,809 |
| Average Crop Damage per Year | $4,156,781 |

Source: USDA

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to drought occurrences:

- 19 insurance claims
- 41,630 acres impacted

- $4,156,781 in insurance claims

The following table summarizes drought event data for **Nemaha County**.

**Table 4.32: Nemaha County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 143 |
| Average Number of Claims per Year | 14 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 495,648 |
| Average Number of Acres Damaged per Year | 49,565 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $76,802,248 |
| Average Crop Damage per Year | $7,680,225 |

Source: USDA

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to drought occurrences:

- 14 insurance claims
- 49,565 acres impacted
- $7,680,225 in insurance claims

The following table summarizes drought event data for **Washington County**.

**Table 4.33: Washington County Drought Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 197 |
| Average Number of Claims per Year | 20 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 194,916 |
| Average Number of Acres Damaged per Year | 19,492 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $18,913,388 |
| Average Crop Damage per Year | $1,891,339 |

Source: USDA

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to drought occurrences:

- 20 insurance claims
- 19,492 acres impacted
- $1,891,339 in insurance claims

### 4.9.4 Vulnerability Analysis

In general, structures and populations are not directly vulnerable to losses as a result of drought. However, there is a small potential that bridges could be impacted by shrinking soil as a result of drought conditions that could cause foundational or support damages.

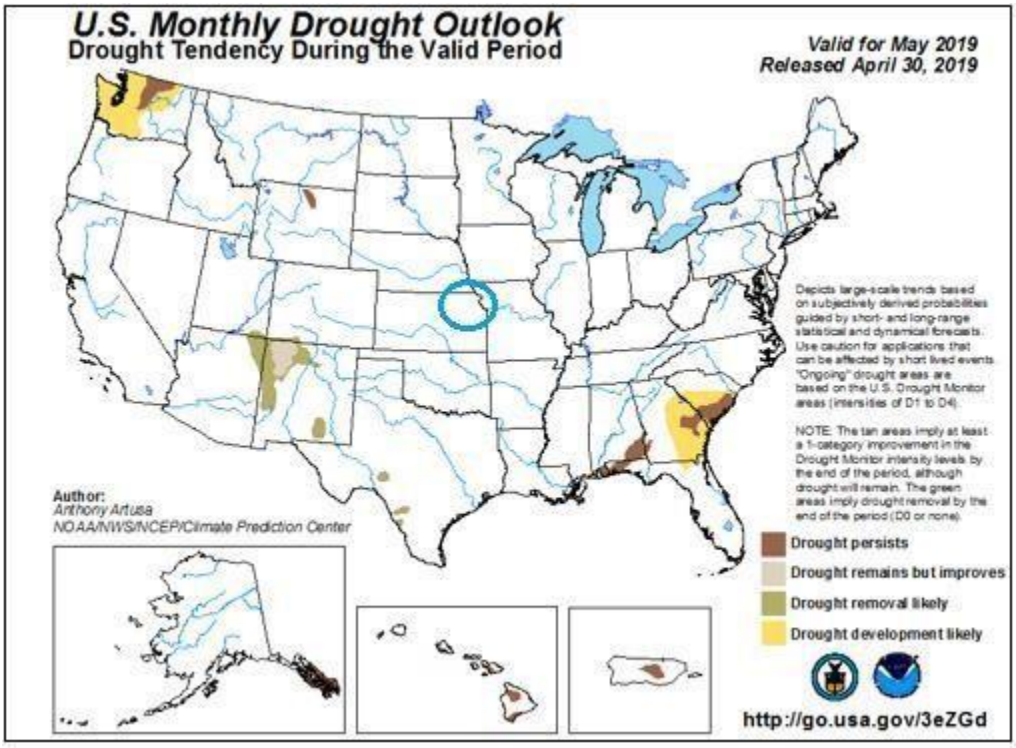
The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data (for the five-year period from 2014 – 2018) allows us to quantify the monetary impact of drought conditions on the agricultural sector. The higher the percentage loss, the higher the vulnerability the county has to drought events.

**Table 4.34: Drought Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 10,167 | 5.83% | $66,913,000 | $1,993,699 | 2.98% |
| Brown | 258,601 | 19,622 | 7.59% | $112,057,000 | $2,990,440 | 2.67% |
| Doniphan | 144,927 | 7,516 | 5.19% | $76,581,000 | $1,029,869 | 1.34% |
| Douglas | 159,261 | 7,505 | 4.71% | $65,867,000 | $1,322,469 | 2.01% |
| Jackson | 168,682 | 11,469 | 6.80% | $40,215,000 | $1,822,273 | 4.53% |
| Jefferson | 153,276 | 9,516 | 6.21% | $44,922,000 | $1,748,773 | 3.89% |
| Marshall | 361,473 | 41,630 | 11.52% | $92,882,000 | $4,156,781 | 4.48% |
| Nemaha | 268,088 | 49,565 | 18.49% | $76,127,000 | $7,680,225 | 10.09% |
| Washington | 336,673 | 19,492 | 5.79% | $87,087,000 | $1,891,339 | 2.17% |

Source: USDA

Additional predictions about drought vulnerability can be made by reviewing data with the National Weather Service (NWS) Climate Prediction Center at www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php. The following map was the latest published data at the time of this report, and indicates no predicted drought conditions for the region.




Drought can severely challenge a public water supplier through depletion of the raw water supply and greatly increased customer water demand. Even if the raw water supply remains adequate, problems due to limited treatment capacity or limited distribution system capacity may be encountered. In addition, the water for cropland and livestock can be greatly impacted. The following are the potential water supply limitations that may result from drought conditions:

- **Basic Source Limitation** - The supplier's primary raw water source is particularly sensitive to drought as evidenced by depleted streamflow, depleted reservoir inflow and storage, or by declining water levels in wells. Restrictions imposed due to inability to use a well(s) because water quality problems were considered indicative of a basic source limitation.
- **Contractual Limitation** - The supplier's sole water source is purchased from another system that is drought vulnerable and there is a drought-cut-off clause in their water purchase contract. In such situations where there is not a drought cut-off clause, the purchaser is considered drought vulnerable under the same limitation category as the seller.
- **Distribution System Limitation** - The supplier has difficulty or is unable to meet drought-induced customer demand for water because of inadequate finished water storage capacity, inadequate finished water pumping capacity, inadequate transmission line sizes.
- **Minimum Desirable Streamflow** - The supplier reported imposing restrictions because of minimum desirable streamflow administration. Water rights junior to those granted for maintenance of established minimum desirable flows are subject to such administration.

- **Single Well Source** - The supplier relies upon a single well as its sole source for raw water. Suppliers with one active well and one emergency well were considered drought vulnerable because emergency wells are not a dependable long-term water source. Excessive hours of operation to meet drought-induced customer demand for water will result in the increased likelihood of mechanical breakdown with no alternative water supply source available.
- **Treatment Capacity Limitation** - The supplier has difficulty or is unable to meet drought-induced customer demand for water due to inadequate raw water treatment capacity.
- **Water Right Limitation** - The supplier reported imposing restrictions because the quantity of water they are authorized to divert under their water right(s) was insufficient to meet customer demands.

Water supply planning is the key to minimizing the effects of drought on the population and economy of the region. State of Kansas agencies have worked with public water suppliers to identify vulnerabilities and develop infrastructure, conservation plans, and partnerships to reduce the likelihood of running out of water during a drought. Information concerning these plans, and any current water supply limitations, may be found with the Kansas Water Office.

### 4.9.5 – Impact and Consequence Analysis

As per EMAP standards, the following table provides the consequence analysis for drought conditions.

**Table 4.35: Drought Consequence Analysis**

| Subject | Impacts of Drought |
|---|---|
| Health and Safety of the Public | Drought impact tends to be agricultural however, because of the lack of precipitation water supply disruptions can occur which can affect people. Impact is expected to be minimal. |
| Health and Safety of Responders | Impact to responders is expected to be minimal. |
| Continuity of Operations | Minimal expectation for utilization of the COOP. |
| Property, Facilities, and Infrastructure | Impact to property, facilities, and infrastructure could be minimal to severe, depending on the length and intensity of the drought. Structural integrity of buildings, and buckling of roads could occur. |
| Environment | The impact to the environment could be severe. Drought can severely affect farming, ranching, wildlife and plants due to the lack of precipitation. |
| Economic Conditions | Impacts to the economy will be dependent on how extreme the drought is and how long it lasts. Communities that depend on an agricultural economic engine will likely be severely stressed. |
| Public Confidence in the Jurisdiction's Governance | Confidence could be an issue during periods of extreme drought if planning is not in place to address intake needs and loss of crops. |

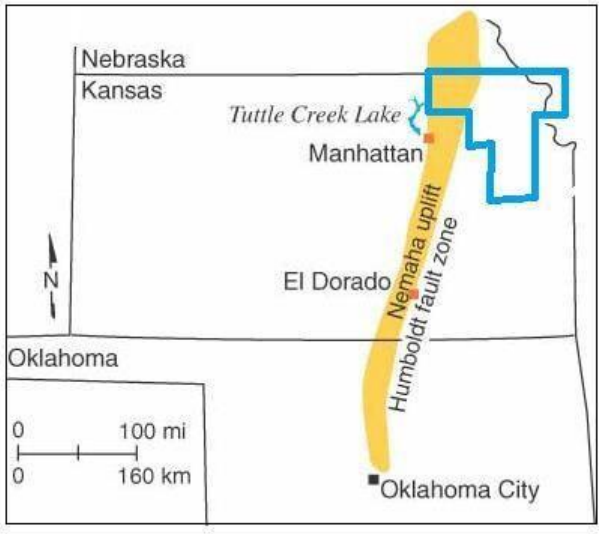
# 4.10 – Earthquake

An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves that are typically caused by the rupturing of geological faults.

## 4.10.1 – Location and Extent

Kansas Region K is in an area of potential seismic activity, with the Humboldt Fault (also known as the Nemaha Uplift) passing through the western portion of the region, including Marshall, Nemaha and Washington counties. Most earthquakes in the Humboldt Fault Zone are small and are detected only with instruments.

**Humboldt Fault Zone**




Two scales are used when referring to earthquake activity. Estimating the total force of an earthquake is the Richter scale, and the observed damage from an earthquake is the Modified Mercalli Intensity Scale. Additionally, both Acceleration (%g) and Velocity (cm/s) can be used to measure and quantify force and movement.

The following table equates the above referenced earthquake scales.

**Table 4.36: Earthquake Magnitude Scale Comparison**

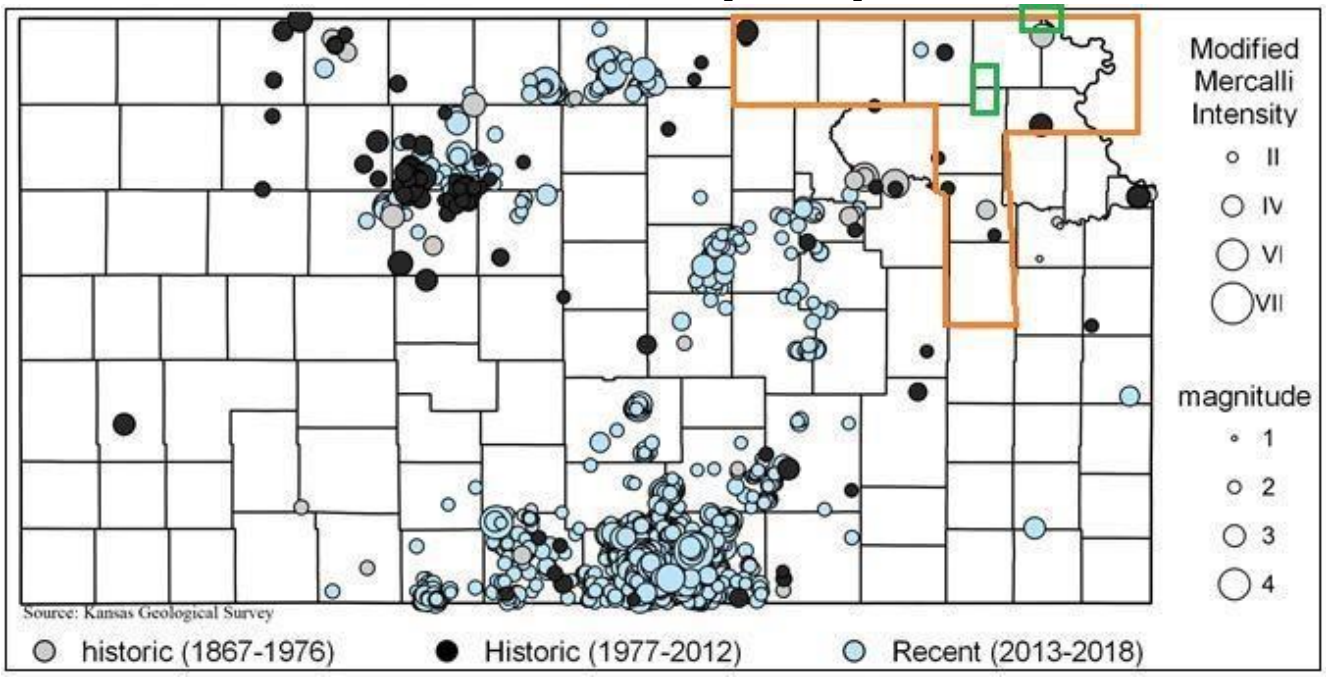
| Mercalli Scale Intensity | Verbal Description | Richter Scale Magnitude | Acceleration (%g) | Velocity (cm/s) | Witness Observations |
|---|---|---|---|---|---|
| I | Instrumental | 1 to 2 | 0.17% | <0.1 | None |

| | | | | | |
|---|---|---|---|---|---|
| II | Feeble | 2 to 3 | 1.40% | 1.1 | Noticed only by sensitive people |
| III | Slight | 3 to 4 | 1.40% | 1.1 | Resembles vibrations caused by heavy traffic |
| IV | Moderate | 4 | 3.90% | 3.4 | Felt by people walking; rocking of free-standing objects |
| V | Rather Strong | 4 to 5 | 9.20% | 8.1 | Sleepers awakened; bells ring |
| VI | Strong | 5 to 6 | 18.00% | 16 | Trees sway, some damage from falling objects |
| VII | Very Strong | 6 | 34.00% | 31 | General alarm, cracking of walls |
| VIII | Destructive | 6 to 7 | 65.00% | 60 | Chimneys fall and some damage to building |
| IX | Ruinous | 7 | 124.00% | 116 | Ground crack, houses begin to collapse, pipes break |
| X | Disastrous | 7 to 8 | >124.0% | >116 | Ground badly cracked, many buildings destroyed. Some landslides |
| XI | Very Disastrous | 8 | >124.0% | >116 | Few buildings remain standing, bridges destroyed. |
| XII | Catastrophic | 8 or greater | >124.0% | >116 | Total destruction; objects thrown in air, shaking and distortion of ground |

### 4.10.2 – Previous Occurrences

The following map, from the KGS, shows all recorded earthquakes from 1867 through 2018.

**KGS Historic Earthquake Map**




The KGS Earthquake Catalog records earthquake events from 1979 through present. According to this archive Kansas Region K has had seven recorded earthquakes since 1979. The following table details the Richter Scale Magnitude of any recorded events in the catalogue.

**Table 4.37: Region K Number of Earthquakes by Richter Scale Magnitude, 1979 - 2018**

| | 0.1 -3.9 | 4.0 – 4.9 | 5.0 – 5.9 | 6.0 – 6.9 | 7.0- 7.9 | 8.0 + | Highest |
|---|---|---|---|---|---|---|---|
| Atchison | 1 | 0 | 0 | 0 | 0 | 0 | 3.1 |
| Brown | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Doniphan | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Douglas | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Jackson | 1 | 0 | 0 | 0 | 0 | 0 | 2.0 |
| Jefferson | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Marshall | 0 | 0 | 0 | 0 | 0 | 0 | - |
| Nemaha | 2 | 0 | 0 | 0 | 0 | 0 | 2.4 |
| Washington | 3 | 0 | 0 | 0 | 0 | 0 | 3.1 |

Source: KGS

According to this archive, Kansas Region K has had no magnitude 4+ earthquakes (with the highest being recorded at a magnitude 3.1) since 1979.

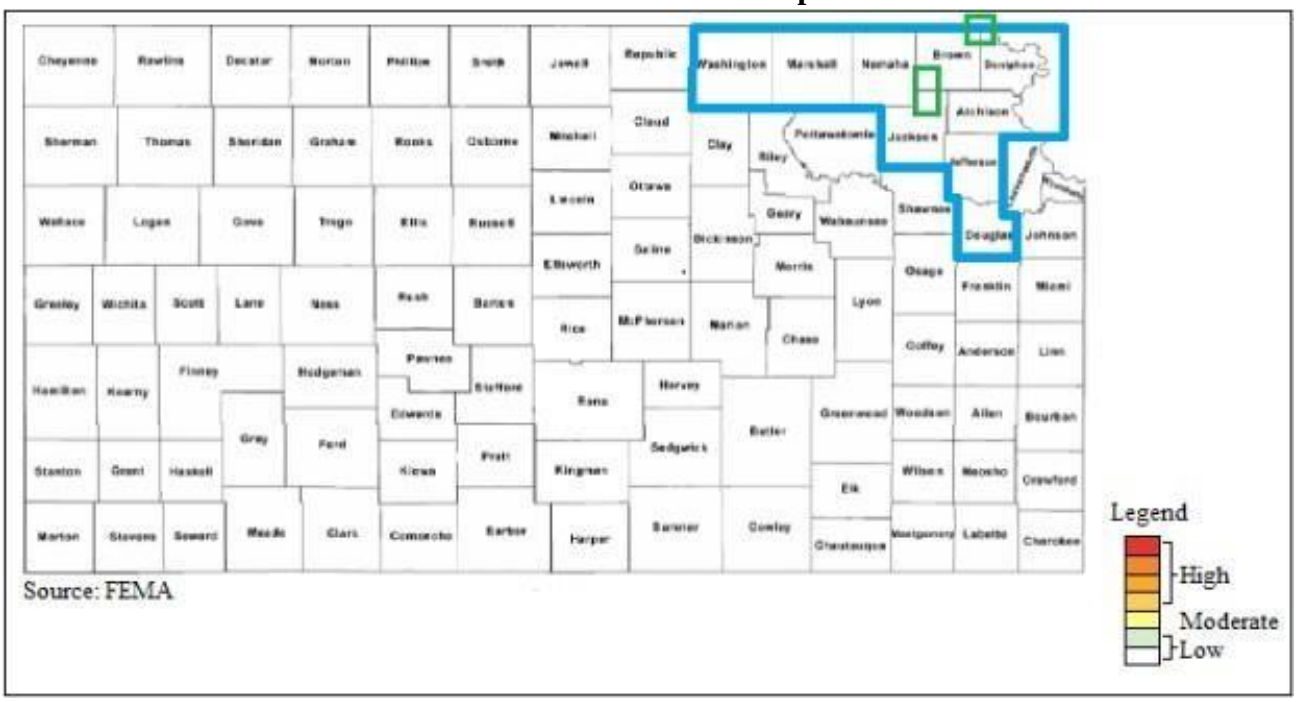
Recently, concern about earthquakes caused by oil and gas exploration and production operations, has grown. Commonly, detected seismic activity associated with oil and gas operations, also known as induced

seismicity, is thought to be triggered when wastewater is injected into disposal wells. According to the KGS, linking earthquakes to wastewater injection is difficult. Complex subsurface geology and limited data about that geology make it hard to pinpoint the cause seismic events. However, an established pattern of increased earthquake activity in an area over time may indicate a correlation between injection and seismic events.

### 4.10.3 – Hazard Probability Analysis

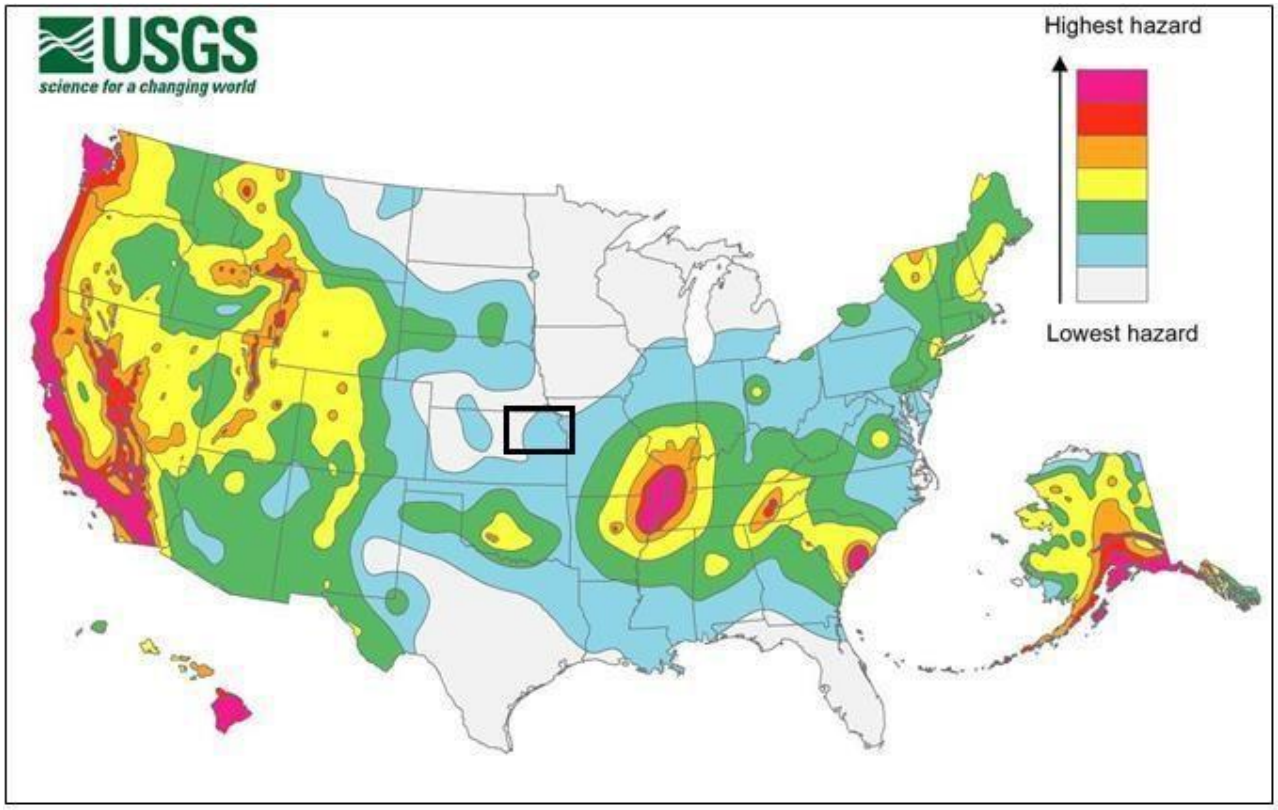
The following FEMA Seismic Risk Map for the United States indicates that all of the State of Kansas, including Kansas Region K, falls into the low hazard rankings.

**FEMA Seismic Risk Map**




The USGS also published a map that indicates hazard rankings based on acceleration (%g) for the United States, with the data correlating with the indicated FEMA risk. This map indicates the probability that ground shaking will exceed a certain level over a 50-year period. The low-hazard areas have a 2% chance of exceeding a designated low level of shaking and the high-hazard areas have a 2% chance of topping a much greater level.

**USGS Earthquake Hazard Map**



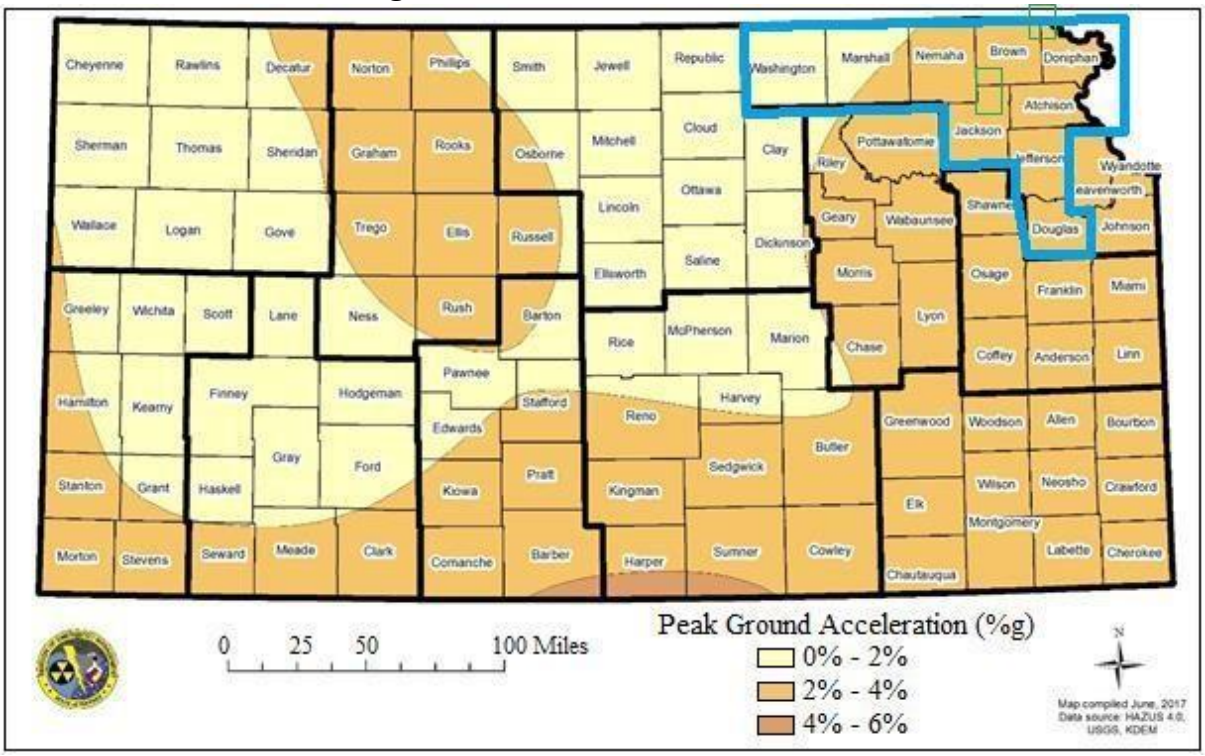

New research by Stanford University shows that oil and gas production injection limits enacted by the State Legislature has reduced he frequency of induced seismicity. Current modelling predicts that at current injection rates the number of widely felt earthquakes in Kansas will decrease to as few as 100 by 2020.

## 4.10.4 – Vulnerability Analysis

HAZUS, using the default inventory 2010 building valuations, was used to analyze vulnerability and estimate potential losses to earthquakes. A probabilistic, 2,500 Year 6.7 magnitude earthquake scenario was chosen to reveal areas of the region and state that are most vulnerable. These results are not meant to indicate annualized losses or damages as a result of a more typical low-magnitude event, but rather reveal vulnerabilities and losses for the worst-case scenario.

The following map, created using available HAZUS data, shows the ground shaking potential of a worst-case scenario 2,500-year 6.7 magnitude earthquake.

**Regional Peak Ground Acceleration**




Using available HAZUS data, the following potential losses from a worst-case scenario 2,500-year 6.7 Magnitude earthquake. However, these assumed vulnerabilities should be viewed as theoretical due to the tremendous number of variables involved in a potential earthquake event.

**Table 4.38: Kansas Region K Probabilistic 6.7 Magnitude Earthquake Damages**

| County | Total Earthquake Losses | Displaced Households |
|---|---|---|
| Atchison | $10,463,000 | 3 |
| Brown | $4,916,000 | 2 |
| Doniphan | $4,090,000 | 1 |
| Douglas | $69,623,000 | 56 |
| Jackson | $6,530,000 | 2 |
| Marshall | $10,176,000 | 2 |
| Jefferson | $4,049,000 | 1 |
| Nemaha | $4,832,000 | 1 |
| Washington | $1,839,000 | <1 |

Source: KDEM and HAZUS

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.39: Kansas Region K Population Vulnerability Data for Earthquakes**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

Counties and tribal reservations with a higher number of structures are to be considered to have a potentially greater vulnerability. The following table indicates the total number of housing units in each county (used as a representative figure for the total number of structures in each county, as housing numbers are closely tied to commercial structures) and the percentage change over the period 2000 to 2017.

**Table 4.40: Kansas Region K Structure Vulnerability Data for Earthquakes**

| County or Tribe | 2017 Housing Units | Percent Change 2000 to 2017 |
|---|---|---|
| Atchison | 6,690 | 2.1% |
| Brown | 4,742 | -1.5% |
| Doniphan | 3,588 | 0.0% |
| Douglas | 49,106 | 22.0% |
| Iowa Tribe | 75 | 36.4% |
| Jackson | 5,835 | 14.5% |
| Jefferson | 8,308 | 10.9% |
| Kickapoo Tribe | 68 | 30.9% |
| Marshall | 4,890 | -2.2% |
| Nemaha | 4,589 | 5.7% |
| Washington | 2,943 | -6.3% |

Source: US Census Bureau or Tribal
Government -: Data Unavailable

## 4.10.5 – Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis

**Table 4.41: Earthquake Consequence Analysis**

| Subject | Impacts of Earthquake |
|---|---|
| Health and Safety of the Public | Severity and location dependent. Impacts on persons near the epicenter are expected to be severe. |
| Health and Safety of Responders | Severity and location dependent. Impacts on persons near the epicenter are expected to be severe. |
| Continuity of Operations | Severity and location dependent. Event will likely require relocation, essential function prioritization based on capabilities and severe disruption of services. |
| Property, Facilities, and Infrastructure | Impact to property, facilities, and infrastructure could be minimal to severe, depending on the location of the facility and the severity of the event. Loss of structural integrity of buildings and infrastructure could occur. |
| Environment | The impact to the environment could be severe, including topological changes and severe destruction. |
| Economic Conditions | Impacts to the economy will be dependent severity of earthquake and proximity to the epicenter. Impacts will likely be long lasting and possibly permanent for most severely impacted businesses. |
| Public Confidence in the Jurisdiction's Governance | Confidence could be an issue if planning is not in place to address need of population, including mass sheltering and mass care. |

## 4.11 – Expansive Soils

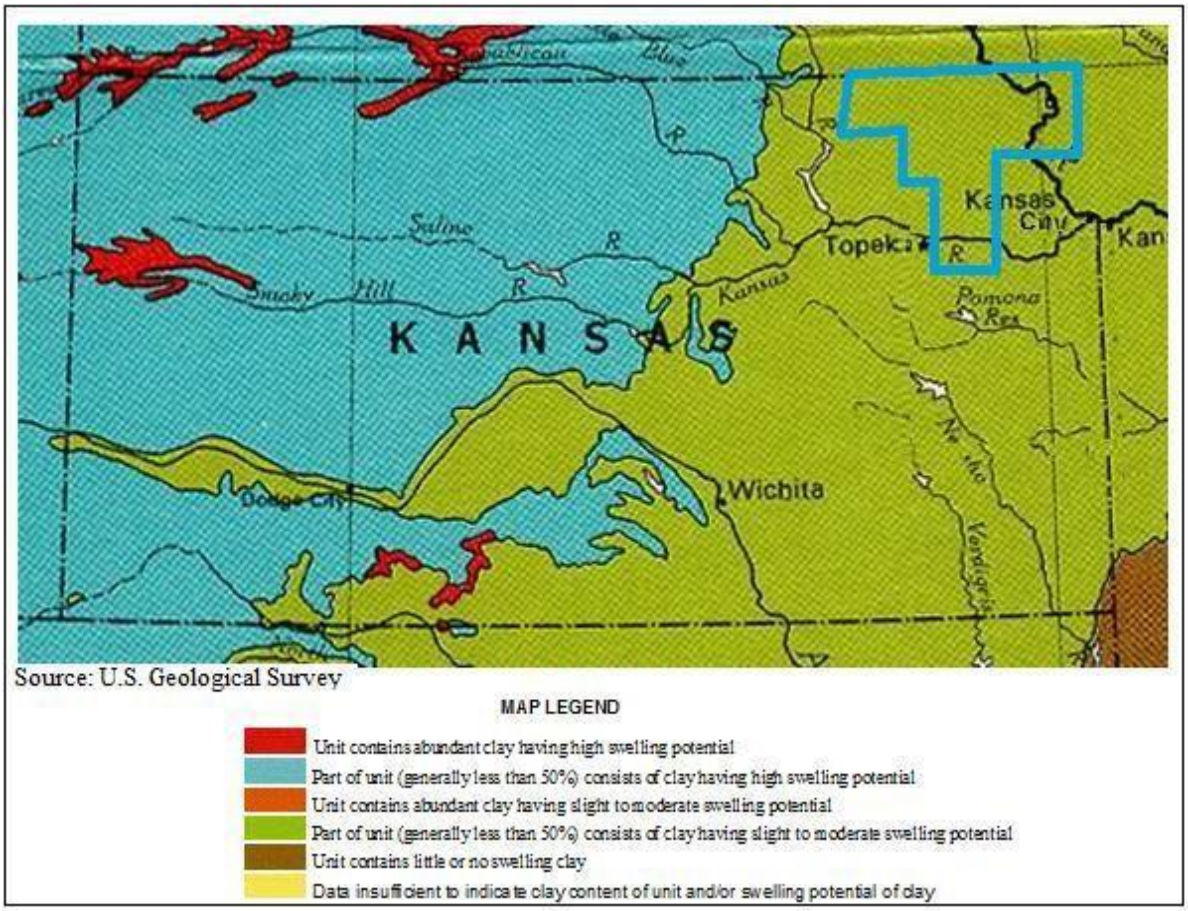
Expansive soils are slow to develop and do not usually pose a risk to public safety. The slow expansion and contraction of the clays and soils places pressure on structural foundations and subsurface dwellings. This pressure can become so great it damages foundations, cracks walls, and deforms structures.

### 4.11.1 – Location and Extent

Kansas Region K possesses a wide array of soils with a range of permeability from moderate to low. Generally, the permeability of the soils is related to the clay content. Clay soils tend to shrink when dry and swell when wet which has large implications on underground utility infrastructure and home foundations.

The map shows the swelling potential of soils in Kansas Region K, indicating it is located in an area where the majority of the soil unit consists of clay having a moderate swelling potential.

**USGS Soil Swelling Potential Map**




## 4.11.2 – Previous Occurrences

No statewide database of expansive soils events is available.

Locally, there have been no reported expansive soil events within the past five years.

## 4.11.3 – Hazard Probability Analysis

Currently there is limited available data on this hazard, but it is held that each year in the United States, expansive soils cause billions of dollars in damage to buildings, roads, pipelines, and other structures. But, as expansive soils cause damage over extended periods of time damages caused may be attributed to other factors such as extended drought or heavy periods of moisture, both of which may exacerbate the hazard.

Because there is high clay content, high swell soils in the region, the probability of shrink/swell occurrence is 100%. However, the probability of damage is so poorly documented that is presently not possible to quantify the potential occurrence of a major damaging expansive soils event.

## 4.11.4 – Vulnerability Analysis

Physical structures are potentially vulnerable to highly expansive soil. It is estimated by KDEM that approximately 10% of the homes built on expansive soils could experience significant damage. Based on this, and using current available building valuations, the following table estimates the potential damages assuming a 50% impact on the value of the structure.

**Table 4.42: Kansas Region K Estimated Potential Structural Damages, Expansive Soil**

| County | HAZUS Structure Valuation | Property Valuation for 10% of Building Stock | Estimated 50% Damage |
|---|---|---|---|
| Atchison | $2,077,340,000 | $207,734,000 | $103,867,000 |
| Brown | $1,135,773,000 | $113,577,300 | $56,788,650 |
| Doniphan | $953,610,000 | $95,361,000 | $47,680,500 |
| Douglas | $12,489,840,000 | $1,248,984,000 | $624,492,000 |
| Iowa Tribal Reservation* | $7,712,800 | $771,280 | $385,640 |
| Jackson | $1,477,185,000 | $147,718,500 | $73,859,250 |
| Jefferson | $2,239,834,000 | $223,983,400 | $111,991,700 |
| Kickapoo Tribal Reservation* | $6,000,000 | $600,000 | $300,000 |
| Marshall | $1,231,049,000 | $123,104,900 | $61,552,450 |
| Nemaha | $1,282,096,000 | $128,209,600 | $64,104,800 |
| Washington | $650,841,000 | $65,084,100 | $32,542,050 |

Source: US Census Bureau
*: Tribal Data

## 4.11.5 – Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.43: Expansive Soils Consequence Analysis**

| Subject | Impacts of Expansive Soils |
|---|---|
| Health and Safety of the Public | Minimal impact. |
| Health and Safety of Responders | Minimal impact. |
| Continuity of Operations | Minimal expectation for utilization of COOP unless structures have extensive damage. |
| Property, Facilities, and Infrastructure | Localized impact could be moderate, including structural integrity to be lost, and roadways, railways to buckle. |
| Environment | Expansive soils could cause moderate damage to dams, levees, watersheds. |

| | |
|---|---|
| Economic Conditions | Economic impacts include rebuilding of the properties and infrastructure. Drought and extreme rain events could increase impact. |
| Public Confidence in the Jurisdiction's Governance | Confidence will be dependent on development trends and mitigation efforts at reducing the effect of expansive soils on new construction. |

## 4.12 – Extreme Temperatures

Extreme temperature events occur when climate conditions produce temperatures well outside of the predicted norm. These extremes can have severe impacts on human health and mortality, natural ecosystems, agriculture, and other economic sectors.

### 4.12.1 – Location and Extent

The Midwest climate region is known for extremes in temperature. Specifically, Kansas lacks any mountain ranges that could act as a barrier to cold air masses from the north or hot, humid air masses from the south or any oceans or large bodies of water that could provide a moderating effect on the climate. The polar jet stream is often located over the region during the winter, bringing frequent storms and precipitation. Kansas summers are generally warm and humid due to the clockwise air rotation caused by Atlantic high-pressure systems bringing warm humid air up from the Gulf of Mexico.

All of Kansas Region K is vulnerable to both extreme heat and extreme cold, defined as follows.

**Table 4.44: Extreme Temperature Definitions**

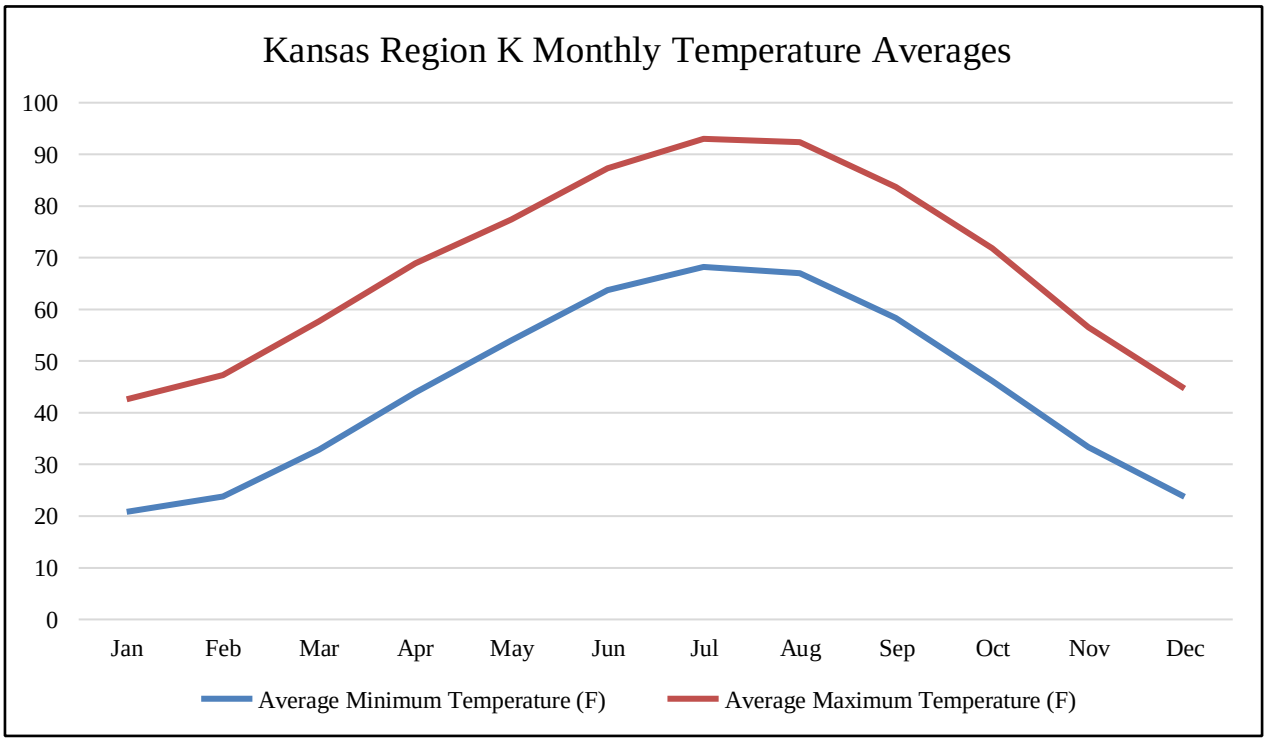
| Term | Definition |
|---|---|
| **Extreme Heat** | Extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when an area of high atmospheric pressure traps moisture laden air near the ground. |
| **Extreme Cold** | Although no specific definition exists for extreme cold, an extreme cold event can generally be defined as temperatures at or below freezing for an extended period of time. Extreme cold events are usually part of Winter Storm events but can occur during anytime of the year and can have devastating effects on agricultural production. |

Data from the following High Plains Regional Climate Center weather stations from the first available date to present was obtained to illustrate regional temperature norms.

**Table 4.45: Regional Average Temperatures**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Minimum Temperature (F) | 16.5 | 21.0 | 31.0 | 42.1 | 52.5 | 62.9 | 66.9 | 65.0 | 55.5 | 44.0 | 31.6 | 20.6 | 42.5 |
| Average Maximum Temperature (F) | 37.2 | 43.0 | 54.4 | 66.6 | 75.5 | 85.3 | 89.7 | 88.5 | 80.5 | 69.3 | 53.7 | 40.4 | 65.3 |

Source: High Plains Regional Climate Center




The following graph illustrates the above data.

When discussing weather patterns climate change should be taken into account as it may markedly change future weather-related events. There is a scientific consensus that climate change is occurring, and recent climate modeling results indicate that extreme weather events may become more common. Rising average temperatures produce a more variable climate system which may result in an increase in the frequency and severity of some extreme weather events including longer and hotter heat waves (and by correlation, an increased risk of wildfires), higher wind speeds, greater rainfall intensity, and increased tornado activity.

### 4.12.2 – Previous Occurrences

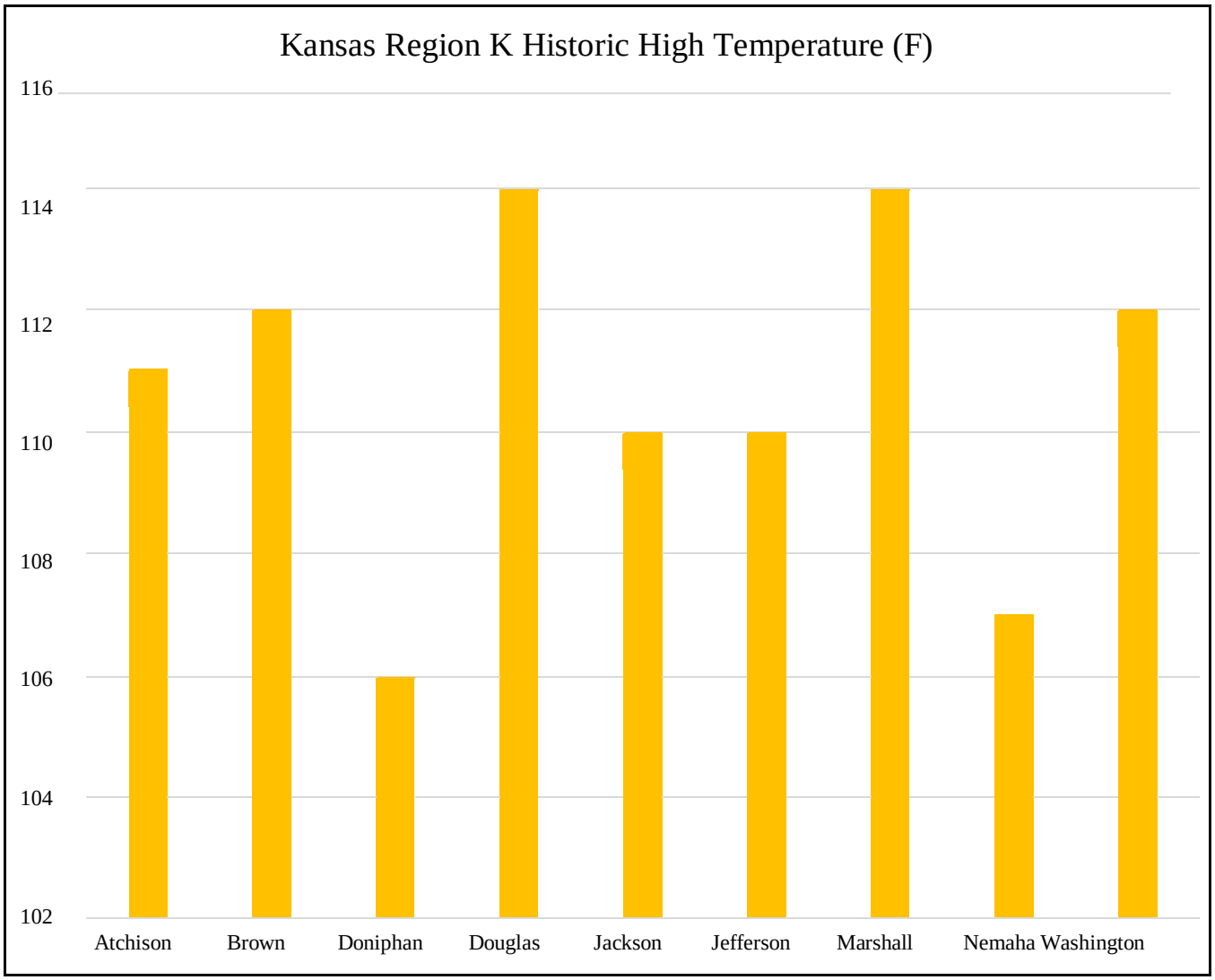
Data from the High Plains Regional Climate Center indicates the following historic high and low temperatures.

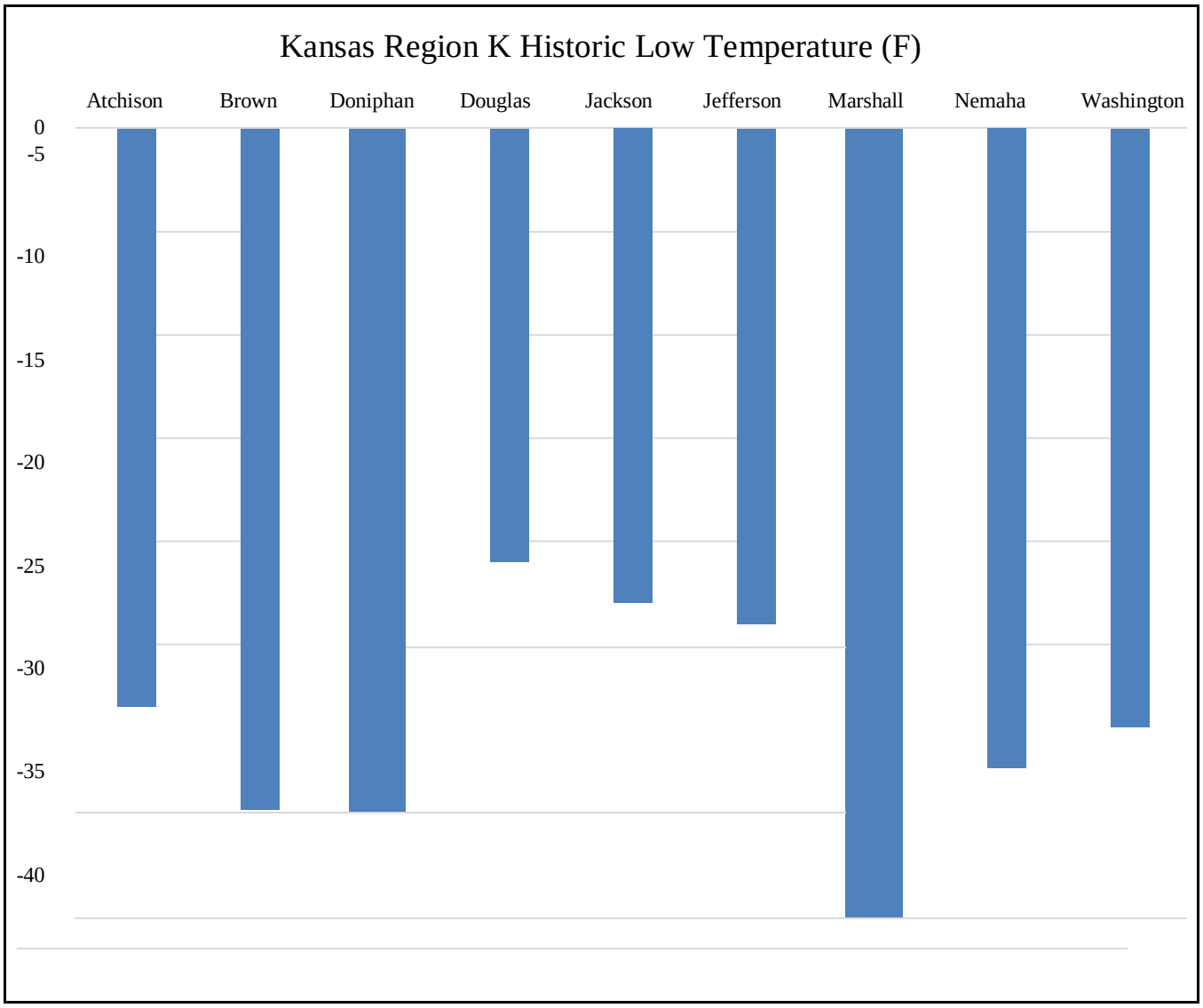
**Table 4.46: Kansas Region K Historic Temperatures**

| County | Historic Low Temperature (F) | Historic High Temperature (F) |
|---|---|---|
| Atchison | -28 (1930) | 111 (1936) |
| Brown | -33 (1892) | 112 (1936) |
| Doniphan | -30 (1899) | 106 (1954) |
| Douglas | -21 (1912) | 114 (1936) |
| Jackson | -23 (1989) | 110 (1980) |

| | | |
|---|---|---|
| Jefferson | -24 (1989) | 110 (1980) |
| Marshall | -35 (1905) | 114 (1911) |
| Nemaha | -31 (1899) | 107 (1901) |
| Washington | -29 (1989) | 112 (1954) |

Source: High Plains Regional Climate Center






The following table presents National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) identified extreme temperature events (Excessive Heat and Extreme Cold/Wind Chill) and the resulting damage totals in Kansas Region K from the period 2009-2018.

**Table 4.47: Kansas Region K NCEI Extreme Temperature Events, 2009 - 2018**

| County | Event Type | Number of Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|---|
| Atchison | Cold | 0 | $0 | 0 | 0 |
| | Heat | 1 | $0 | 0 | 0 |
| Brown | Cold | 1 | $0 | 0 | 0 |
| | Heat | 7 | $0 | 0 | 0 |
| Doniphan | Cold | 0 | $0 | 0 | 0 |
| | Heat | 1 | $0 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Douglas | Cold | 0 | $0 | 0 | 0 |
| | Heat | 0 | $0 | 0 | 0 |
| Jackson | Cold | 1 | $0 | 0 | 0 |

**Table 4.47: Kansas Region K NCEI Extreme Temperature Events, 2009 - 2018**

| County | Event Type | Number of Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|---|
| | Heat | 9 | $0 | 0 | 0 |
| Jefferson | Cold | 1 | $0 | 0 | 0 |
| | Heat | 10 | $0 | 0 | 0 |
| Marshall | Cold | 0 | $0 | 0 | 0 |
| | Heat | 6 | $0 | 0 | 0 |
| Nemaha | Cold | 1 | $0 | 0 | 0 |
| | Heat | 8 | $0 | 3 | 0 |
| Washington | Cold | 1 | $0 | 0 | 0 |
| | Heat | 5 | $0 | 0 | 0 |

Source: NOAA NCEI

Crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of extreme temperatures on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates 338 claims on 115,064 acres for $14,504,532.

**Table 4.48: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Extreme Temperatures**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 15 | 3,591 | $586,422 |
| Brown | 22 | 5,933 | $904,687 |
| Doniphan | 11 | 1,178 | $223,984 |
| Douglas | 47 | 26,345 | $3,879,891 |
| Jackson | 30 | 13,208 | $1,313,233 |
| Jefferson | 34 | 8,241 | $1,262,715 |
| Marshall | 70 | 21,944 | $2,061,521 |
| Nemaha | 45 | 18,753 | $2,185,009 |
| Washington | 64 | 15,870 | $2,087,070 |

Source: USDA Farm Service Agency

## 4.12.3 – Hazard Probability Analysis

Although periods of extreme heat and cold occur on an annual basis, events that create a serious public health risk or threaten infrastructure capacity occur less often. An extreme heat event is more likely to occur in the months of June, July, August, and September, and an extreme cold event is more likely to occur in the months of November, December, January, February, and March. Also, the EPA has projected that with climate changes in the Great Plains, temperatures will continue to increase and impact all Kansas Region K communities.

The following table summarizes extreme temperature event data for **Kansas Region K**.

**Table 4.49: Kansas Region K Extreme Temperature Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 11 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Kansas Region K can expect on a yearly basis, relevant to extreme temperature events:

- One event
- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to extreme temperatures. The following table summarizes extreme temperature event data for **Atchison County**

**Table 4.50: Atchison County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 15 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 3,591 |
| Average Number of Acres Damaged per Year | 359 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $586,422 |
| Average Crop Damage per Year | $58,642 |

Source: USDA

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Two insurance claims
- 359 acres impacted
- $58,642 in insurance claims

The following table summarizes extreme temperatures event data for **Brown County**.

**Table 4.51: Brown County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 22 |

| | |
|---|---|
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 5,933 |
| Average Number of Acres Damaged per Year | 593 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $904,687 |
| Average Crop Damage per Year | $90,469 |

Source: USDA

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Two insurance claims
- 593 acres impacted
- $90,469 in insurance claims

The following table summarizes extreme temperatures event data for **Doniphan County**.

**Table 4.52: Doniphan County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 22 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,178 |
| Average Number of Acres Damaged per Year | 118 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $223,984 |
| Average Crop Damage per Year | $22,398 |

Source: USDA

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Two insurance claims
- 118 acres impacted
- $22,398 in insurance claims

The following table summarizes extreme temperatures event data for **Douglas County**.

**Table 4.53: Douglas County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 47 |
| Average Number of Claims per Year | 5 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 26,345 |
| Average Number of Acres Damaged per Year | 2,635 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $3,879,891 |
| Average Crop Damage per Year | $387,989 |

Source: USDA

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Five insurance claims
- 2,635 acres impacted
- $387,989 in insurance claims

The following table summarizes extreme temperatures event data for **Jackson County**.

**Table 4.54: Jackson County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 30 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 13,208 |
| Average Number of Acres Damaged per Year | 1,321 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,313,233 |
| Average Crop Damage per Year | $131,323 |

Source: USDA

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Three insurance claims
- 1,321 acres impacted
- $131,323 in insurance claims

The following table summarizes extreme temperatures event data for **Jefferson County**.

**Table 4.55: Jefferson County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 34 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 8,241 |
| Average Number of Acres Damaged per Year | 824 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,262,715 |
| Average Crop Damage per Year | $126,272 |

Source: USDA

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Three insurance claims
- 824 acres impacted
- $126,272 in insurance claims

The following table summarizes extreme temperatures event data for **Marshall County**.

**Table 4.56: Marshall County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 70 |
| Average Number of Claims per Year | 7 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 21,944 |
| Average Number of Acres Damaged per Year | 2,194 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $2,061,521 |
| Average Crop Damage per Year | $206,152 |

Source: USDA

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Seven insurance claims
- 2,194 acres impacted
- $206,152 in insurance claims

The following table summarizes extreme temperatures event data for **Nemaha County**.

**Table 4.57: Nemaha County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 45 |
| Average Number of Claims per Year | 5 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 18,753 |
| Average Number of Acres Damaged per Year | 1,875 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $2,185,009 |
| Average Crop Damage per Year | $218,501 |

Source: USDA

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Five insurance claims
- 1,875 acres impacted
- $218,501 in insurance claims

The following table summarizes Extreme temperatures event data for **Washington County**.

**Table 4.58: Washington County Extreme Temperatures Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 64 |

| | |
|---|---|
| Average Number of Claims per Year | 6 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 15,870 |
| Average Number of Acres Damaged per Year | 1,587 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $2,087,070 |
| Average Crop Damage per Year | $208,707 |

Source: USDA

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to extreme temperatures occurrences:

- Six insurance claims
- 1,587acres impacted
- $208,707 in insurance claims

### 4.12.4 – Vulnerability Analysis

The primary concerns with this hazard are human health safety issues. Specific at-risk groups identified were outdoor workers, farmers, and senior citizens. Due to the potential for fatalities and the possibility for the loss of electric power due to increased strain on power generation and distribution for air conditioning, periods of extreme heat can affect the planning area.

Exposure to direct sun can increase Heat Index values by as much as 15°F. The zone above 105°F corresponds to a Heat Index that may cause increasingly severe heat disorders with continued exposure and/or physical activity. The following table discusses potential impacts on human health related to excessive heat.

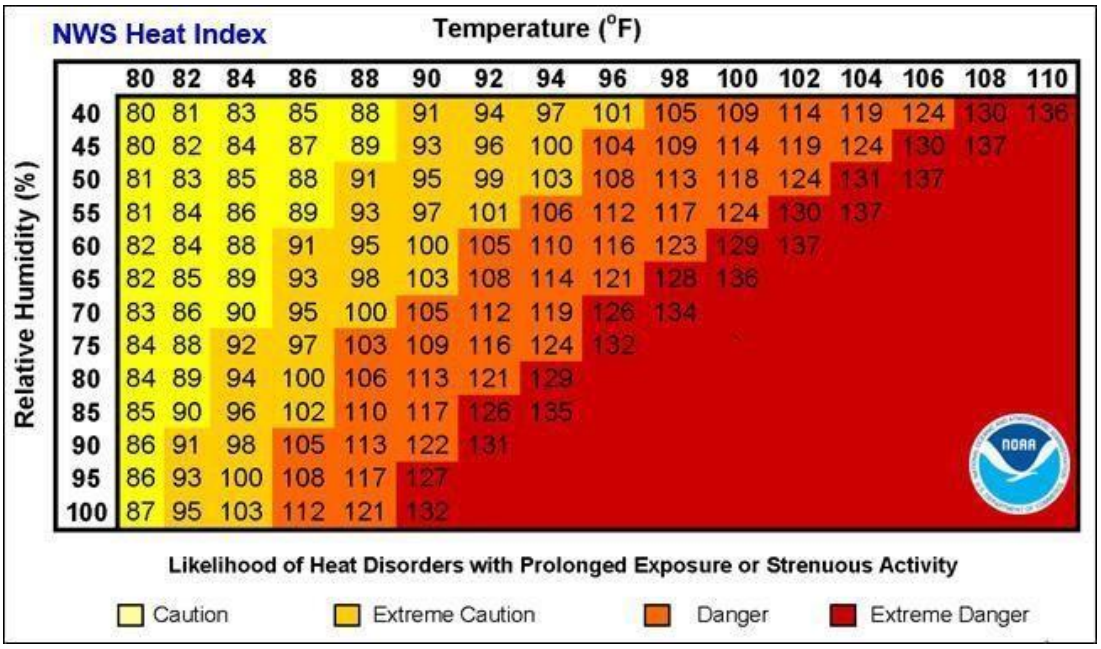
**Table 4.59: Extreme Heat Impacts on Human Health**

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

Source: National Weather Service Heat Index Program

The following graph, from the NWS, indicates Heat Index values.

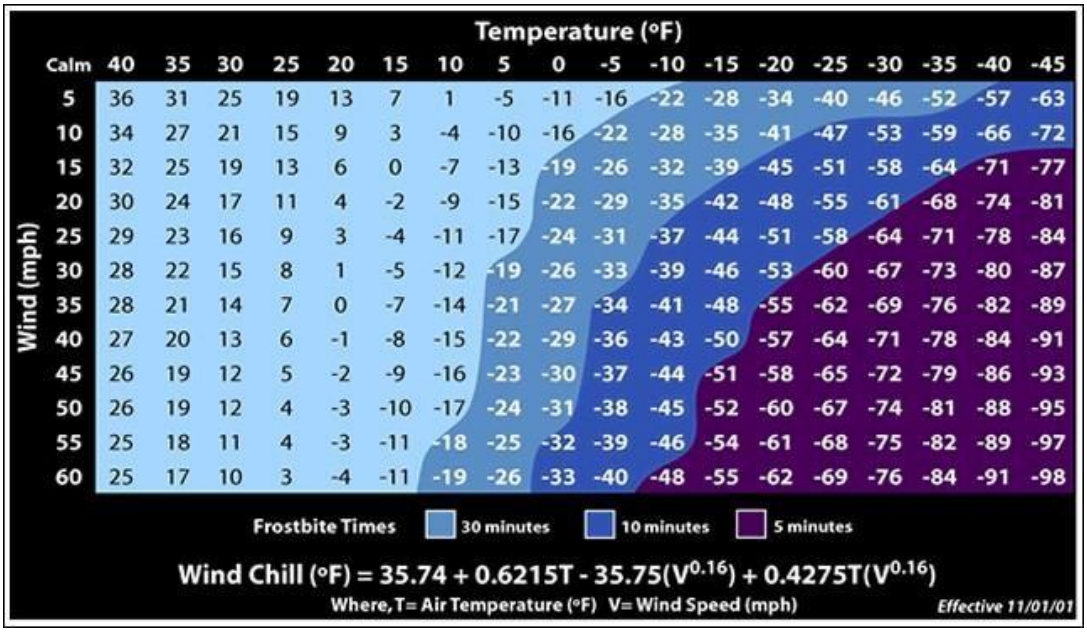
**Heat Index**




Extreme cold can cause hypothermia, an extreme lowering of the body's temperature, frostbite and death. Infants and the elderly are particularly at risk, but anyone can be affected. Other impacts of extreme cold include asphyxiation from toxic fumes from emergency heaters, household fires, which can be caused by fireplaces and emergency heaters, and frozen/burst water pipes. There are no specific data sources recording cold related deaths in east-central Kansas.

The following graph, from the NWS, shows wind chill values.

**Wind Chill Values**



Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.60: Kansas Region K Population Vulnerability Data for Extreme Temperatures**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

Additionally, there is an increased likelihood of mortality for very young and very old populations due to extreme temperatures following table indicates the percentage of the total county population that may be considered especially vulnerable to extreme temperatures.

**Table 4.61: Kansas Region K Vulnerable Population Vulnerability Data for Extreme Temperatures**

| County | Percentage of Population 5 and Under (2017) | Percentage of Population 65+ (2017) |
|---|---|---|
| Atchison | 6.0% | 16.8% |
| Brown | 6.6% | 19.8% |
| Doniphan | 5.9% | 19.1% |
| Douglas | 5.3% | 11.7% |
| Iowa Tribe | - | - |
| Jackson | 6.7% | 18.6% |
| Jefferson | 5.3% | 18.1% |
| Kickapoo Tribe | - | - |
| Marshall | 6.8% | 21.3% |
| Nemaha | 7.6% | 20.0% |
| Washington | 7.1% | 23.8% |

Source: US Census Bureau

In addition, extreme temperatures may exacerbate agricultural and economic losses. The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data for the five-year period 2009 - 2018 (data set includes full years for 2014 and 2018) allows us to quantify the

monetary impact of extreme temperature conditions on the agricultural sector. In general, the higher the percentage loss, the higher the vulnerability the county has to extreme temperature events.

**Table 4.62: Extreme Temperature Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 359 | 0.21% | $66,913,000 | $58,642 | 0.09% |
| Brown | 258,601 | 593 | 0.23% | $112,057,000 | $90,469 | 0.08% |
| Doniphan | 144,927 | 118 | 0.08% | $76,581,000 | $22,398 | 0.03% |
| Douglas | 159,261 | 2,635 | 1.65% | $65,867,000 | $387,989 | 0.59% |
| Jackson | 168,682 | 1,321 | 0.78% | $40,215,000 | $131,323 | 0.33% |
| Jefferson | 153,276 | 824 | 0.54% | $44,922,000 | $126,272 | 0.28% |
| Marshall | 361,473 | 2,194 | 0.61% | $92,882,000 | $206,152 | 0.22% |
| Nemaha | 268,088 | 1,875 | 0.70% | $76,127,000 | $218,501 | 0.29% |
| Washington | 336,673 | 1,587 | 0.47% | $87,087,000 | $208,707 | 0.24% |

Source: USDA

## 4.12.5 – Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.63: Extreme Temperature Consequence Analysis**

| Subject | Impacts of Expansive Soils |
|---|---|
| Health and Safety of the Public | Depending on the duration of the event, impact is expected to be severe for unprepared and unprotected persons. Impact will be minimal to moderate for prepared and protected persons. |
| Health and Safety of Responders | Impact could be severe if proper precautions are not taken, i.e. hydration in heat, clothing in extreme cold. With proper preparedness and protection, the impact would be minimal. |
| Continuity of Operations | Minimal expectation for utilization of the COOP. |
| Property, Facilities, and Infrastructure | Impact to infrastructure could be minimal to severe depending on the temperature extremes. |
| Environment | The impact to the environment could be severe. Extreme heat and or cold could seriously damage wildlife and plants, trees and crops. |
| Economic Conditions | Impacts to the economy will be dependent on how extreme the temperatures get, but only in the sense of whether people will venture out to spend money. Utility bills could increase causing more financial hardship. |
| Public Confidence in the Jurisdiction's Governance | Confidence will be dependent on how well utilities hold up as they are stretched to provide heat and cool air, depending on the extreme. Planning and response could be challenged. |

# 4.13 – Flood

Floods are most common in seasons of rain and thunderstorms. Floods that threaten Kansas Region K can be generally classified under two categories:

- **Flash Flood:** The product of heavy, localized precipitation in a short time period over a given location
- **Riverine Flood:** Occurs when precipitation over a given river basin for a long period of time causes the overflow of rivers, streams, lakes and drains

## 4.13.1 – Location and Extent

### Flash Flooding

The NWS provides the following definitions of warnings for actual and potential flood conditions for Flash Floods:

- **Flash Flood Watch**: Issued to indicate current or developing hydrologic conditions that are favorable for flash flooding in and close to the watch area, but the occurrence is neither certain or imminent.
- **Flash Flood Warning**: Issued to inform the public, emergency management and other cooperating agencies that flash flooding is in progress, imminent, or highly likely.
- **Flash Flood Statement**: In hydrologic terms, a statement by the NWS which provides follow-up information on flash flood watches and warnings.

In general, flash flooding occurs in those locations in the planning area that are low-lying and/or do not have adequate drainage. Data from University of Kanas indicates that the average annual precipitation for Kansas Region K counties for 2017:

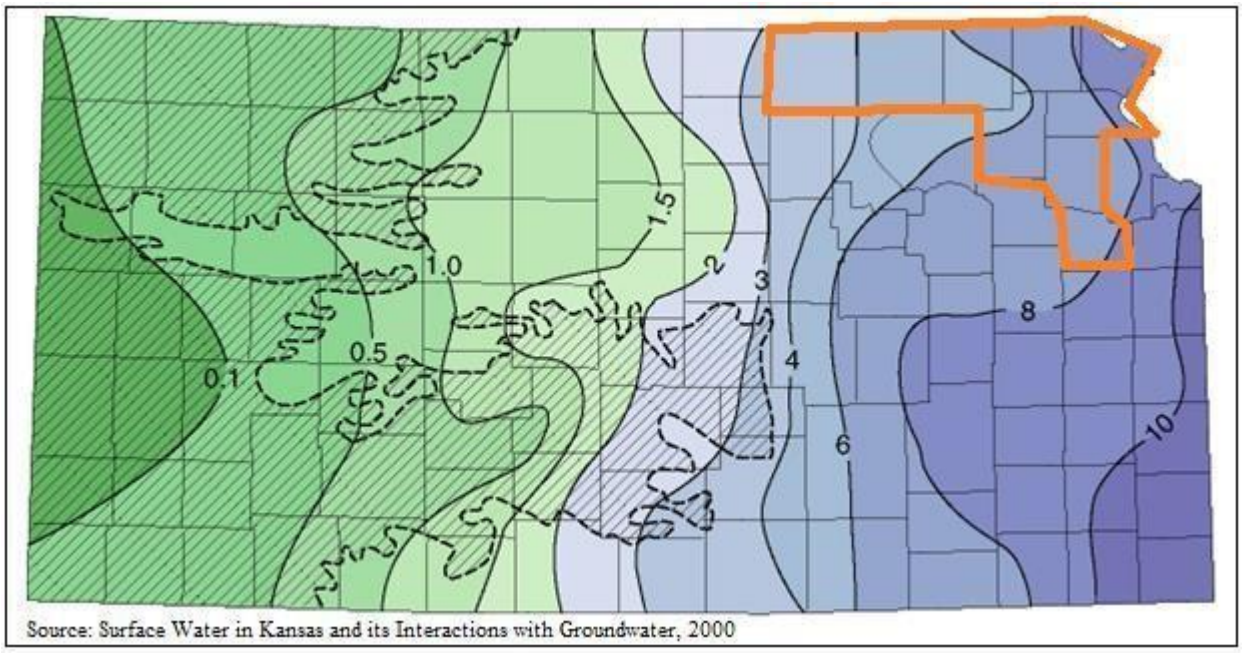
- Atchison County: 31.22 inches
- Brown County: 29.56 inches
- Doniphan County: 21.29 inches
- Douglas County: 38.48 inches
- Jackson County: 33.79 inches
- Jefferson County: 32.58 inches
- Marshall County: 27.61 inches
- Nemaha County: 28.30 inches

- Washington County: 29.65 inches

This equates to a regional average of 30.28 inches of precipitation for 2017.

The following map illustrates the distribution of water runoff in Kansas. Surface runoff is water from rain or snowmelt that flows on the surface and does not percolate into the subsurface. In general, the higher the surface runoff, the higher the potential for flash flooding.

**Kansas Region K Average Annual Runoff, In Inches**




**Riverine Flooding**

Riverine flooding occurs from the overflow of rivers, streams, drains, and lakes due to excessive rainfall. The NWS provides the following definitions of warnings for actual and potential flood conditions for riverine flooding:

- **Flood Potential Outlook:** In hydrologic terms, a NWS outlook that is issued to alert the public of potentially heavy rainfall that could send rivers and streams into flood or aggravate an existing flood.
- **Flood Watch:** Issued to inform the public and cooperating agencies that current and developing hydro meteorological conditions are such that there is a threat of flooding, but the occurrence is neither certain nor imminent.
- **Flood Warning:** In hydrologic terms, a release by the NWS to inform the public of flooding along larger streams in which there is a serious threat to life or property. A flood warning will usually contain river stage (level) forecasts.
- **Flood Statement:** In hydrologic terms, a statement issued by the NWS to inform the public of flooding along major streams in which there is not a serious threat to life or property. It may also follow a flood warning to give later information.

All areas of Kansas Region K located near a stream or river are at risk of riverine flooding. 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 and regulatory purposes.

In general, flood probability can be expressed by recurrence interval, the average period of time for a flood that equals or exceeds a given magnitude, expressed as a period of years. The probability of occurrence of a given flood can also be expressed as the odds of recurrence of one or more similar or bigger floods in a certain number of years. Large, catastrophic floods have a very low frequency or probability of occurrence, whereas smaller floods occur more often. The larger the number of years in a recurrence interval, the smaller the chances of experiencing that flood in a year. However, the odds are never zero, even very large, uncommon floods always have a very small chance of recurring every year. When reviewing flood probability, it is important to note that once a flood occurs its chance of recurring the next year remains the same.

**Table 4.64: Flood Recurrence Interval Probability**

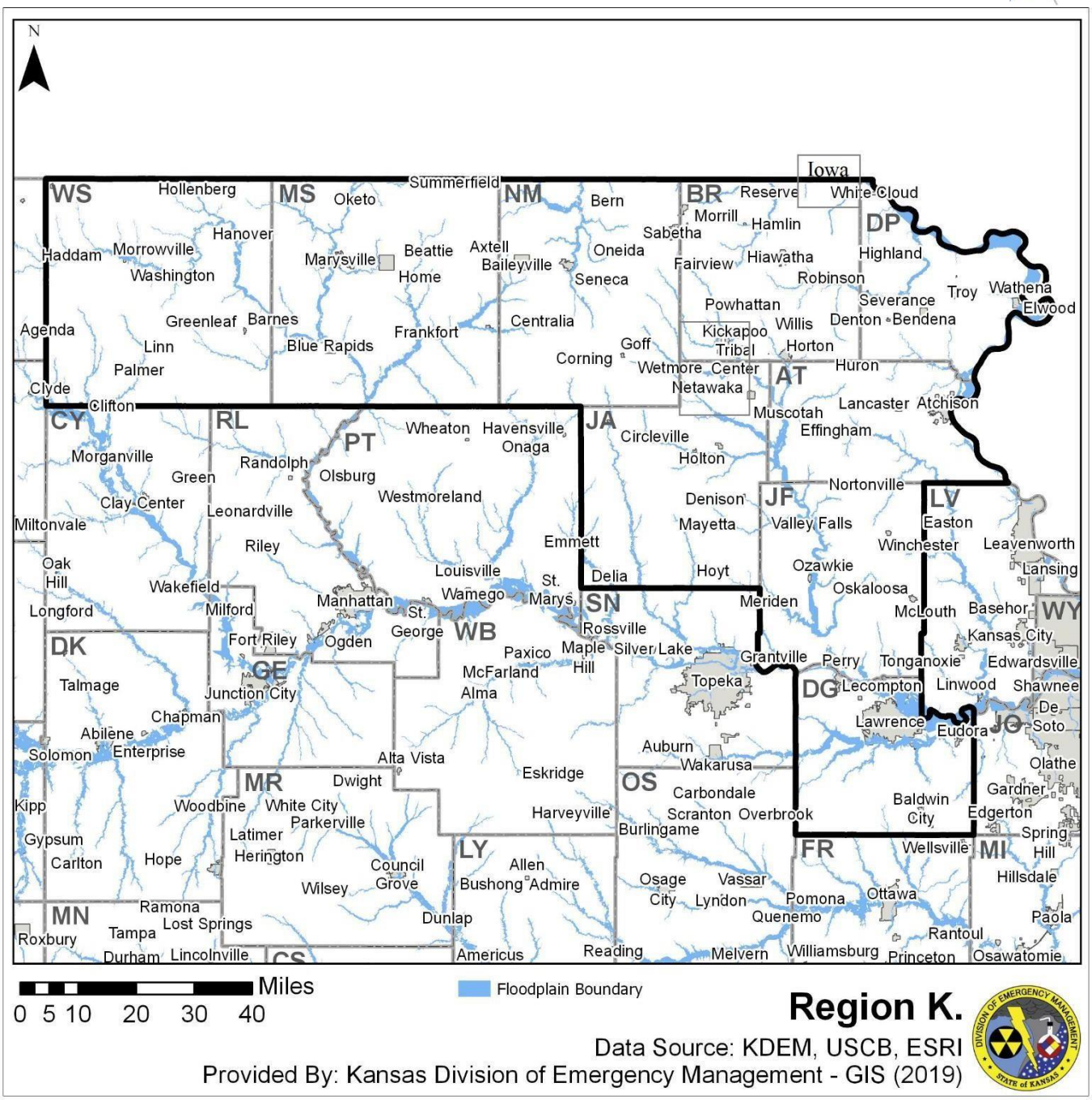
| Recurrence Interval, in Years | Probability of Occurrence in Any Given Year | Percent Chance of Occurrence in Any Given Year |
|---|---|---|
| 100 | 1 in 100 | 1 |
| 50 | 1 in 50 | 2 |
| 25 | 1 in 25 | 4 |
| 10 | 1 in 10 | 10 |
| 5 | 1 in 5 | 20 |
| 2 | 1 in 2 | 50 |

Source: FEMA

The following map, generated by KDEM using available data, depicts regional one percent annual flood areas.

## Local Concerns

Many local jurisdictions are subject to areas of repeat flooding. In an effort to identify these areas the KDA, in conjunction with the USACE Silver Jackets, has created a mapping system under the Recurring Flood Identification Project. This system allows for the local mapping of known flood areas within regional jurisdictions. Three classifications of flooding areas are used, minimal moderate and severe. The following map indicates identified repeat flood areas within the region.




*Local Concerns*

Many local jurisdictions are subject to areas of repeat flooding. In an effort to identify these areas the KDA, in conjunction with the USACE Silver Jackets, has created a mapping system under the Recurring Flood Identification Project. This system allows for the local mapping of known flood areas within regional jurisdictions. Three classifications of flooding areas are used, minimal moderate and severe. No repeat flood areas within the region were mapped.

### 4.13.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been 12 Presidential Disaster Declarations for Kansas Region K for floods (along with other associates hazard events such as tornados or severe storms), totaling $373,722,379 in damages. The following 20-year information on past declared disasters is presented to provide a historical perspective on flood events that have impacted Kansas Region K. Declaration numbers in bold indication declared disaster that have occurred since the previous mitigation plan update in 2013.

**Table 4.65: Kansas Region K FEMA Flood Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| **4230** | 07/20/2015 (05/04/2015 – 06/21/2015) | Severe Storms, Tornados, Straight-Line Winds, and **Flooding** | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, McPherson, Nemaha, Neosho, and Washington. | $13,848,325 |
| 4150 | 10/22/2013 (07/22/2013 – 08/15/2013) | Severe Storms, Straight-Line Winds, Tornados, and **Flooding** | Washington | $11,412,827 |
| 4035 | 09/23/2011 (6/1-8/1/2011) | **Flooding** | Atchison and Doniphan, | $7,462,881 |
| 4010 | 07/29/2011 (5/19-6/4/2011) | Severe Storms, Straight-Line Winds, Tornados and **Flooding** | Washington | $8,259,620 |
| 1932 | 08/10/2010 (6/7-7/21/2010) | Severe Storms, **Flooding** and Tornados | Atchison, Brown, Doniphan, Jackson, Marshall and Washington | $9,279,257 |
| 1849 | 06/25/2009 (4/25-5/16/2009) | Severe Storms, **Flooding**, Straight-Line Winds, and Tornados | Marshall | $15,013,488 |
| 1776 | 07/09/2008 | Severe Storms, **Flooding**, and Tornados | Brown and Jackson | $70,629,544 |
| 1699 | 5/6/2007 (5/4/2007) | Severe Storms, Tornados, and **Flooding** | Brown, Doniphan, Douglas, Jackson, Marshall, Nemaha and Washington | $117,565,269 |
| 1615 | 11/21/2005 (10/1-2/2005) | Severe Storms and **Flooding** | Atchison, Jackson and Jefferson | $10,286,064 |
| 1579 | 2/8/2005 (1/4-6/2005) | Severe Winter Storm, Heavy Rains, and **Flooding** | Atchison, Brown, Douglas, Jackson and Jefferson, | $106,873,672 |
| 1562 | 09/30/2004 (8/27-30/2004) | Severe Storms, **Flooding**, and Tornados | Douglas | $2,103,376 |
| 1462 | 5/6/2003 (5/4-30/2003) | Severe Storms, Tornados, and **Flooding** | Douglas | $988,056 |
| Emergency Declaration 3324 | 6/25/2011 | **Flooding** | Atchison, Doniphan, Leavenworth and Wyandotte | n/a |

Source: FEMA

The following provides details of the one Presidential Disaster Declaration for Kansas Region K since the last plan update in 2014.

**Kansas – Severe Storms, Tornados, Straight-Line Winds, and Flooding FEMA-4230-DR**
Declared July 20, 2015

On July 1, 2015, Governor Sam Brownback requested a major disaster declaration due to severe storms, tornados, straight-line winds, and flooding during the period of May 4 to June 21, 2015. The Governor requested a declaration for Public Assistance, including direct federal assistance for 42 counties and Hazard Mitigation statewide. During the period of May 4 to June 27, 2015, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.

On July 20, 2015, President Obama declared that a major disaster exists in the State of Kansas. This declaration made Public Assistance requested by the Governor available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms, tornados, straight-line winds, and flooding in Atchison, Barton, Brown, Atchison, Chase, Chautauqua, Cherokee, Cheyenne, Clay, Cloud, Coffey, Brown, Doniphan, Edwards, Elk, Ellsworth, Franklin, Gray, Greenwood, Doniphan, Haskell, Hodgeman, Jackson, Jefferson, Jewell, Lyon, Marshall, Marshall, Jefferson, Meade, Miami, Morris, Nemaha, Neosho, Osage, Pottawatomie, Republic, Washington, Stevens, Sumner, Wabaunsee, and Washington Counties. Direct Federal assistance was also authorized. Finally, this declaration made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.

In addition to the above reported events, the following table presents NOAA NCEI identified flood events and the resulting damage totals in Kansas Region K from the period 2009 - 2018. This data is limited to reported events.

**Table 4.66: Kansas Region K NCEI Flood and Flash Flood Events, 2009 - 2018**

| County | Event Type | Number of Days with Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|---|
| Atchison | Flood | 2 | $ | 0 | 0 |
| | Flash Flood | 3 | $0 | 0 | 0 |
| Brown | Flood | 4 | $0 | 0 | 0 |
| | Flash Flood | 8 | $1,000 | 0 | 0 |
| Doniphan | Flood | 1 | $0 | 0 | 0 |
| | Flash Flood | 5 | $0 | 0 | 0 |
| Douglas | Flood | 4 | $0 | 0 | 0 |
| | Flash Flood | 11 | $0 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Jackson | Flood | 3 | $0 | 0 | 0 |
| | Flash Flood | 5 | $0 | 0 | 0 |
| Jefferson | Flood | 4 | $0 | 0 | 0 |
| | Flash Flood | 6 | $0 | 0 | 0 |

**Table 4.66: Kansas Region K NCEI Flood and Flash Flood Events, 2009 - 2018**

| County | Event Type | Number of Days with Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|---|
| Marshall | Flood | 2 | $0 | 0 | 0 |
| | Flash Flood | 13 | $0 | 0 | 0 |
| Nemaha | Flood | 2 | $0 | 0 | 0 |
| | Flash Flood | 10 | $0 | 0 | 0 |
| Washington | Flood | 3 | $0 | 0 | 0 |
| | Flash Flood | 4 | $0 | 0 | 0 |

Source: FEMA

The following provides local accounts of notable flood events:

- **October 5 – 9, 2018: Regional**

  .

- **October 9, 2018: Sedgwick (Douglas County)**

- **October 2018: Lyons (Jackson County)** Damages were estimated at $300,000.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of flooding on the Region's agricultural base. Crop loss data for the years 2015- 2018, for the region, indicates 255 flood related claims on 37,974 acres for $19,946,797.

**Table 4.67: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Flooding**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 35 | 7,300 | $1,970,359 |
| Brown | 9 | 891 | $44,584 |
| Doniphan | 60 | 16,447 | $6,052,308 |
| Douglas | 9 | 898 | $127,444 |
| Jackson | 12 | 948 | $42,472 |
| Jefferson | 21 | 1,513 | $132,142 |
| Marshall | 66 | 6,652 | $1,287,564 |
| Nemaha | 10 | 1,210 | $47,524 |
| Washington | 33 | 2,115 | $242,399 |

Source: USDA Farm Service Agency

### 4.13.3 – Hazard Probability Analysis

The following table summarizes riverine flood probability data for **Atchison County**.

**Table 4.68: Atchison County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Atchison County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Atchison County**.

**Table 4.69: Atchison County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 4 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Atchison County can expect on a yearly basis, relevant to flash flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Atchison County.**

**Table 4.70: Atchison County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|

| | |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 35 |
| Average Number of Claims per Year | 4 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 7,300 |
| Average Number of Acres Damaged per Year | 730 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,970,359 |
| Average Crop Damage per Year | $197,036 |

Source: USDA

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to flooding occurrences:

- Four insurance claims
- 730 acres impacted
- $197,036 in insurance claims

The following table summarizes riverine flood probability data for **Brown County**.

**Table 4.71: Brown County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 4 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Brown County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Brown County**.

**Table 4.72: Brown County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 8 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $1,000 |
| Average Property Damage per Year | $100 |

Source: NCEI

Data from the NCEI indicates that Brown County can expect on a yearly basis, relevant to flash flood events:

- One event
- No deaths or injuries
- $100 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Brown County.**

**Table 4.73: Brown County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 9 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 891 |
| Average Number of Acres Damaged per Year | 89 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $44,584 |
| Average Crop Damage per Year | $4,458 |

Source: USDA

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to flooding occurrences:

- One insurance claim
- 89 acres impacted
- $4,458 in insurance claims

The following table summarizes riverine flood probability data for **Doniphan County**.

**Table 4.74: Doniphan County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that County can expect on a yearly basis, relevant to riverine flood events:

- One event
- No deaths or injuries

- $210 in property damages

The following table summarizes flash flood probability data for **Doniphan County**.

**Table 4.75: Doniphan County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 5 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Doniphan County can expect on a yearly basis, relevant to flash flood events:

- One event
- No deaths or injuries
- $500,000 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Doniphan County.**

**Table 4.876: Doniphan County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 9 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 16,447 |
| Average Number of Acres Damaged per Year | 1,645 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $6,052,308 |
| Average Crop Damage per Year | $605,231 |

Source: USDA

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to flooding occurrences:

- One insurance claim
- 1,645 acres impacted
- $605,231 in insurance claims

The following table summarizes riverine flood probability data for **Douglas County**.

**Table 4.77: Douglas County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 4 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Douglas County**.

**Table 4.78: Douglas County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 11 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Douglas County can expect on a yearly basis, relevant to flash flood events:

- One event
- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Douglas County.**

**Table 4.79: Douglas County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 9 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 898 |
| Average Number of Acres Damaged per Year | 90 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $127,444 |

| | |
|---|---|
| Average Crop Damage per Year | $12,744 |

Source: USDA

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to flooding occurrences:

- One insurance claim
- 90 acres impacted
- $12,744 in insurance claims

The following table summarizes riverine flood probability data for **Jackson County**.

**Table 4.80: Jackson County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 3 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Jackson County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Jackson County**.

**Table 4.81: Jackson County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 5 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Jackson County can expect on a yearly basis, relevant to flash flood events:

- One event

- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Jackson County.**

**Table 4.82: Jackson County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 12 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 948 |
| Average Number of Acres Damaged per Year | 95 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $42,472 |
| Average Crop Damage per Year | $4,247 |

Source: USDA

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to flooding occurrences:

- One insurance claim
- 95 acres impacted
- $4,247 in insurance claims

The following table summarizes riverine flood probability data for **Jefferson County**.

**Table 4.83: Jefferson County Riverine Flood Probability**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009**Summary** - 2018) | 4 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Jefferson County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Jefferson County**.

**Table 4.84: Jefferson County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 6 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Jefferson County can expect on a yearly basis, relevant to flash flood events:

- One event
- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Jefferson County.**

**Table 4.85: Jefferson County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 21 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,513 |
| Average Number of Acres Damaged per Year | 151 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $132,142 |
| Average Crop Damage per Year | $13,214 |

Source: USDA

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to flooding occurrences:

- Two insurance claims
- 151 acres impacted
- $13,214 in insurance claims

The following table summarizes riverine flood probability data for **Marshall County**.

**Table 4.86: Marshall County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|

| | |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Marshall County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Marshall County**.

**Table 4.87: Marshall County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 13 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Marshall County can expect on a yearly basis, relevant to flash flood events:

- One event
- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Marshall County.**

**Table 4.88: Marshall County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 66 |
| Average Number of Claims per Year | 7 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 6,652 |
| Average Number of Acres Damaged per Year | 665 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,287,564 |
| Average Crop Damage per Year | $128,756 |

Source: USDA

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to flooding occurrences:

- Seven insurance claims
- 665 acres impacted
- $128,756 in insurance claims

The following table summarizes riverine flood probability data for **Nemaha County**.

**Table 4.89: Nemaha County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Nemaha County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Nemaha County**.

**Table 4.90: Nemaha County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 10 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Nemaha County can expect on a yearly basis, relevant to flash flood events:

- One event
- No deaths or injuries

- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Nemaha County.**

**Table 4.91: Nemaha County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 10 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,210 |
| Average Number of Acres Damaged per Year | 121 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $47,524 |
| Average Crop Damage per Year | $4,752 |

Source: USDA

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to flooding occurrences:

- One insurance claim
- 121 acres impacted
- $4,752 in insurance claims

The following table summarizes riverine flood probability data for **Washington County**.

**Table 4.92: Washington County Riverine Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 3 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Washington County can expect on a yearly basis, relevant to riverine flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

The following table summarizes flash flood probability data for **Washington County**.

**Table 4.93: Washington County Flash Flood Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 4 |

| | |
|---|---|
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Washington County can expect on a yearly basis, relevant to flash flood events:

- <1 event
- No deaths or injuries
- $0 in property damages

Data was reviewed from the USDA Risk Management agency to determine vulnerability to flooding. The following table summarizes drought event data for **Washington County.**

**Table 4.94: Washington County Flooding Agricultural Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 33 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 2,115 |
| Average Number of Acres Damaged per Year | 211 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $242,399 |
| Average Crop Damage per Year | $24,240 |

Source: USDA

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to flooding occurrences:

- Three insurance claims
- 211 acres impacted
- $24,240 in insurance claims

In addition, Kansas Region K has had 12 Presidentially Declared Disasters relating to flooding (and other causes) in the last 20 years. This represents an average of one declared flood disaster per year.

### 4.13.4 – Vulnerability Analysis

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

HAZUS determines the displaced population based on the inundation area, not necessarily impacted buildings. As a result, there may be population vulnerable to displacement even if the structure is not vulnerable to damage. Individuals and households will be displaced from their homes even when the home has suffered little or no damage either because they were evacuated or there was no physical access to the property because of flooded roadways.

Flood sheltering needs are based on the displaced population, not the damage level of the structure. HAZUS determines the number of individuals likely to use government-provided short-term shelters through determining the number of displaced households as a result of the flooding. To determine how many of those households and the corresponding number of individuals will seek shelter in government-provided shelters, the number is modified by factors accounting for income and age. Displaced people using shelters will most likely be individuals with lower incomes and those who do not have family or friends within the immediate area. Since the income and age factors are taken into account, the proportion of displaced population and those seeking shelter will vary from county to county.

Additionally, HAZUS takes into account flood depth when modeling damage (based on FEMA's depth-damage functions). Generated reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments up to 50%. Buildings that sustain more than 50% damage are considered to be substantially damaged.

The following table provides the HAZUS results for vulnerable populations and the population estimated to seek short term shelter as well as the numbers of damaged and substantially damaged buildings for each Kansas Region K county.

**Table 4.95: Kansas Region K HAZUS Flood Scenario Displaced Population Building Damages**

| County | Population Vulnerable to Displacement | Population with Short Term Shelter Needs | Vulnerable Buildings | Damaged Buildings | Substantially Damaged Buildings |
|---|---|---|---|---|---|
| Atchison | 219 | 7 | 198 | 8 | 0 |
| Brown | 211 | 9 | 63 | 8 | 0 |
| Doniphan | 165 | 60 | 619 | 13 | 0 |
| Douglas | 850 | 295 | 1778 | 65 | 0 |
| Jackson | 422 | 58 | 243 | 19 | 0 |
| Jefferson | 365 | 26 | 230 | 6 | 0 |
| Marshall | 325 | 48 | 240 | 31 | 0 |
| Nemaha | 274 | 13 | 79 | 5 | 0 |
| Washington | 138 | 4 | 95 | 4 | 0 |

Source: FEMA and HAZUS

The HAZUS analysis also provides an estimate the repair costs for impacted buildings as well as the associated loss of building contents and business inventory. Building damage can also cause additional losses to a community by restricting a building's ability to function properly. Income loss data accounts

for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by HAZUS using a methodology based on the building damage estimates.

The damaged building counts generated by HAZUS are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. Generated reports include this disclaimer: "Unlike the earthquake and hurricane models, the flood model performs its analysis at the census block level. This means that the analysis starts with a small number of buildings within each census block and applies a series of distributions necessary for analyzing the potential damage. The application of these distributions and the small number of buildings make the flood model more sensitive to rounding errors that introduces uncertainty into the building count results." Additionally, losses are not calculated for individual buildings, but instead are based on the performances of entire classes of buildings obtained from the general building stock data. In the flood model, the number of grid cells (pixels) at each flood depth value is divided by the total number of grid cells in the census block. The result is used to weight the flood depths applied to each specific occupancy type in the general building stock. First floor heights are then applied to determine the damage depths to analyze damages and losses.

The following table provides the HAZUS results for building damages and lost income due to these damages.

**Table 4.96: Kansas Region K HAZUS Flood Scenario Structural Damage and Income Loss**

| County | Structural Damage | Contents Damage | Inventory Loss | Total Direct Loss | Total Income Loss | Total Direct and Income Loss |
|---|---|---|---|---|---|---|
| Atchison | $14,246,000 | $27,466,000 | $1,011,000 | $42,723,000 | $260,000 | $42,983,000 |
| Brown | $3,870,000 | $3,312,000 | $113,000 | $7,295,000 | $13,000 | $7,308,000 |
| Doniphan | $1,974,000 | $1,310,000 | $42,000 | $3,326,000 | $1,000 | $3,327,000 |
| Douglas | $26,333,000 | $39,360,000 | $1,676,000 | $67,369,000 | $564,000 | $67,933,000 |
| Jackson | $8,402,000 | $7,227,000 | $352,000 | $15,981,000 | $58,000 | $16,039,000 |
| Jefferson | $9,423,000 | $7,936,000 | $120,000 | $17,479,000 | $149,000 | $17,628,000 |
| Marshall | $6,653,000 | $8,535,000 | $618,000 | $15,806,000 | $38,000 | $15,844,000 |
| Nemaha | $5,602,000 | $4,295,000 | $193,000 | $10,090,000 | $18,000 | $10,108,000 |
| Washington | $3,302,000 | $3,372,000 | $276,000 | $6,950,000 | $22,000 | $6,972,000 |

Source: FEMA and HAZUS

The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years) allows us to quantify the monetary impact of flood conditions on the agricultural sector. The higher the percentage loss, the higher the vulnerability the county has to flood events.

**Table 4.97: Flood Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|

| | | | | | Insurance Paid | |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 730 | 0.42% | $66,913,000 | $197,036 | 0.29% |
| Brown | 258,601 | 89 | 0.03% | $112,057,000 | $4,458 | 0.00% |
| Doniphan | 144,927 | 1,645 | 1.13% | $76,581,000 | $605,231 | 0.79% |
| Douglas | 159,261 | 90 | 0.06% | $65,867,000 | $12,744 | 0.02% |
| Jackson | 168,682 | 95 | 0.06% | $40,215,000 | $4,247 | 0.01% |
| Jefferson | 153,276 | 151 | 0.10% | $44,922,000 | $13,214 | 0.03% |
| Marshall | 361,473 | 665 | 0.18% | $92,882,000 | $128,756 | 0.14% |
| Nemaha | 268,088 | 121 | 0.05% | $76,127,000 | $4,752 | 0.01% |
| Washington | 336,673 | 211 | 0.06% | $87,087,000 | $24,240 | 0.03% |

Source: USDA

Flood risk can also change over time because of new building and development, weather patterns and other factors. Although the frequency or severity of impacts cannot be changed, FEMA is working with federal, state, tribal and local partners across the nation to identify flood risk and promote informed planning and development practices to help reduce that risk through the Risk Mapping, Assessment and Planning (Risk MAP) program. Risk MAP uses the watershed boundaries to conduct studies. This watershed approach allows communities to come together to develop partnerships, combine resources, share flood risk information with FEMA, and identify broader opportunities for mitigation action.

The Flood Risk Products and datasets present information that can enhance hazard mitigation planning activities, especially the risk and vulnerability assessment portion of a hazard mitigation plan, and the development of risk-based mitigation strategies. Risk MAP can also help guide land use and development decisions and help you take mitigation action by highlighting areas of highest risk, areas in need of mitigation, and areas of floodplain change. Currently Kansas Region K has no current or scheduled Risk Map projects.

***Mold***

In general, mold is plant-like organism that obtains nourishment it directly from surrounding organic materials. Mold can grow on a variety of materials and thrives in damp environments. As such, a recently flooded home or business provides an ideal environment for mold growth, especially on materials such as drywall and carpeting. The young, old and ill may be specifically susceptible to the effects of mold, with symptoms including:

- congestion
- cough
- breathing difficulties
- sore throat
- membrane irritation
- upper respiratory infections

As such, any instance of flood related mold should be remediated as soon as possible.

### 4.13.5 – National Flood Insurance Program Communities

The National Flood Insurance Program (NFIP) is a federal program, managed by FEMA, that exists to provide flood insurance for property owners in participating communities, to improve floodplain management practices, and to develop maps of flood hazard areas. The following table presents the number of NFIP participating communities in each county.

**Table 4.98: Kansas Region K NFIP Communities**

| Community | Initial Flood Hazard Boundary Map Identified | Initial Flood Insurance Rate Map Identified | Current Effective Map Date |
|---|---|---|---|
| **Atchison County** | | | |
| Atchison County | 5/31/1977 | 12/1/2007 | 12/01/07(L) |
| City of Atchison | 2/8/1974 | 6/1/1978 | 6/1/1978 |
| Effingham | 2/1/1974 | - | NSFHA |
| Muscotah | 11/22/1974 | - | 7/9/1976 |
| **Brown County** | | | |
| Brown County | 5/17/1977 | 9/1/1987 | 09/01/87(L) |
| Hiawatha | 2/8/1974 | - | NSFHA |
| Horton | 2/15/1974 | - | NSFHA |
| Morrill | 11/22/1974 | - | 12/12/1975 |
| Robinson | 11/29/1974 | 5/1/1990 | 05/01/90(L) |
| **Doniphan County** | | | |
| Doniphan County | 6/3/1977 | 6/1/1978 | 6/1/1978 |
| Elwood | 6/28/1974 | - | NSFHA |

**Table 4.98: Kansas Region K NFIP Communities**

| Community | Initial Flood Hazard Boundary Map Identified | Initial Flood Insurance Rate Map Identified | Current Effective Map Date |
|---|---|---|---|
| Highland | 4/23/1976 | 9/1/2011 | 09/01/11(L) |
| Troy | 2/15/1974 | - | NSFHA |
| Wathena | 3/22/1974 | - | NSFHA |
| **Douglas County** | | | |
| Douglas County | 6/17/1977 | 3/2/1981 | 8/5/2010 |
| Baldwin City | 2/15/1974 | 1/2/1980 | 8/5/2010 |
| Eudora | 1/9/1974 | 1/16/1981 | 8/5/2010 |
| Lawrence | 6/14/1974 | 3/2/1981 | 8/5/2010 |
| Lecompton | 1/23/1974 | 3/15/1979 | 8/5/2010 |
| **Jackson County** | | | |
| Jackson County | 5/31/1977 | 12/15/1989 | 5/3/2010 |
| Circleville | 12/20/1974 | 5/3/2010 | 5/3/2010 |
| Delia | 8/30/1974 | 5/3/2010 | 5/3/2010 |
| Denison | - | 5/3/2010 | NSFHA |
| Holton | 2/22/1974 | 1/16/1981 | 5/3/2010 |
| Hoyt | 12/20/1974 | 5/3/2010 | NSFHA |
| Mayetta | 11/8/1974 | 5/3/2010 | NSFHA |
| Soldier | 11/22/1974 | 5/3/2010 | 5/3/2010 |
| Whiting | 11/29/1974 | 5/3/2010 | 5/3/2010 |
| **Jefferson County** | | | |
| Jefferson County | 8/16/1977 | 9/4/1991 | 12/17/2010 |
| McLouth | 3/22/1974 | 11/4/2009 | 11/04/09(M) |
| Meriden | 11/5/1976 | 11/4/2009 | 11/04/09(M) |
| Nortonville | 3/1/1974 | 11/4/2009 | 11/04/09(M) |
| Oskaloosa | 5/24/1974 | 11/4/2009 | 11/04/09(M) |
| Ozawkie | - | 11/04/2009 | 11/04/2009 |
| Perry | 12/7/1973 | 3/2/1981 | 11/4/2009 |
| Valley Falls | 10/10/1975 | 11/4/2009 | 11/04/09(M) |
| Winchester | - | 11/4/2009 | NSFHA |
| **Marshall County** | | | |
| Marshall County | 6/28/1977 | 5/1/1990 | 05/01/90(L) |
| Axtell | 3/26/1976 | - | NSFHA |
| Blue Rapids | 3/26/1976 | 11/1/2011 | 11/01/11(L) |
| Frankfort | 1/23/1974 | 9/27/1985 | 09/27/85(M) |
| Marysville | 12/7/1973 | 12/1/1977 | 12/1/1977 |
| Vermillion | 12/20/1974 | 5/1/1990 | 05/01/90(L) |
| Waterville | 8/29/1975 | - | NSFHA |
| **Nemaha County** | | | |
| Nemaha County | 7/5/1977 | 8/19/1985 | 08/19/85(M) |
| Centralia | 5/24/1974 | 9/1/1986 | 09/01/86(L) |
| Corning | - | - | - |
| Goff | 11/8/1974 | - | 12/26/1975 |
| Wathena | 3/22/1974 | - | NSFHA |
| Sabetha | 4/16/1976 | - | NSFHA |
| Seneca | 2/8/1974 | 9/27/1985 | 09/27/85(M) |

**Table 4.98: Kansas Region K NFIP Communities**

| Community | Initial Flood Hazard Boundary Map Identified | Initial Flood Insurance Rate Map Identified | Current Effective Map Date |
|---|---|---|---|
| **Washington County** | | | |
| Washington County | - | - | 1/1/1950 |
| Haddam | 12/27/1974 | - | 12/27/1974 |
| Hanover | 7/18/1975 | 9/27/1985 | 09/27/85(M) |
| Morrowville | 12/6/1974 | - | 12/6/1974 |
| Palmer | 12/20/1974 | - | 12/20/1974 |
| City of Washington | 8/15/1975 | 9/27/1985 | 09/27/85(M) |

Notes: NSFHA: No Special Flood Hazard Area - All Zone C
(L): Original FIRM by letter - All Zone A, C and X (M):
No elevation determined - All Zone A, C and X

Additionally, the NFIP's Community Rating System (CRS) incentive rewards communities for the work they do managing their floodplains. Eligible communities that qualify for this voluntary program go above the minimum NFIP requirements and can offer their citizens discounted flood insurance in both Special Flood Hazard Areas (SFHAs) areas or non-SFHA areas. Additionally, work already being done by the state of Kansas (e.g., dam safety program and state freeboard requirements) gives communities additional discounts. The following Region K communities are currently CRS participants:

**Table 4.99: Kansas Region K CRS Participating Jurisdictions**

| Jurisdiction | County | CRS Entry Date | CRS Class | % Discount for SFHA | % Discount for Non-SFHA | Status |
|---|---|---|---|---|---|---|
| Douglas County | Douglas | 10/02/13 | 7 | 15% | 5% | Current |
| Jefferson County | Jefferson | 05/01/15 | 7 | 15% | 5% | Current |
| Lawrence | Douglas | 10/01/04 | 7 | 15% | 5% | Current |

Source: FEMA and KDEM

## 4.13.6 – FEMA Flood Policy and Loss Data

Kansas Region K flood-loss information was pulled from FEMA's "Policy and Loss Data by Community with County and State Data." There are several limitations to this data, including:

- Only losses to participating NFIP communities are represented
- Communities joined the NFIP at various times since 1978
- The number of flood insurance policies in effect may not include all structures at risk to flooding
- Some of the historical loss areas have been mitigated with property buyouts

Some properties are under-insured. The flood insurance purchase requirement is for flood insurance in the amount of federally backed mortgages, not the entire value of the structure. Additionally, contents coverage is not required.

The following table shows the details of NFIP policy and loss statistics for each county in Kansas Region K. Loss statistics include losses through December 31, 2018.

**Table 4.100: Kansas Region K NFIP Policy and Loss Statistics, As of December 31. 2018**

| Jurisdiction | Number of Policies in Force | Insurance in Force | Number of Closed Losses | Total Payments |
|---|---|---|---|---|
| **Atchison County** | | | | |
| Atchison County | 7 | $939,300 | 0 | $0 |
| City of Atchison | 7 | $2,826,700 | 1 | $15,391 |
| **Brown County** | | | | |
| Brown County | 1 | $29,100 | 0 | $0 |
| Robinson | 16 | $380,100 | 0 | $0 |
| **Doniphan County** | | | | |
| Doniphan County | 49 | $13,187,100 | 19 | $78,043 |
| Elwood | 89 | $18,248,900 | 48 | $630,717 |
| Wathena | 18 | $3,125,500 | 0 | $0 |
| **Douglas County** | | | | |
| Douglas County | 69 | $17,076,400 | 26 | $673,690 |
| Baldwin City | 27 | $5,744,500 | 6 | $74,764 |
| Eudora | 21 | $3,066,700 | 6 | $77,589 |
| Lawrence | 272 | $62,804,300 | 63 | $519,920 |
| Lecompton | 2 | $512,800 | 2 | $18,427 |
| **Jackson County** | | | | |
| Jackson County | 9 | $1,816,400 | 2 | $103,609 |
| Circleville | 1 | $60,000 | 0 | $0 |
| Holton | 2 | $660,000 | 1 | $16,000 |
| **Jefferson County** | | | | |
| Jefferson County | 56 | $8,838,500 | 22 | $579,049 |
| Meriden | 1 | $45,000 | 0 | $0 |
| Oskaloosa | 1 | $280,000 | 0 | $0 |
| Perry | 20 | $4,466,800 | 21 | $21,103 |
| **Marshall County** | | | | |
| Marshall County | 1 | $105,000 | 2 | $33,839 |
| Marysville | 1 | $70,000 | 14 | $67,847 |
| **Nemaha County** | | | | |
| Centralia | 3 | $450,200 | 0 | $0 |
| Seneca | 1 | $70,000 | 1 | $5,264 |
| **Washington County** | | | | |

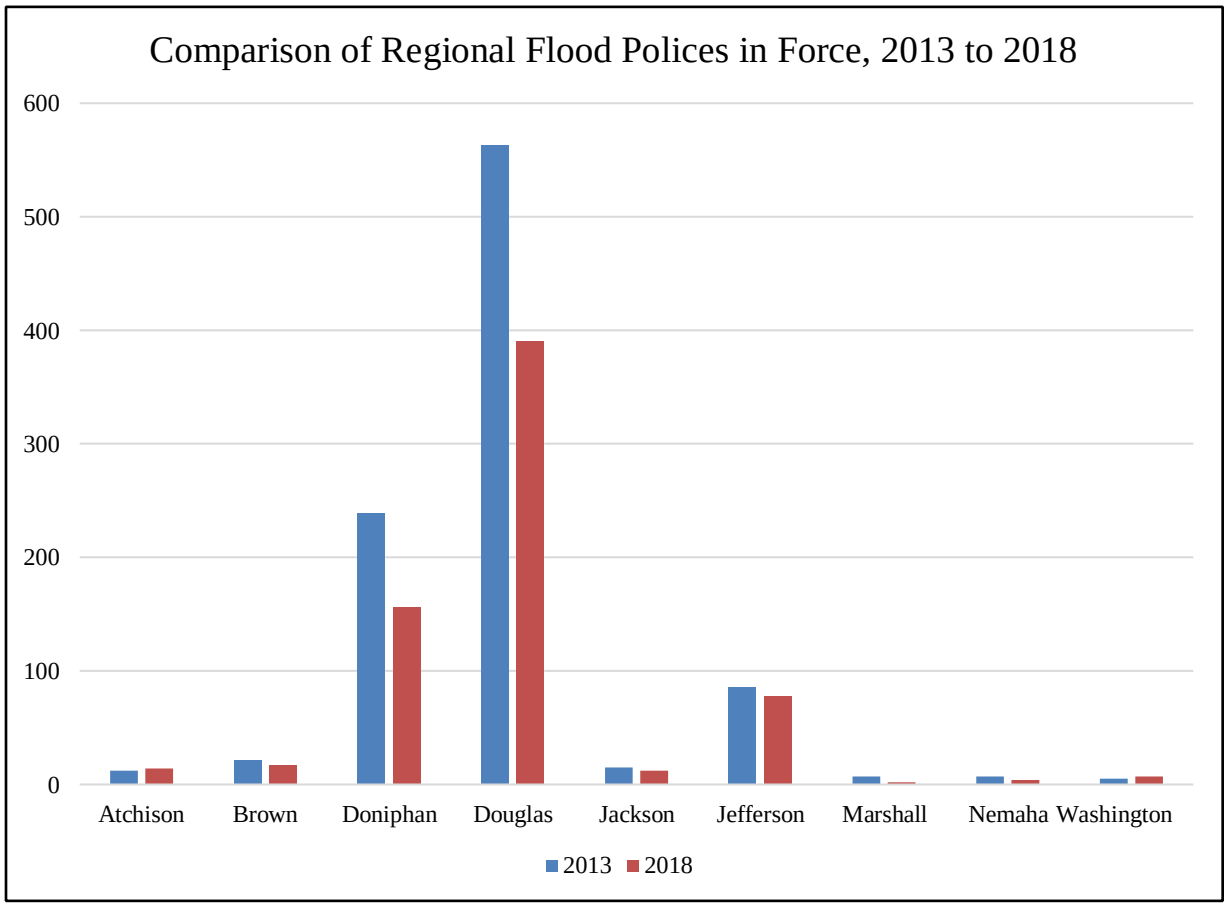
| | | | | |
|---|---|---|---|---|
| Washington County | 5 | $266,500 | 0 | $0 |
| Hanover | 2 | $296,000 | 0 | $0 |

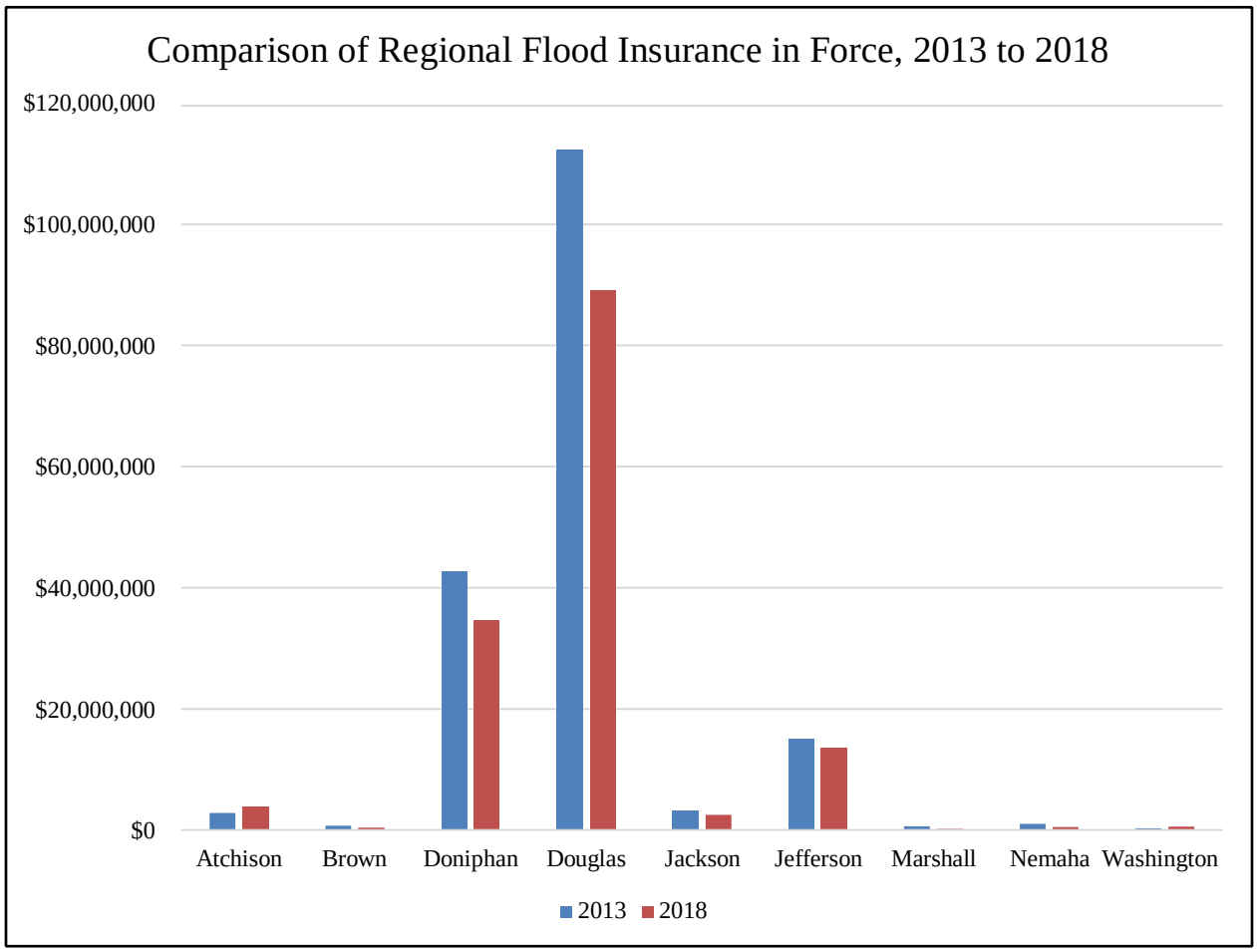
Source: FEMA, "Policy and Loss Data by Community with County and State Data"

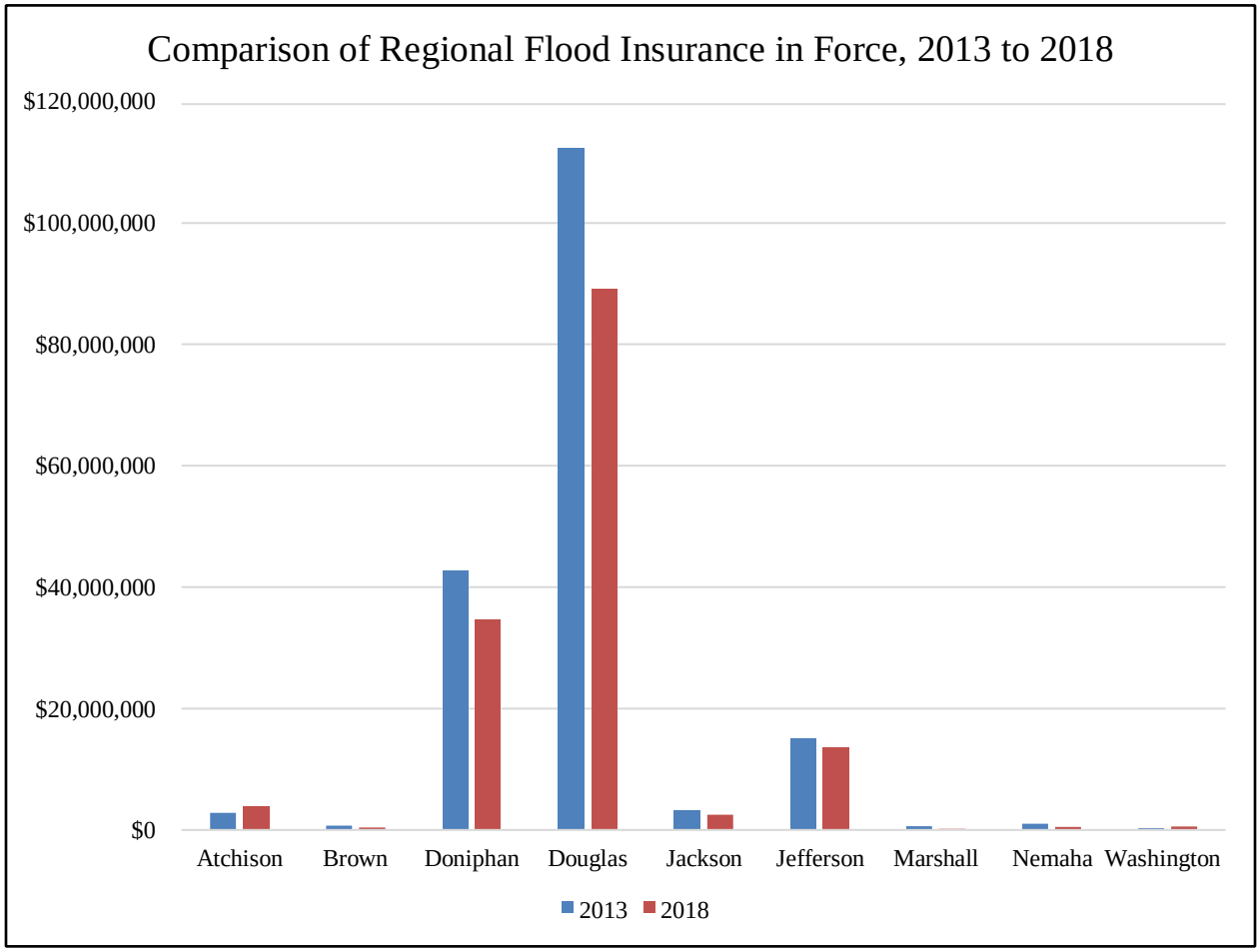
The following graphs summarize data from the above table for Kansas Region K in comparison to 2013 data. Of note:

- Regionally the number of flood policies has decreased from 2013 to 2018, from 955 to 681 
  Regionally the amount of flood insurance in-force decreased from 2013 to 2018, from $178,703,000 to $145,365,800

- Regionally the number of flood insurance closed losses increased from 2013 to 2018, from 147 to
  153




Comparison of Regional Flood Insurance in Force, 2013 to 2018
$120,000,000
$100,000,000
$80,000,000
$60,000,000
$40,000,000
$20,000,000
$0
Atchison
Brown
Doniphan
Douglas
Jackson
Jefferson
Marshall
Nemaha
Washington
2013
2018




### 4.13.7 _ Repetitive Loss Properties

A high priority to Kansas Region K is the reduction of losses to Repetitive Loss (RL) and Severe Repetitive Loss (SRL) structures. The NFIP defines a RL property as:

- Any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978

At least two of the claims must be more than 10 days apart.

The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended, 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both of the above, at least two of the referenced claims must have occurred within any ten-year period and must be greater than ten days apart.

The following table details RL and SRL properties in Kansas Region K.

**Table 4.101: Kansas Region K Repetitive Loss Properties, As of December 2018**

| County | Number of RL Properties | Number of RL Properties Mitigated | Number of RL Properties Insured | Number of Losses | Total Paid |
|---|---|---|---|---|---|
| Atchison | 0 | 0 | 0 | 0 | $0 |
| Brown | 0 | 0 | 0 | 0 | $0 |
| Doniphan | 5 | 1 | 0 | 10 | $182,203 |
| Douglas | 7 | 1 | 1 | 17 | $165,194 |
| Jackson | 0 | 0 | 0 | 0 | $0 |
| Jefferson | 2 | 0 | 1 | 4 | $112,240 |
| Marshall | 2 | 2 | 0 | 4 | $40,204 |
| Nemaha | 0 | 0 | 0 | 0 | $0 |
| Washington | 0 | 0 | 0 | 0 | $0 |

The following table details jurisdiction specific information concerning RL property type.

**Table 4.102: Kansas Region K Repetitive Loss Properties Type, by Jurisdiction**

| Jurisdiction | Number of Non-Mitigated RL Properties | Other, Non-Residential | Single Family | 2-4 Family |
|---|---|---|---|---|
| **Doniphan County** | | | | |
| Doniphan County | 3 | 0 | 2 | |
| Elwood | 1 | 0 | 2 | |
| **Douglas County** | | | | |
| Baldwin City | 3 | 1 | 2 | 0 |
| Douglas County | 2 | 0 | 2 | 0 |
| Eudora | 1 | 0 | 1 | 0 |
| Lawrence | 1 | 0 | 0 | 1 |
| **Jefferson County** | | | | |
| Jefferson County | 2 | 0 | 2 | 0 |
| **Marshall County** | | | | |
| Marshall County | 1 | 0 | 1 | 0 |
| Marysville | 1 | 1 | 0 | 0 |

Source: KDEM

No regional SRL properties have been identified.

## 4.13.8 – Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.103: Flood Consequence Analysis**

| Subject | Impacts of Flood |
|---|---|
| Health and Safety of the Public | Impact dependent on the level of flood waters. Individuals further away from the incident area are at a lower risk. Casualties are dependent on warning time. |
| Health and Safety of Responders | Impact to responders is expected to be minimal unless responders live within the affected area. |
| Continuity of Operations | Temporary relocation may be necessary if inundation affects government facilities. |
| Property, Facilities, and Infrastructure | Localized impact could be severe in the inundation area of the incident to facilities and infrastructure. The further away from the incident area the damage lessens. |
| Environment | Impact will be severe for impacted area. Impact will lessen with distance. |
| Economic Conditions | Impacts to the economy depend on the area flooded, depth of water, and the amount of time it takes for the water to recede. |
| Public Confidence in the Jurisdiction's Governance | Perception of whether the flood could have been prevented, warning time, and response and recovery time will greatly impact the public's confidence. |

## 4.14 – Hailstorms

According to NOAA, hail is precipitation that is formed when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere causing them to freeze. The raindrops form into small frozen droplets and then continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen rain droplet can continue to grow and form hail.

.

### 4.14.1 – Location and Extent

Hailstorms occur over broad geographic regions. The entire planning area, including all participating jurisdictions, is at risk to hailstorms.

Based on information provided by the Tornado and Storm Research Organization, the following table describes typical damage impacts of the various sizes of hail.

**Table 4.104: Hailstorm Intensity Scale**

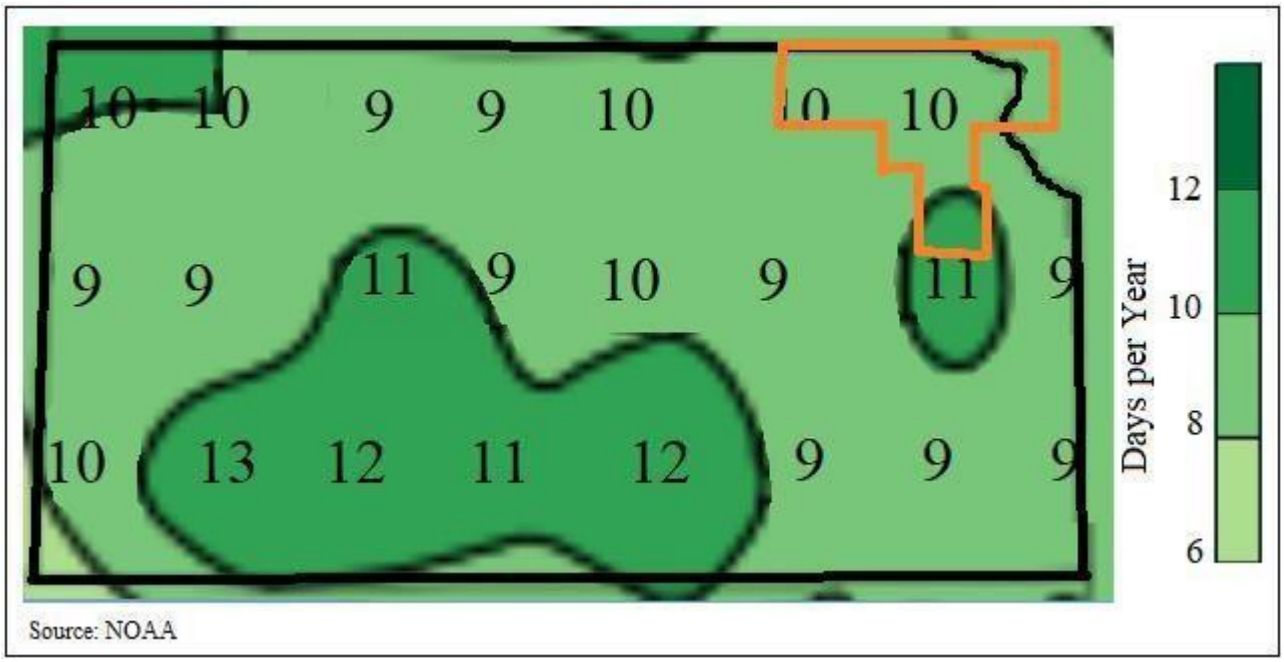
| Intensity Category | Diameter (mm) | Diameter (inches) | Size Description | Typical Damage Impacts |
|---|---|---|---|---|
| Hard Hail | 5-9 | 0.2-0.4 | Pea | No damage |
| Potentially Damaging | 10-15 | 0.4-0.6 | Mothball | Slight general damage to plants, crops |
| Significant | 16-20 | 0.6-0.8 |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

| | | | | |
|---|---|---|---|---|
| Super Hailstorms | >100 | 4.0+ | Melon | Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open |

Source: Tornado and Storm Research Organization

The following map, generated by data compiled by NOAA, indicates the average number of severe hail event days for Kansas Region K (9).

**Kansas Region K Severe Hail Days per Year from 2003 to 2012 Reports**




## 4.14.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been 11 Presidential Disaster Declarations for Kansas Region K for severe storms (along with other associates hazard event), of which hail may be a component. The following 20-year information (with 1999 and 2018 being full data years) on past declared disasters is presented to provide a historical perspective on hail events that have impacted Kansas Region K. Declaration numbers in bold indication declared disaster that have occurred since the previous mitigation plan update in 2014.

**Table 4.105: Kansas Region K FEMA Severe Storm Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| **4230** | 07/20/2015 (05/04/2015 – 06/21/2015) | **Severe Storms**, Tornados, Straight-Line Winds, and Flooding | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, McPherson, Nemaha, Neosho, and Washington. | $13,848,325 |
| 4150 | 10/22/2013 (07/22/2013 – 08/15/2013) | **Severe Storms**, Straight-Line Winds, Tornados, and Flooding | Washington | $11,412,827 |

| | | | | |
|---|---|---|---|---|
| 4010 | 07/29/2011 (5/19-6/4/2011) | **Severe Storms**, Straight-Line Winds, Tornados and Flooding | Washington | $8,259,620 |
| 1932 | 08/10/2010 (6/7-7/21/2010) | **Severe Storms**, Flooding and Tornados | Atchison, Brown, Doniphan, Jackson, Marshall and Washington | $9,279,257 |

**Table 4.105: Kansas Region K FEMA Severe Storm Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| 1849 | 06/25/2009 (4/25-5/16/2009) | **Severe Storms**, Flooding, Straight-Line Winds, and Tornados | Marshall | $15,013,488 |
| 1776 | 07/09/2008 | **Severe Storms**, Flooding, and Tornados | Brown and Jackson | $70,629,544 |
| 1699 | 5/6/2007 (5/4/2007) | **Severe Storms**, Tornados, and Flooding | Brown, Doniphan, Douglas, Jackson, Marshall, Nemaha and Washington | $117,565,269 |
| 1638 | 4/14/2006 (3/12-13/2006) | **Severe Storms**, Tornados, and Straight-Line Winds | Douglas | $6,233,044 |
| 1615 | 11/21/2005 (10/1-2/2005) | **Severe Storms** and Flooding | Atchison, Jackson and Jefferson | $10,286,064 |
| 1562 | 09/30/2004 (8/27-30/2004) | **Severe Storms**, Flooding, and Tornados | Douglas | $2,103,376 |
| 1462 | 5/6/2003 (5/4-30/2003) | **Severe Storms**, Tornados, and Flooding | Douglas | $988,056 |

Source: FEMA
-: Data unavailable

The following provides details of the two Presidential Disaster Declarations for Kansas Region K since the last plan update in 2014.

**Kansas – Severe Storms, Tornados, Straight-Line Winds, and Flooding FEMA-4230-DR**
Declared July 20, 2015

On July 1, 2015, Governor Sam Brownback requested a major disaster declaration due to severe storms, tornados, straight-line winds, and flooding during the period of May 4 to June 21, 2015. The Governor requested a declaration for Public Assistance, including direct federal assistance for 42 counties and Hazard Mitigation statewide. During the period of May 4 to June 27, 2015, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.

On July 20, 2015, President Obama declared that a major disaster exists in the State of Kansas. This declaration made Public Assistance requested by the Governor available to state and eligible

local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms, tornados, straight-line winds, and flooding in Atchison, Barton, Brown, Atchison, Chase, Chautauqua, Cherokee, Cheyenne, Clay, Cloud, Coffey, Brown, Doniphan, Edwards, Elk, Ellsworth, Franklin, Gray, Greenwood, Doniphan, Haskell, Hodgeman, Jackson, Jefferson, Jewell, Lyon, Marshall, Marshall, Jefferson, Meade, Miami, Morris, Nemaha, Neosho, Osage, Pottawatomie, Republic, Washington, Stevens, Sumner, Wabaunsee, and Washington Counties.

Direct Federal assistance was also authorized. Finally, this declaration made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.

In addition to the above reported events, the following table presents NOAA NCEI identified hailstorm events and the resulting damage totals in Kansas Region K for the period 2009 - 2018 (with 2009 and 2018 being full data set years).

**Table 4.106: Kansas Region K NCEI Hailstorm Events, 2009 - 2018**

| County | Number of Days with Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|
| Atchison | 27 | $2,000 | 0 | 0 |
| Brown | 31 | $1,000 | 0 | 0 |
| Doniphan | 12 | $0 | 0 | 0 |
| Douglas | 35 | $0 | 0 | 0 |
| Jackson | 35 | $24,000 | 0 | 0 |
| Jefferson | 25 | $8,000 | 0 | 2 |
| Marshall | 43 | $9,000 | 0 | 0 |
| Nemaha | 32 | $0 | 0 | 0 |
| Washington | 41 | $0 | 0 | 0 |

Source: NOAA NCEI

The following provides both **local accounts** and NOAA NCEI descriptions of notable recorded events:

- **May 25, 2016: Jefferson County**
  Two injuries reported by the Emergency Manager caused by hail. The victims refused treatment. Time was based on radar.

- **August 19, 2011: Jackson County and Kickapoo Tribal Reservation**
  Multiple windows were broken out due to large hail and gusty winds. Property damage was recorded at $15,000.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of hail on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates 266 hail related claims on 110,543 acres for $12,294,003.

**Table 4.107: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Hail**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 21 | 7,385 | $960,799 |
| Brown | 19 | 1,616 | $149,404 |
| Doniphan | 7 | 1,015 | $33,724 |
| Douglas | 11 | 444 | $15,332 |
| Jackson | 15 | 3,463 | $383,026 |
| Jefferson | 11 | 2,382 | $167,056 |
| Marshall | 59 | 26,955 | $2,835,792 |
| Nemaha | 34 | 9,831 | $1,267,739 |

**Table 4.107: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Hail**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Washington | 89 | 57,454 | $6,481,131 |

Source: USDA Farm Service Agency

## 4.12.3 – Hazard Probability Analysis

The following table summarizes hailstorm probability data for **Atchison County**.

**Table 4.108: Atchison County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 27 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $2,000 |
| Average Property Damage per Year | $200 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 21 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 7,385 |
| Average Number of Acres Damaged per Year | 738 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $960,799 |
| Average Crop Damage per Year | $96,080 |

Source: NCEI and USDA

Data from the NCEI indicates that Atchison County can expect on a yearly basis, relevant to hail events:

- Three events
- No deaths or injuries
- $200 in property damages

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to hail occurrences:

- Two insurance claims
- 738 acres impacted
- $96,080 in insurance claims

The following table summarizes hailstorm probability data for **Brown County**.

**Table 4.109: Brown County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 31 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |

**Table 4.109: Brown County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Total Reported NCEI Property Damage (2009-2018) | $1,000 |
| Average Property Damage per Year | $100 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 19 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,616 |
| Average Number of Acres Damaged per Year | 162 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $149,404 |
| Average Crop Damage per Year | $14,940 |

Source: NCEI and USDA

Data from the NCEI indicates that Brown County can expect on a yearly basis, relevant to hail events:

- Three events
- No deaths or injuries
- $100 in property damages

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to hail occurrences:

- Two insurance claims
- 162 acres impacted
- $14,940 in insurance claims

The following table summarizes hailstorm probability data for **Doniphan County**.

**Table 4.110: Doniphan County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|

| | |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 12 |
| Average Events per Year | 1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 19 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,015 |
| Average Number of Acres Damaged per Year | 102 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $33,724 |
| Average Crop Damage per Year | $3,372 |

Source: NCEI and USDA

Data from the NCEI indicates that Doniphan County can expect on a yearly basis, relevant to hail events:

- One event
- No deaths or injuries

- $0 in property damages

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to hail occurrences:

- Two insurance claims
- 102 acres impacted
- $3,372 in insurance claims

The following table summarizes hailstorm probability data for **Douglas County**.

**Table 4.111: Douglas County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 35 |
| Average Events per Year | 4 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 11 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 444 |
| Average Number of Acres Damaged per Year | 44 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $15,332 |
| Average Crop Damage per Year | $1,533 |

Source: NCEI and USDA

Data from the NCEI indicates that Douglas County can expect on a yearly basis, relevant to hail events:

- Four events
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to hail occurrences:

- One insurance claim
- 44 acres impacted
- $1,533 in insurance claims

The following table summarizes hailstorm probability data for **Jackson County**.

**Table 4.112: Jackson County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 35 |
| Average Events per Year | 4 |

**Table 4.112: Jackson County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $24,000 |
| Average Property Damage per Year | $2,400 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 15 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 3,463 |
| Average Number of Acres Damaged per Year | 346 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $383,026 |
| Average Crop Damage per Year | $38,303 |

Source: NCEI and USDA

Data from the NCEI indicates that Jackson County can expect on a yearly basis, relevant to hail events:

- Four events
- No deaths or injuries
- $2,400 in property damages

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to hail occurrences:

- Two insurance claims
- 346 acres impacted
- $38,303 in insurance claims

The following table summarizes hailstorm probability data for **Jefferson County**.

**Table 4.113: Jefferson County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 25 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 2 |
| Average Number of Days with Event and Death or Injury | <1 |
| Total Reported NCEI Property Damage (2009-2018) | $8,000 |
| Average Property Damage per Year | $800 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 11 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 2,382 |
| Average Number of Acres Damaged per Year | 238 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $167,056 |
| Average Crop Damage per Year | $16,706 |

Source: NCEI and USDA

Data from the NCEI indicates that Jefferson County can expect on a yearly basis, relevant to hail events:

- Three events
- <1 death or injury
- $800 in property damages

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to hail occurrences:

- One insurance claim
- 238 acres impacted
- $16,706 in insurance claims

The following table summarizes hailstorm probability data for **Marshall County**.

**Table 4.114: Marshall County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 43 |
| Average Events per Year | 4 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |

| | |
|---|---|
| Total Reported NCEI Property Damage (2009-2018) | $9,000 |
| Average Property Damage per Year | $900 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 59 |
| Average Number of Claims per Year | 6 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 26,955 |
| Average Number of Acres Damaged per Year | 2,696 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $2,835,792 |
| Average Crop Damage per Year | $283,579 |

Source: NCEI and USDA

Data from the NCEI indicates that Marshall County can expect on a yearly basis, relevant to hail events:

- Four events
- No deaths or injuries
- $900 in property damages

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to hail occurrences:

- Six insurance claims
- 2,696 acres impacted
- $283,579 in insurance claims

The following table summarizes hailstorm probability data for **Nemaha County**.

**Table 4.115: Nemaha County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 32 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 34 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 9,831 |
| Average Number of Acres Damaged per Year | 983 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,267,739 |
| Average Crop Damage per Year | $126,774 |

Source: NCEI and USDA

Data from the NCEI indicates that Nemaha County can expect on a yearly basis, relevant to hail events:

- Three events
- No deaths or injuries

- $0 in property damages

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to hail occurrences:

- Three insurance claims
- 983 acres impacted
- $126,774 in insurance claims

The following table summarizes hailstorm probability data for **Washington County**.

**Table 4.116: Washington County Hailstorm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 41 |
| Average Events per Year | 4 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Event and Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 89 |
| Average Number of Claims per Year | 9 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 57,454 |
| Average Number of Acres Damaged per Year | 5,745 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $6,481,131 |
| Average Crop Damage per Year | $648,113 |

Source: NCEI and USDA

Data from the NCEI indicates that Washington County can expect on a yearly basis, relevant to hail events:

- Four events
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to hail occurrences:

- Nine insurance claims
- 5,745 acres impacted
- $648,113 in insurance claims

In addition, Kansas Region K has had 11 Presidentially Declared Disasters relating to severe storms (of which hail is a potential component) in the last 20 years. This represents an average of one declared severe storm disaster per year.

## 4.14.4 – Vulnerability Analysis

For purposes of this assessment, all counties and tribal reservations within the region were determined to be at equal risk to hailstorm events. In general, counties and reservations with a higher or increasing structural inventory, or having a high structural valuation are to be considered to have a potentially greater vulnerability. Additionally, population vulnerabilities to hail events are expected to be minimal.

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county incurring damage over the period 2009 to 2018 from hailstorm events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. Building valuations are provided, if available, for each tribal reservation as a reference against county valuations and percentage damage. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.
.

**Table 4.117: Kansas Region K Structural Vulnerability Data for Hail, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $2,077,340,000 | $2,000 | 0.0% |
| Brown | $1,135,773,000 | $1,000 | 0.0% |
| Doniphan | $953,610,000 | $0 | 0.0% |
| Douglas | $12,489,840,000 | $0 | 0.0% |
| Iowa Tribal Reservation* | $7,712,800 | - | - |
| Jackson | $1,477,185,000 | $24,000 | 0.0% |
| Jefferson | $2,239,834,000 | $8,000 | 0.0% |
| Kickapoo Tribal Reservation* | $6,000,000 | - | - |
| Marshall | $1,231,049,000 | $9,000 | 0.0% |
| Nemaha | $1,282,096,000 | $0 | 0.0% |
| Washington | $650,841,000 | $0 | 0.0% |

Source: NCEI and HAZUS
*: Data provided by Tribal Government
-: Data unavailable

The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data allows us to quantify the monetary impact of hailstorm conditions on the agricultural sector. In general, the higher the percentage loss, the higher the vulnerability the county has to hailstorm events.

**Table 4.118: Hailstorm Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 738 | 0.42% | $66,913,000 | $96,080 | 0.14% |
| Brown | 258,601 | 162 | 0.06% | $112,057,000 | $14,940 | 0.01% |
| Doniphan | 144,927 | 102 | 0.07% | $76,581,000 | $3,372 | 0.00% |
| Douglas | 159,261 | 44 | 0.03% | $65,867,000 | $1,533 | 0.00% |
| Jackson | 168,682 | 346 | 0.21% | $40,215,000 | $38,303 | 0.10% |
| Jefferson | 153,276 | 238 | 0.16% | $44,922,000 | $16,706 | 0.04% |
| Marshall | 361,473 | 2,696 | 0.75% | $92,882,000 | $283,579 | 0.31% |
| Nemaha | 268,088 | 983 | 0.37% | $76,127,000 | $126,774 | 0.17% |
| Washington | 336,673 | 5,745 | 1.71% | $87,087,000 | $648,113 | 0.74% |

Source: USDA

## 4.14.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.119: Hailstorm Consequence Analysis**

| Subject | Impacts of Hailstorm |
|---|---|
| Health and Safety of the Public | Severity and location dependent. Impacts on persons in the areas of hail are expected to be severe if caught without proper shelter. |
| Health and Safety of Responders | Impacts will be predicated on the severity of the event. Damaged infrastructure will likely result in hazards such as downed utility lines, main breakages and debris on roadways. . |
| Continuity of Operations | Temporary relocation may be necessary if government facilities experience damage. Services may be limited to essential tasks if utilities are impacted. |
| Property, Facilities, and Infrastructure | Impact to property, facilities, and infrastructure could be minimal to severe, depending on the location and structural capacity of the facility. Loss of structural integrity of buildings and infrastructure could occur. Utility lines, roads, residential and business properties will be affected. |
| Environment | 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 | Impacts to the economy will be dependent severity of the event and the impact on structures and infrastructure. Impacts could be severe if roads/utilities are affected. |
| Public Confidence in the Jurisdiction's Governance | 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. |

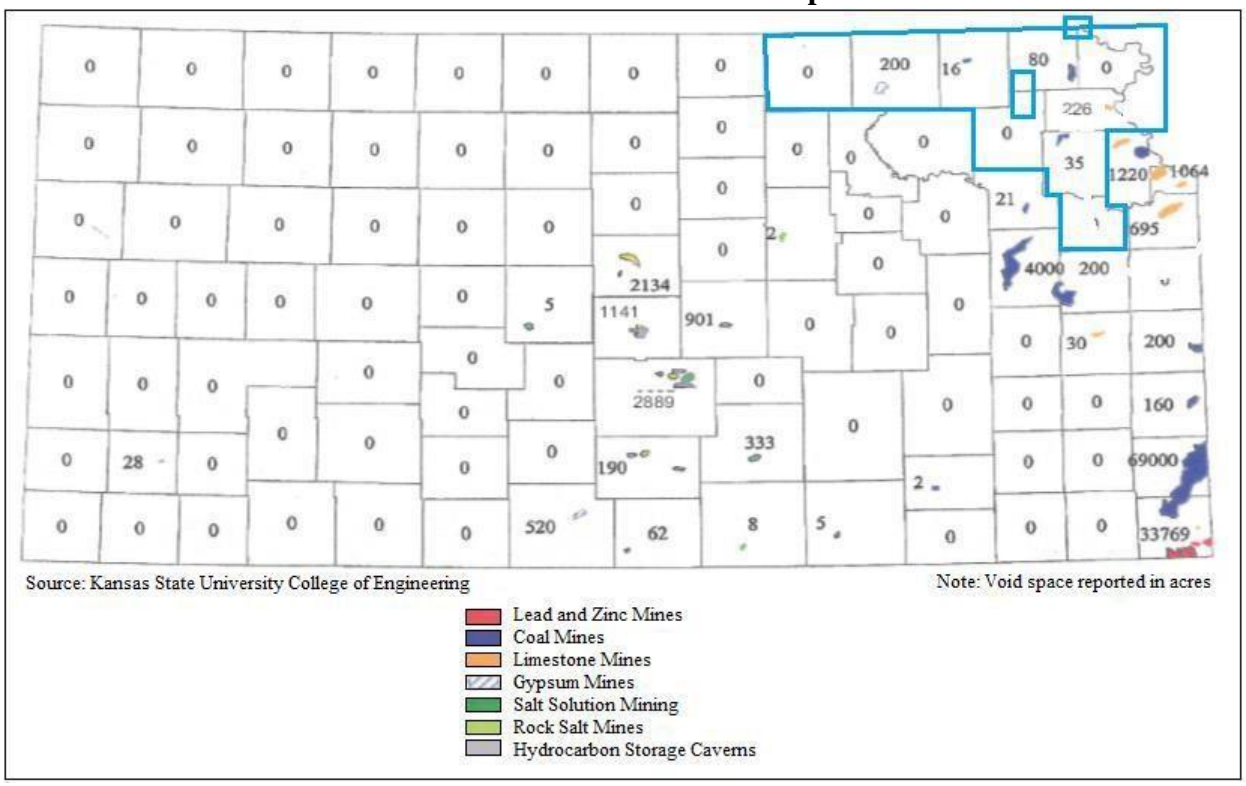
## 4.15 – Land Subsidence

Land 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.

### 4.15.1 – Location and Extent

The Kansas Department of Health and Environment (KDHE) 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. The following map details the distribution of total acres and major cause of void spaces for all Kansas Region K counties.

**KDHE Total Subsurface Void Space**




The following table details the total amount of subsurface void space as calculated using data from the KDHE map.

**Table 4.120: Kansas Region K Sub-Surface Void Space**

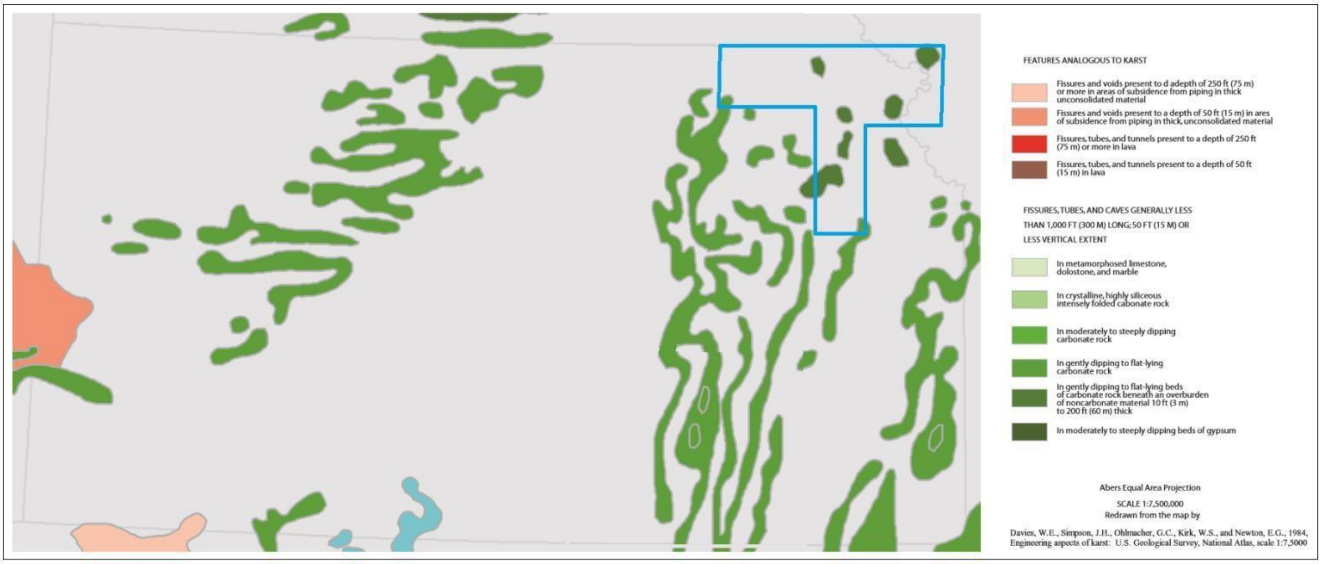
| County | Total Sub-Surface Void Space |
|---|---|
| Atchison | 226 |
| Brown | 80 |
| Doniphan | 0 |
| Douglas | 0 |
| Jackson | 0 |
| Jefferson | 35 |
| Marshall | 200 |
| Nemaha | 16 |
| Washington | 0 |

Source: KDHE

Of additional concern to Kansas Region K is Karst topography. The following map from the United States Geologic Survey (USGS) indicates areas of Karst topography in the region. 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 Region K.

**USGS Karst Topography**




## 4.15.2 – Previous Occurrences

There have been no reported land subsidence events in Kansas Region K during the ten-year period from 2009 to 2018.

## 4.15.3 – Hazard Probability Analysis

Land subsidence events with the potential to affect Kansas Region K are incredibly difficult to quantify and forecast. Compounding the difficulty, land subsidence events occur on their own or occur as a secondary hazard with incidents of heavy rain, melting snow, and earthquakes as a primary cause. Hence, their future occurrences are highly dependent on the likelihood of the mentioned hazards.

Based on limited available data, indicating that there have been no reported events in the past ten years, and bearing in mind that many events may be unreported as they have no impact on human activities, the probability of a reported land subsidence occurrence in any given year is very low.

## 4.15.4 Vulnerability Analysis

In general, counties with a higher or increasing population, high, or increasing, or having a high structural valuation are to be considered to have a potentially greater vulnerability. Population vulnerabilities to land subsidence events are expected to be minimal.

Vulnerability to land subsidence in Kansas Region K was analyzed using the KDHE “Subsurface Void Space and Sinkhole/Subsidence Area Inventory for the State of Kansas” report. 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

Based on these classifications, a risk category was assigned to each of the subsurface void acres:

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

The following table shows the classification of the void space in each of Kansas Region K counties. Please note that not all classifications with identified acreage are shown.

**Table 4.121: Kansas Region K Sub-Surface Void Space Risk Classification**

| County | Coal Category II | Coal Category III | Limestone Category I | Limestone Category II | Limestone Category III | Hydrocarbon Storage Category III | Total Sub-Surface Void Space |
|---|---|---|---|---|---|---|---|
| Atchison | 0 | 27 | 66 | 66 | 67 | 0 | 226 |
| Brown | 0 | 80 | 0 | 0 | 0 | 0 | 80 |
| Doniphan | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Douglas | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jackson | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jefferson | 30 | 0 | 0 | 5 | 0 | 0 | 35 |
| Marshall | 0 | 0 | 0 | 0 | 200 | 0 | 200 |
| Nemaha | 16 | 0 | 0 | 0 | 0 | 0 | 16 |
| Washington | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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

Based on this data, the area for each county underlain by sub-surface void acreage was determined. In general, the higher percentage of acreage underlain by void area the higher the vulnerability.

**Table 4.122: Kansas Region K Percentage of Land Underlain by Sub-Surface Void Space**

| County | Total County Acreage | Sub-Surface Void Space Acreage | Percentage of County Acreage Underlain by Void Space |
|---|---|---|---|
| Atchison | 278,400 | 226 | 0.08% |
| Brown | 366,208 | 80 | 0.02% |
| Doniphan | 254,144 | 0 | 0.00% |
| Douglas | 303,680 | 0 | 0.00% |
| Iowa Tribal Reservation | 948 | 0 | 0.00% |
| Jackson | 421,030 | 0 | 0.00% |
| Jefferson | 356,442 | 35 | 0.01% |
| Kickapoo Tribal Reservation | 19,200 | 0 | 0.00% |
| Marshal | 578,816 | 200 | 0.03% |
| Nemaha | 460,416 | 16 | 0.00% |
| Washington | 575,258 | 0 | 0.00% |

Source: KDHE

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county incurring damage over the period 2009 to 2018 from land subsidence events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. Building valuations are provided, if available, for each tribal reservation as a reference against county valuations and percentage damage. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.

**Table 4.123: Kansas Region K Structural Vulnerability Data for Land Subsidence, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $2,077,340,000 | $0 | 0.00% |
| Brown | $1,135,773,000 | $0 | 0.0% |
| Doniphan | $953,610,000 | $0 | 0.0% |
| Douglas | $12,489,840,000 | $0 | 0.0% |
| Iowa Tribal Reservation* | $7,712,800 | - | - |
| Jackson | $1,477,185,000 | $0 | 0.0% |
| Jefferson | $2,239,834,000 | $0 | 0.0% |
| Kickapoo Tribal Reservation* | $6,000,000 | - | - |
| Marshall | $1,231,049,000 | $0 | 0.0% |
| Nemaha | $1,282,096,000 | $0 | 0.0% |
| Washington | $650,841,000 | $0 | 0.0% |

Source: NCEI, HAZUS and Tribal data
*: Data provided by Tribal Government
-: Data unavailable

### 4.15.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.124: Land Subsidence Consequence Analysis**

| Subject | Impacts of Land Subsidence |
|---|---|
| Health and Safety of the Public | Local impact expected to be moderate to severe for the incident area, depending on the scale of the area. |
| Health and Safety of Responders | Impact to responders would be minimal. |
| Continuity of Operations | Minimal expectation of execution of the COOP, unless a facility is impacted. |
| Property, Facilities, and Infrastructure | Localized impact to facilities and infrastructure in the incident area has the potential to do severe damage. |
| Environment | Impact to the area would be minimal. |
| Economic Conditions | Impacts to the economy will depend on the severity of the damage. |
| Public Confidence in the Jurisdiction's Governance | Local development policies will be questioned |

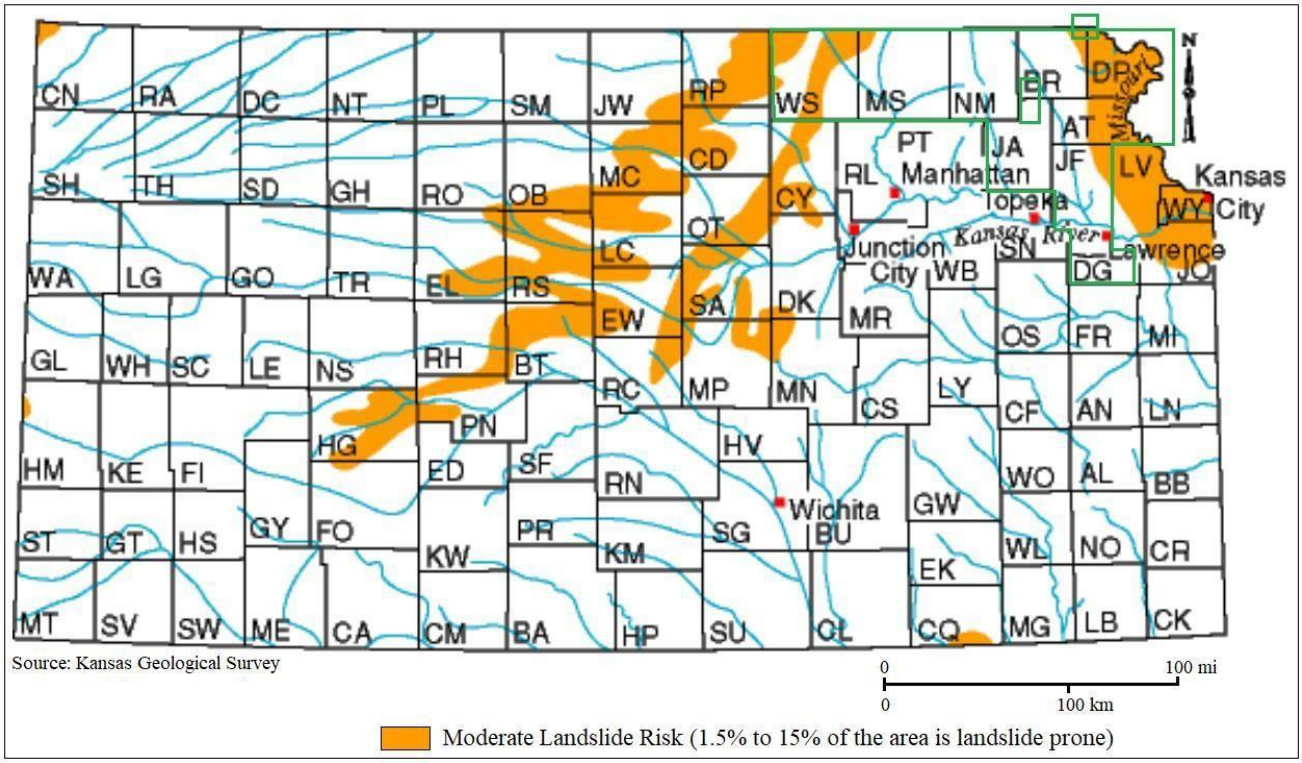
## 4.16 – Landslides

Landslides are the downward and outward movement of slopes. Landslides include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on and over steepened slopes is the primary reason for a landslide, landslides are often prompted by the occurrence of other disasters. Other contributing factors include erosion, steep slopes, rain and snow, and earthquakes.

### 4.16.1 – Location and Extent

Landslides are classified based mostly on their character of movement and degree of internal disruption. These landslide classes are rock fall, flow, slide, and creep. Although these are clear divisions, in the real world a landslide may have components of more than one type. Areas prone to landslides can cover broad geographic regions, but occurrences are generally localized. The entire planning area, including all participating jurisdictions, is potentially at risk to landslides. However, landslides require an earth or rock covered slope, and so flatter areas have a much-decreased risk of occurrence. The following map, produced by the Kansas Geological Survey (KGS), shows areas of the region with a moderate susceptibility of landslides, equating to 1.5% to 15% of the area being landslide prone.

**KGS Regional Landslide Map**




## 4.16.2 – Previous Occurrences

At present there is no centralized and complete database containing historical records for landslides in Kansas. For Kansas Region K there has been one reported landslide in the past 10 years.

- **Fall, 2018: Atchison County**
  A slow-moving landslide impacted Atchison High School. Property damage was reported at $14,850.

## 4.16.3 – Hazard Probability Analysis

Landslides with the potential to affect Kansas Region K are incredibly difficult to quantify and forecast. Compounding the difficulty, landslides occur on their own or occur as a secondary hazard with incidents of heavy rain, melting snow, earthquakes, and land subsidence are their primary cause. Hence, their future occurrences are highly dependent on the likelihood of the mentioned hazards.

As indicated in the map above, small areas of Kansas Region K (in Washington, Jefferson and Marshall counties) have a moderate susceptibility to landslides. However, the limited available past occurrence data indicate that there is a very low rate of occurrence. Based on limited available data, and bearing in mind that many landslides may be unreported as they have no impact on human activities, it is not likely that a major landslide will impact the region based on one reported occurrences in 10 years.

## 4.16.4 Vulnerability Analysis

Based on landslide mapping by the KGS, the area for each county with a moderate landslide risk was estimated. In general, the higher percentage of acreage in a moderate landslide risk area the higher the vulnerability. However, landslides require an earth or rock covered slope, and so flatter areas have a much-decreased risk of occurrence.

**Table 4.125: Kansas Region K Percentage of Land in Moderate Landslide Risk Area**

| County | Total County Acreage | Percentage of County Acreage Identified in Potential Slide Area | Estimated Acreage with Moderate Landslide Potential |
|---|---|---|---|
| Atchison | 278,400 | 50% | 139,200 |
| Brown | 366,208 | 5% | 18,310 |
| Doniphan | 254,144 | 100% | 254,144 |
| Douglas | 303,680 | 0% | 0 |
| Iowa Tribal Reservation | 948 | 100% | 948 |
| Jackson | 421,030 | 0% | 0 |
| Jefferson | 356,442 | 15% | 53,466 |
| Kickapoo Tribal Reservation | 19,200 | 0% | 0 |
| Marshal | 578,816 | 0% | 0 |
| Nemaha | 460,416 | 0% | 0 |
| Washington | 575,258 | 50% | 287,629 |

Source: KDEM and HAZUS

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county incurring damage over the period 2009 to 2018 from landslide events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. Building valuations are provided, if available, for each tribal reservation as a reference against county valuations and percentage damage. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.

.

**Table 4.126: Kansas Region K Structural Vulnerability Data for Landslide, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $2,077,340,000 | $0 | 0.0% |
| Brown | $1,135,773,000 | $0 | 0.0% |
| Doniphan | $953,610,000 | $0 | 0.0% |
| Douglas | $12,489,840,000 | $0 | 0.0% |
| Iowa Tribal Reservation | $7,712,800 | - | - |
| Jackson | $1,477,185,000 | $0 | 0.0% |
| Jefferson | $2,239,834,000 | $0 | 0.0% |
| Kickapoo Tribal Reservation | $6,000,000 | - | - |
| Marshall | $1,231,049,000 | $0 | 0.0% |
| Nemaha | $1,282,096,000 | $0 | 0.0% |
| Washington | $650,841,000 | $0 | 0.0% |

Source: NCEI, HAZUS and Tribal data

-: Data unavailable

Population vulnerabilities to landslide events are expected to be minimal.

### 4.16.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.127: Landslide Consequence Analysis**

| Subject | Impacts of Landslide |
|---|---|
| Health and Safety of the Public | Severity and location dependent. Impacts on persons in the path of the slide are expected to be severe. |
| Health and Safety of Responders | Impacts are expected to be minimal. |
| Continuity of Operations | Minimal expectation of execution of the COOP, unless a facility is impacted. |
| Property, Facilities, and Infrastructure | Impact to property, facilities, and infrastructure could be minimal to severe, depending on the location of the facility in relation to the slide. Loss of structural integrity of buildings and infrastructure could occur. |
| Environment | Impact to the area would be minimal other than the immediate area. |
| Economic Conditions | Impacts to the economy will be dependent severity of landslide and the impact on structures and infrastructure. Impacts could be severe if roads/utilities are affected. Otherwise impact would be non-existent to minimal. |
| Public Confidence in the Jurisdiction's Governance | Confidence could be an issue if local development policies are questioned. |

## 4.17 – Lightning

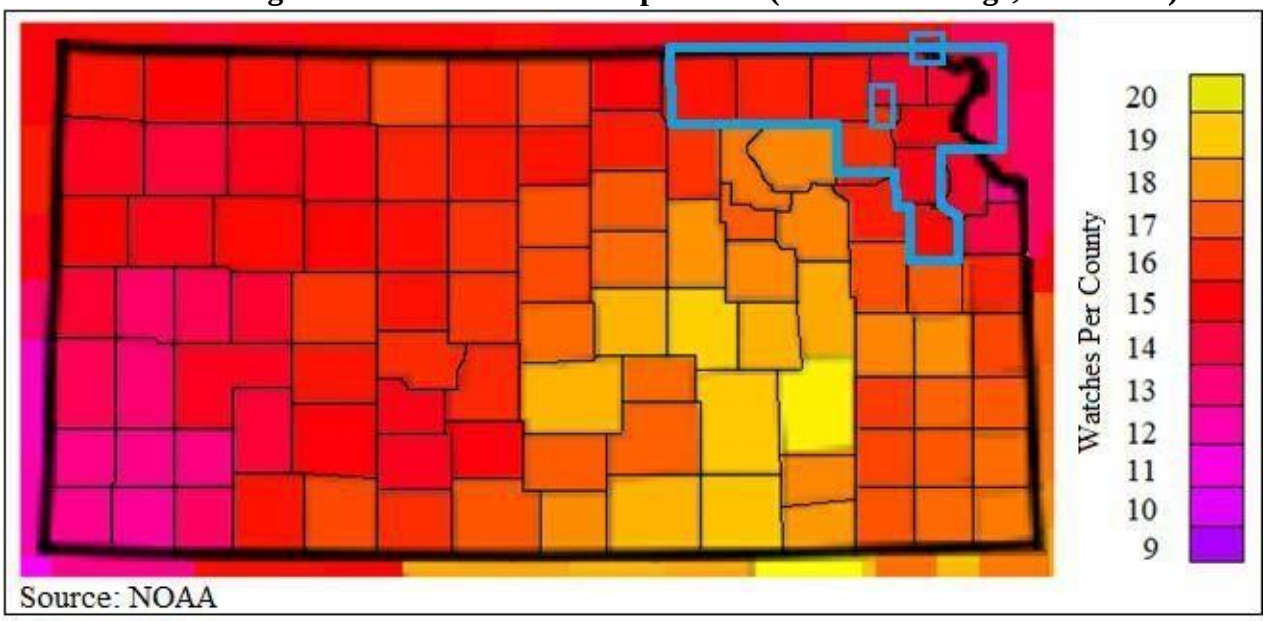
Lightning is a discharge of atmospheric electricity that is triggered by a buildup of differing charges within a cloud. According to the NWS, lightning is one of the most underrated severe weather hazards and is the second deadliest weather killer in the United States.

### 4.17.1 – Location and Extent

Lightning occurs over broad geographic regions. The entire Kansas Region K planning area, including all participating jurisdictions, is at risk to lightning.

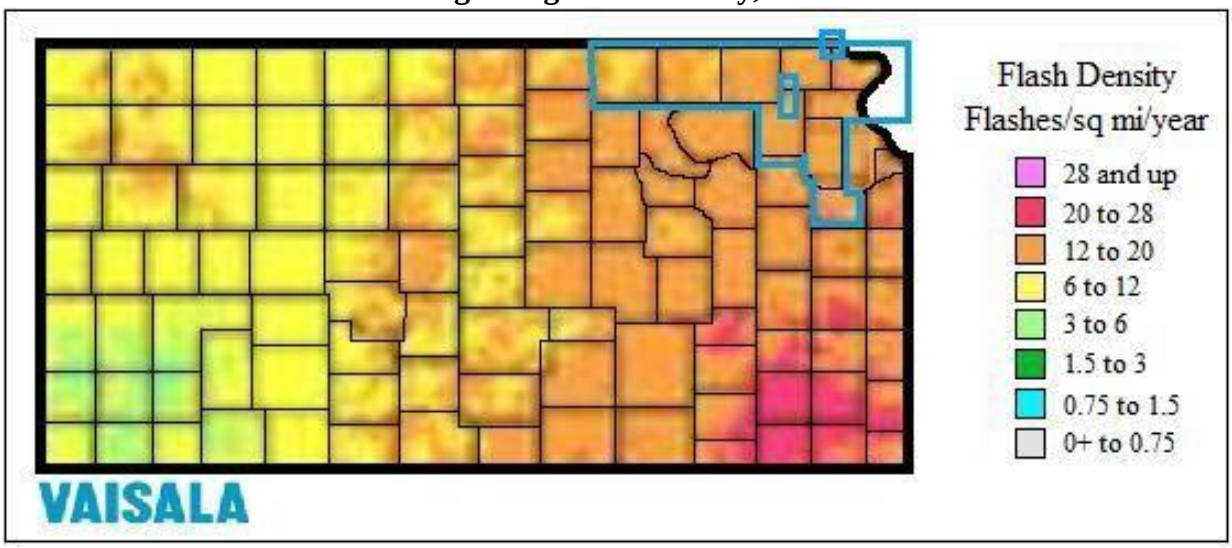
Thunderstorms are often the generator of lightning. The following map, generated by NOAA, indicates the average number severe thunderstorm watches per year for Kansas Region K.

**Annual Average Thunderstorm Watches per Year (20-Year Average, 1993-2012)**




The following map, generated by Vaisala, indicates the average number of lightning flashes per square mile per year for Kansas Region K. In general, the more recorded flashes the greater the potential for lightning strikes.

**Vaisala Lightning Flash Density, 2008-2017**




## 4.17.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been 11 Presidential Disaster Declarations for Kansas Region K for severe storms (along with other associates hazard event), of which lightning may be a component. The following 20-year information (with 1999 and 2018 being full data years) on past declared disasters is presented to provide a historical perspective on hail events that have impacted Kansas Region K. Declaration numbers in bold indication declared disaster that have occurred since the previous mitigation plan update in 2014.

**Table 4.128: Kansas Region K FEMA Severe Storm Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| **4230** | 07/20/2015 (05/04/2015 – 06/21/2015) | **Severe Storms**, Tornados, Straight-Line Winds, and Flooding | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, McPherson, Nemaha, Neosho, and Washington. | $13,848,325 |
| 4150 | 10/22/2013 (07/22/2013 – 08/15/2013) | **Severe Storms**, Straight-Line Winds, Tornados, and Flooding | Washington | $11,412,827 |
| 4010 | 07/29/2011 (5/19-6/4/2011) | **Severe Storms**, Straight-Line Winds, Tornados and Flooding | Washington | $8,259,620 |
| 1932 | 08/10/2010 (6/7-7/21/2010) | **Severe Storms**, Flooding and Tornados | Atchison, Brown, Doniphan, Jackson, Marshall and Washington | $9,279,257 |
| 1849 | 06/25/2009 (4/25-5/16/2009) | **Severe Storms**, Flooding, Straight-Line Winds, and Tornados | Marshall | $15,013,488 |
| 1776 | 07/09/2008 | **Severe Storms**, Flooding, and Tornados | Brown and Jackson | $70,629,544 |
| 1699 | 5/6/2007 (5/4/2007) | **Severe Storms**, Tornados, and Flooding | Brown, Doniphan, Douglas, Jackson, Marshall, Nemaha and Washington | $117,565,269 |

**Table 4.128: Kansas Region K FEMA Severe Storm Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| 1638 | 4/14/2006 (3/12-13/2006) | **Severe Storms**, Tornados, and Straight-Line Winds | Douglas | $6,233,044 |
| 1615 | 11/21/2005 (10/1-2/2005) | **Severe Storms** and Flooding | Atchison, Jackson and Jefferson | $10,286,064 |
| 1562 | 09/30/2004 (8/27-30/2004) | **Severe Storms**, Flooding, and Tornados | Douglas | $2,103,376 |
| 1462 | 5/6/2003 (5/4-30/2003) | **Severe Storms**, Tornados, and Flooding | Douglas | $988,056 |

Source: FEMA -:
Data unavailable

The following provides details of the two Presidential Disaster Declarations for Kansas Region K since the last plan update in 2014.

**Kansas – Severe Storms, Tornados, Straight-Line Winds, and Flooding FEMA-4230-DR**
Declared July 20, 2015

On July 1, 2015, Governor Sam Brownback requested a major disaster declaration due to severe storms, tornados, straight-line winds, and flooding during the period of May 4 to June 21, 2015.

The Governor requested a declaration for Public Assistance, including direct federal assistance for 42 counties and Hazard Mitigation statewide. During the period of May 4 to June 27, 2015, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.

On July 20, 2015, President Obama declared that a major disaster exists in the State of Kansas. This declaration made Public Assistance requested by the Governor available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms, tornados, straight-line winds, and flooding in Atchison, Barton, Brown, Atchison, Chase, Chautauqua, Cherokee, Cheyenne, Clay, Cloud, Coffey, Brown, Doniphan, Edwards, Elk, Ellsworth, Franklin, Gray, Greenwood, Doniphan, Haskell, Hodgeman, Jackson, Jefferson, Jewell, Lyon, Marshall, Marshall, Jefferson, Meade, Miami, Morris, Nemaha, Neosho, Osage, Pottawatomie, Republic, Washington, Stevens, Sumner, Wabaunsee, and Washington Counties. Direct Federal assistance was also authorized. Finally, this declaration made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.

In addition to the above reported events, the following table presents NOAA NCEI identified lightning events and the resulting damage totals in Kansas Region K from the period 2009 - 2018.

**Table 4.129: Kansas Region K NCEI Lightning Events, 2009 - 2018**

| County | Number of Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|
| Atchison | 0 | $0 | 0 | 0 |
| Brown | 0 | $0 | 0 | 0 |
| Doniphan | 0 | $0 | 0 | 0 |
| Douglas | 0 | $0 | 0 | 0 |
| Jackson | 0 | $0 | 0 | 0 |
| Jefferson | 1 | $0 | 1 | 1 |
| Marshall | 0 | $0 | 0 | 0 |
| Nemaha | 0 | $0 | 0 | 0 |
| Washington | 0 | $0 | 0 | 0 |

Source: NOAA NCEI

The following local events were reported.

- **April 25, 2009: Jefferson County**

  A group of seven motorcyclists riding together as members of the group Bikers Against Child Abuse were struck by lightning just before 5pm on the 25th. One biker was killed by the strike, and the rider next to him was injured and taken to the hospital but released later that evening. The other 5 were not injured.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of lightning on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates no related claims.

**Table 4.130: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Lightning**

| County | USDA Crop Loss | Acres Impacted | Number of Claims |
|---|---|---|---|
| Atchison | $0 | 0 | 0 |
| Brown | $0 | 0 | 0 |
| Doniphan | $0 | 0 | 0 |
| Douglas | $0 | 0 | 0 |
| Jackson | $0 | 0 | 0 |
| Marshall | $0 | 0 | 0 |
| Jefferson | $0 | 0 | 0 |
| Nemaha | $0 | 0 | 0 |
| Washington | $0 | 0 | 0 |

Source: USDA

## 4.17.3 – Hazard Probability Analysis

Data from the NCEI indicates that Region K counties can expect on a yearly basis, relevant to lightning events:

- One events
- <1 death
- <1 injury

- $0 in property damages

According to the USDA Risk Management Agency, Region K counties can expect on a yearly basis, relevant to lightning occurrences:

- No claims
- No impacted acres
- $0 in damages

In addition, Kansas Region K has had 11 Presidentially Declared Disasters relating to severe storms (of which lightning is a potential component) in the last 20 years. This represents an average of one declared severe storm disaster per year.

## 4.17.4 – Vulnerability Analysis

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county incurring damage over the period 2009

to 2018 from lightning events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. Building valuations are provided, if available, for each tribal reservation as a reference against county valuations and percentage damage. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.

.

**Table 4.131: Kansas Region K Structural Vulnerability Data for Lightning, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $2,077,340,000 | $0 | 0.0% |
| Brown | $1,135,773,000 | $0 | 0.0% |
| Doniphan | $953,610,000 | $0 | 0.0% |
| Douglas | $12,489,840,000 | $0 | 0.0% |
| Iowa Tribal Reservation* | $7,712,800 | - | - |
| Jackson | $1,477,185,000 | $0 | 0.0% |
| Jefferson | $2,239,834,000 | $0 | 0.0% |
| Kickapoo Tribal Reservation* | $6,000,000 | - | - |
| Marshall | $1,231,049,000 | $0 | 0.0% |
| Nemaha | $1,282,096,000 | $0 | 0.0% |
| Washington | $650,841,000 | $0 | 0.0% |

Source: NCEI, HAZUS and Tribal data
-: Data unavailable

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.132: Kansas Region K Population Vulnerability Data for Lightning**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

In addition, lightning may exacerbate agricultural and economic losses. The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data (2014 –

2018) allows us to quantify the monetary impact of lightning strikes on the agricultural sector. In general, the higher the percentage loss, the higher the vulnerability the county has to lightning events.

**Table 4.133: Lightning Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 0 | 0.0% | $66,913,000 | $0 | 0.0% |
| Brown | 258,601 | 0 | 0.0% | $112,057,000 | $0 | 0.0% |
| Doniphan | 144,927 | 0 | 0.0% | $76,581,000 | $0 | 0.0% |
| Douglas | 159,261 | 0 | 0.0% | $65,867,000 | $0 | 0.0% |
| Jackson | 168,682 | 0 | 0.0% | $40,215,000 | $0 | 0.0% |
| Jefferson | 153,276 | 0 | 0.0% | $44,922,000 | $0 | 0.0% |
| Marshall | 361,473 | 0 | 0.0% | $92,882,000 | $0 | 0.0% |
| Nemaha | 268,088 | 0 | 0.0% | $76,127,000 | $0 | 0.0% |
| Washington | 336,673 | 0 | 0.0% | $87,087,000 | $0 | 0.0% |

Source: USDA

## 4.17.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.134: Lightning Consequence Analysis**

| Subject | Impacts of Lightning |
|---|---|
| Health and Safety of the Public | Severity and location dependent. Impacts on persons in the areas of lightning are expected to be severe if caught without proper shelter. |
| Health and Safety of Responders | Impacts will be predicated on the severity of the event. Damaged infrastructure will likely result in hazards such as downed utility lines, main breakages and debris on roadways. |
| Continuity of Operations | Temporary relocation may be necessary if government facilities experience damage. Services may be limited to essential tasks if utilities are impacted. |
| Property, Facilities, and Infrastructure | Impact to property, facilities, and infrastructure could be minimal to severe, depending on the location and structural capacity of the facility. Loss of utility infrastructure could occur. Utility lines, residential and business properties will be affected. |
| Environment | 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 | Impacts to the economy will be dependent severity of the event and the impact on structures and infrastructure. Impacts could be severe if utilities are affected. |
| Public Confidence in the Jurisdiction's Governance | 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. |

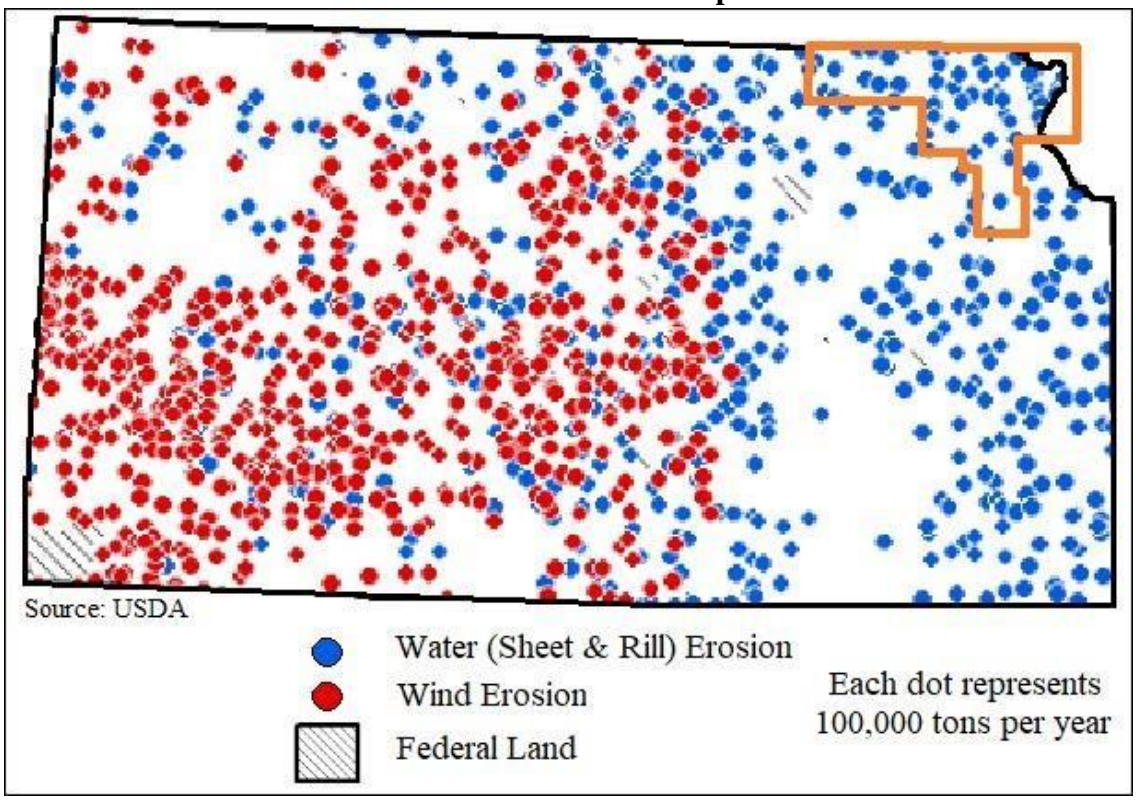
## 4.18 – Soil Erosion and Dust

Soil erosion, in general, is a process that removes topsoil through the application of water, wind, or farming activities. Soil erosion can be a slow, unobserved process or can happen quickly due to extreme environmental factors. The United States is losing soil 10 times faster than the natural replenishment rate, and related production losses cost the country about $44,000,000,000 each year. On average, wind erosion is responsible for about 40% of this loss and can increase markedly in drought years.


### 4.18.1 – Location and Extent

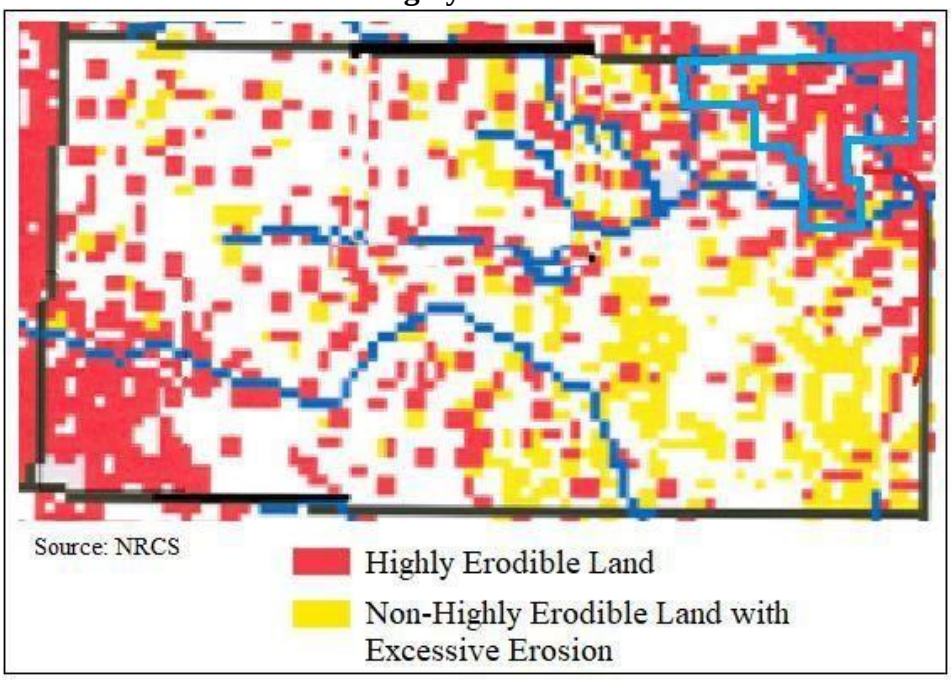
Soil erosion and dust occurs over broad geographic regions. The entire Kansas Region K planning area, including all participating jurisdictions, is at risk to soil erosion and dust.

**Wind and Water Erosion on Cropland 2012**




The following figure, from the Natural Resources Conservation Service (NRCS) shows areas of excessive erosion of farmland in Kansas. 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.

**NRCS Highly Erodible Land**




## 4.18.2 – Previous Occurrences

At present there is no centralized and complete database containing historical records for soil erosion in Kansas. For Kansas Region K there have been no reported or recorded soil erosion or dust events impacting either participating jurisdictions or the region in the past 10 years.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of soil erosion and dust on the Region's agricultural base. Crop loss data for the years 2009 - 2018, for the region, indicates no related claims

## 4.18.3 – Hazard Probability Analysis

Predicting future erosion amounts is problematic as much relies on farm management practices, available moisture and crop type. Due to the on-going nature of this hazard, and the small agricultural base for the region, it is expected that future events causing minimally measurable impact to the regions crops and farmers will continue occur. Again, the rate of occurrence and potential future occurrence will be predicated on farm management practices and drought and water conditions.

## 4.18.4 – Vulnerability Analysis

For purposes of this assessment, all counties within the region were determined to be at equal risk to soil erosion and dust events. Additionally, as this hazard disproportionately impacts the agricultural sector, only data on that sector was reviewed for potential vulnerability. Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of

soil erosion on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates no soil erosion related claims.

**Table 4.135: Soil Erosion and Dust Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 0 | 0.0% | $66,913,000 | $0 | 0.0% |
| Brown | 258,601 | 0 | 0.0% | $112,057,000 | $0 | 0.0% |
| Doniphan | 144,927 | 0 | 0.0% | $76,581,000 | $0 | 0.0% |
| Douglas | 159,261 | 0 | 0.0% | $65,867,000 | $0 | 0.0% |
| Jackson | 168,682 | 0 | 0.0% | $40,215,000 | $0 | 0.0% |
| Jefferson | 153,276 | 0 | 0.0% | $44,922,000 | $0 | 0.0% |
| Marshall | 361,473 | 0 | 0.0% | $92,882,000 | $0 | 0.0% |
| Nemaha | 268,088 | 0 | 0.0% | $76,127,000 | $0 | 0.0% |
| Washington | 336,673 | 0 | 0.0% | $87,087,000 | $0 | 0.0% |

Source: USDA

## 4.18.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.136: Soil Erosion and Dust Consequence Analysis**

| Subject | Impacts of Soil Erosion and Dust |
|---|---|
| Health and Safety of the Public | Impact tends to be agricultural; however, dust can be a danger to susceptible individuals in the form of air pollutants. |
| Health and Safety of Responders | With proper preparedness and protection, impact to the responders is expected to be minimal. |
| Continuity of Operations | Minimal expectation for utilization of the COOP. |
| Property, Facilities, and Infrastructure | 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. |
| Environment | 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 | 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 the Jurisdiction's Governance | Planning, response, and recovery may be questioned if not timely and effective. |

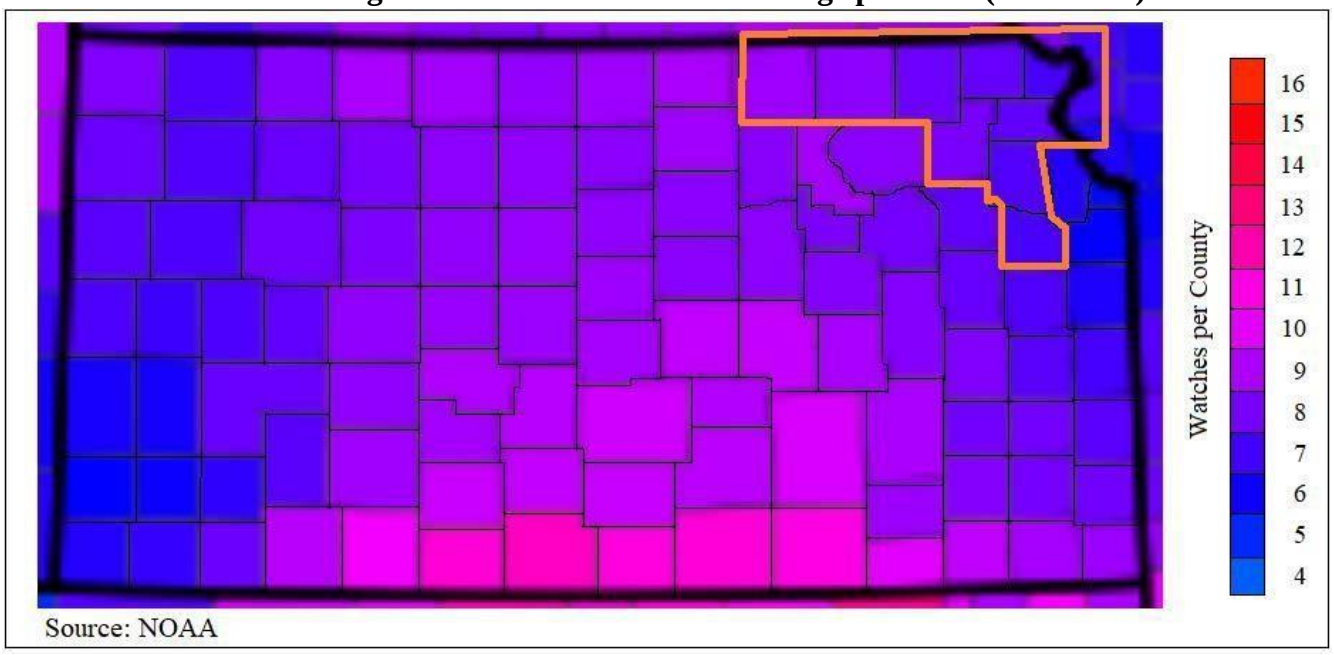
# 4.19 – Tornado

A tornado is a violently rotating column of air in contact with the ground. Often referred to as a twister or a cyclone, they can strike anywhere and with little warning. Tornados come in many shapes and sizes but are typically in the form of a visible condensation funnel, whose narrow end touches the earth and is often encircled by a cloud of debris and dust.

## 4.19.1 – Location and Extent

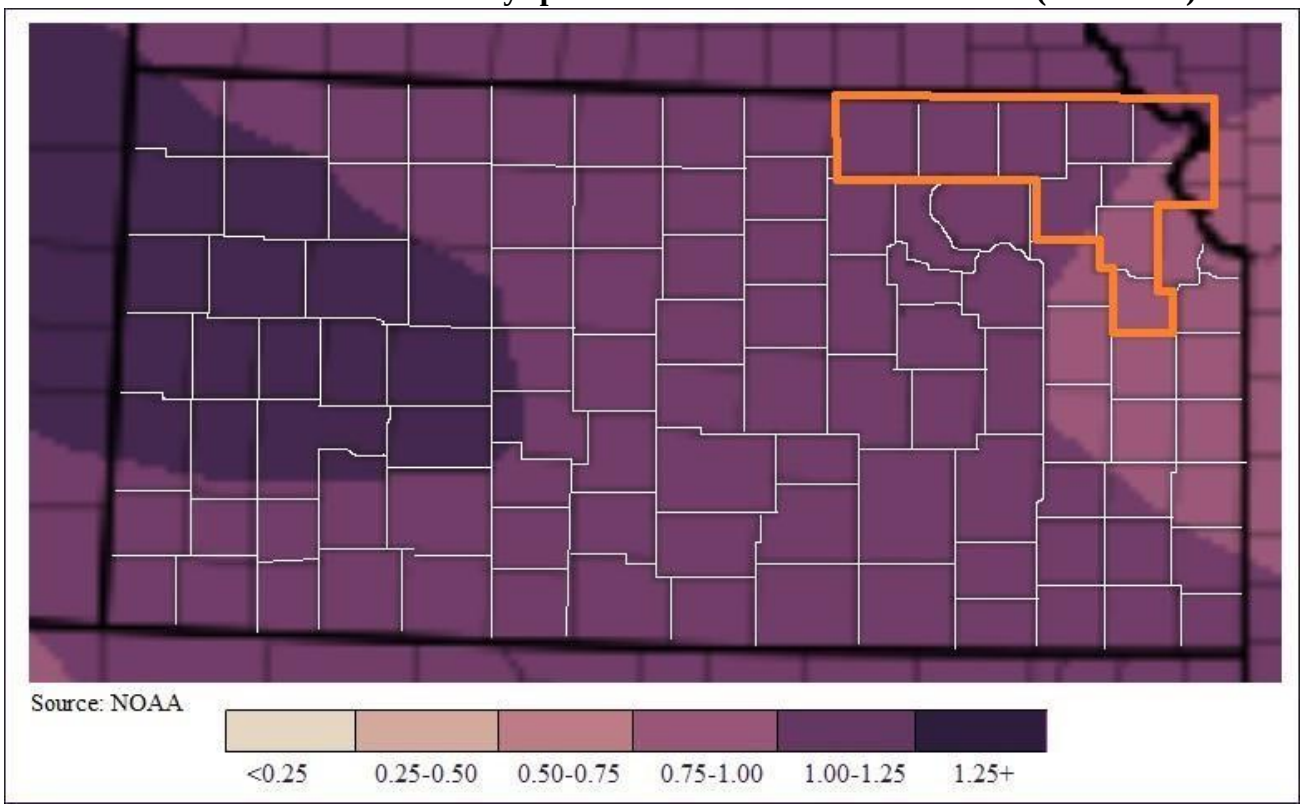
Tornados can strike anywhere in Kansas Region K, placing the entire planning area at risk. The following map, generated by NOAA, shows the average annual tornado watches per year for Kansas Region K.

**Annual Average Tornado Watches Year Average per Year (1933-2012)**




Additionally, NOAA generated the following map indicating the mean number of tornado days per year, using data compiled from the years 1986 to 2015.

**Mean Number of Tornado Days per Year Within 25 Miles of a Point (1986-2015)**




Many tornados only exist for a few seconds in the form of a touchdown. The most extreme tornados can attain wind speeds of more than 200 miles per hour, stretch more than two miles across, and travel dozens of miles.

A tornado may arrive with a squall line or cold front and touch down quickly. Smaller tornados can strike without warning. Other times tornado watches and sirens will alert communities of high potential tornado producing weather or an already formed tornado and its likely path.

Since 2007, the United States uses the Enhanced Fujita Scale to categorize tornados. The scale correlates wind speed values per F level and provides a rubric for estimating damage.

**Table 4.137: 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 tornados 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 |

**Table 4.137: Enhanced Fujita Scale**

| Scale | Wind Speed (mph) | Relative Frequency | Potential Damage |
|---|---|---|---|
| | | | 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

## 4.19.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been 10 Presidential Disaster Declarations for Kansas Region K for tornados (along with other associates hazard event), of which hail may be a component. The following 20-year information (with 1999 and 2018 being full data years) on past declared disasters is presented to provide a historical perspective on tornado events that have impacted Kansas Region K. Declaration numbers in bold indication declared disaster that have occurred since the previous mitigation plan update in 2014.

**Table 4.138: Kansas Region K FEMA Tornado Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| 4230 | 07/20/2015 (05/04/2015 – 06/21/2015) | Severe Storms, **Tornados**, Straight-Line Winds, and Flooding | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, McPherson, Nemaha, Neosho, and Washington. | $13,848,325 |
| 4150 | 10/22/2013 (07/22/2013 – 08/15/2013) | Severe Storms, Straight-Line Winds, **Tornados**, and Flooding | Washington | $11,412,827 |
| 4010 | 07/29/2011 (5/19-6/4/2011) | Severe Storms, Straight-Line Winds, **Tornados** and Flooding | Washington | $8,259,620 |
| 1932 | 08/10/2010 (6/7-7/21/2010) | Severe Storms, Flooding and **Tornados** | Atchison, Brown, Doniphan, Jackson, Marshall and Washington | $9,279,257 |
| 1849 | 06/25/2009 (4/25-5/16/2009) | Severe Storms, Flooding, Straight-Line Winds, and **Tornados** | Marshall | $15,013,488 |

| | | | | |
|---|---|---|---|---|
| 1776 | 07/09/2008 | Severe Storms, Flooding, and **Tornados** | Brown and Jackson | $70,629,544 |
| 1699 | 5/6/2007 (5/4/2007) | Severe Storms, **Tornados**, and Flooding | Brown, Doniphan, Douglas, Jackson, Marshall, Nemaha and Washington | $117,565,269 |

**Table 4.138: Kansas Region K FEMA Tornado Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| 1638 | 4/14/2006 (3/12-13/2006) | Severe Storms, **Tornados**, and Straight-Line Winds | Douglas | $6,233,044 |
| 1562 | 09/30/2004 (8/27-30/2004) | Severe Storms, Flooding, and **Tornados** | Douglas | $2,103,376 |
| 1462 | 5/6/2003 (5/4-30/2003) | Severe Storms, **Tornados**, and Flooding | Douglas | $988,056 |

Source: FEMA
-: Data unavailable

The following provides details of the single Presidential Disaster Declarations for Kansas Region K since the last plan update in 2014.

**Kansas – Severe Storms, Tornados, Straight-Line Winds, and Flooding FEMA-4230-DR**
Declared July 20, 2015

On July 1, 2015, Governor Sam Brownback requested a major disaster declaration due to severe storms, tornados, straight-line winds, and flooding during the period of May 4 to June 21, 2015. The Governor requested a declaration for Public Assistance, including direct federal assistance for 42 counties and Hazard Mitigation statewide. During the period of May 4 to June 27, 2015, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.

On July 20, 2015, President Obama declared that a major disaster exists in the State of Kansas. This declaration made Public Assistance requested by the Governor available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms, tornados, straight-line winds, and flooding in Atchison, Barton, Brown, Atchison, Chase, Chautauqua, Cherokee, Cheyenne, Clay, Cloud, Coffey, Brown, Doniphan, Edwards, Elk, Ellsworth, Franklin, Gray, Greenwood, Doniphan, Haskell, Hodgeman, Jackson, Jefferson, Jewell, Lyon, Marshall, Marshall, Jefferson, Meade, Miami, Morris, Nemaha, Neosho, Osage, Pottawatomie, Republic, Washington, Stevens, Sumner, Wabaunsee, and Washington Counties. Direct Federal assistance was also authorized. Finally, this declaration made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.

In addition to the above reported events, the following table presents NOAA NCEI identified tornado events and the resulting damage totals in Kansas Region K for the period 2009 - 2018 (with 2009 and 2018 being full data set years).

**Table 4.139: Kansas Region K NCEI Tornado Events, 2009 - 2018**

| County | Number of Days with Event | Property Damage | Deaths | Injuries | Highest Rated Tornado |
|---|---|---|---|---|---|
| Atchison | 0 | $0 | 0 | 0 | - |
| Brown | 3 | $0 | 0 | 0 | EF1 |
| Doniphan | 2 | $0 | 0 | 0 | EF0 |
| Douglas | 3 | $0 | 0 | 0 | EF1 |
| Jackson | 2 | $25,000 | 0 | 0 | EF0 |
| Jefferson | 2 | $0 | 0 | 0 | EF0 |
| Marshall | 4 | $0 | 0 | 0 | EF2 |
| Nemaha | 4 | $0 | 0 | 2 | EF3 |
| Washington | 5 | $10,000 | 0 | 0 | EF1 |

Source: NOAA NCEI

The following provides both **local accounts** and NOAA NCEI descriptions of notable recorded events:

- **June 3, 2014: Nemaha County**

  A tornado touched down around the intersection of highway 71 and 63 around 1030 pm CDT. The damage path moved southeast and included several homes that were severely damaged, and one totally destroyed. The worst damage occurred to a slab home anchored to the foundation by anchor bolts installed with nuts and washers every 12-18 inches. All exterior and interior walls were destroyed however the debris was primarily laid on top of the slab with some debris blown to the south. Two adult residents took shelter in a tub and survived with minor injuries although the tub was gone and it was suspected to have been blown into a lake to the south.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of tornados on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates no tornado related claims.

**Table 4.140: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Tornados**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 0 | 0 | $0 |
| Brown | 0 | 0 | $0 |
| Doniphan | 0 | 0 | $0 |
| Douglas | 0 | 0 | $0 |
| Jackson | 0 | 0 | $0 |
| Jefferson | 0 | 0 | $0 |
| Marshall | 0 | 0 | $0 |

| | | | |
|---|---|---|---|
| Nemaha | 4 | 610 | $27,739 |
| Washington | 0 | 0 | $0 |
| Sedgwick | 0 | 0 | $0 |

Source: USDA

### 4.19.3 – Hazard Probability Analysis

The following table summarizes tornado probability data for **Atchison County**.

**Table 4.141: Atchison County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 0 |
| Average Events per Year | 0 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | 0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Atchison County can expect on a yearly basis, relevant to tornado events:

- Two events
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes tornado probability data for **Brown County**.

**Table 4.142: Brown County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 3 |
| Average Events per Year | <1 |

| | |
|---|---|
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | 0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |

**Table 4.142: Brown County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Brown County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes Tornado probability data for **Doniphan County**.

**Table 4.143: Doniphan County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | 0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |

| | |
|---|---|
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Doniphan County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes tornado probability data for **Douglas County**.

**Table 4.144: Douglas County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 3 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Douglas County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes tornado probability data for **Jackson County**.

**Table 4.145: Jackson County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |

**Table 4.145: Jackson County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Total Reported NCEI Property Damage (2009-2018) | $25,000 |
| Average Property Damage per Year | $2,500 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Jackson County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $2,500 in property damages

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes tornado probability data for **Jefferson County**.

**Table 4.146: Jefferson County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 2 |

| | |
|---|---|
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Jefferson County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes Tornado probability data for **Marshall County**.

**Table 4.147: Marshall County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 4 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Marshall County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $0 in property damages

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes tornado probability data for **Nemaha County**.

**Table 4.148: Nemaha County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 4 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 2 |
| Average Number of Days with a Death or Injury | <1 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 4 |
| Average Number of Claims per Year | <1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 610 |
| Average Number of Acres Damaged per Year | 61 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $27,739 |
| Average Crop Damage per Year | $2,774 |

Source: NCEI and USDA

Data from the NCEI indicates that Nemaha County can expect on a yearly basis, relevant to tornado events:

- <1 event
- <1 death or injury
- $0 in property damages

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to tornado occurrences:

- <1 insurance claim

- 61 acres impacted
- $2,774 in insurance claims

The following table summarizes tornado probability data for **Washington County**.

**Table 4.149: Washington County Tornado Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 5 |
| Average Events per Year | <1 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with a Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $10,000 |
| Average Property Damage per Year | $1,000 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: NCEI and USDA

Data from the NCEI indicates that Washington County can expect on a yearly basis, relevant to tornado events:

- <1 event
- No deaths or injuries
- $1,000 in property damages

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to tornado occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

Based on the number of NCEI reported events we derive the following probability for event occurrence in Kanas Region K:

- **Tornado Probability:** Approximately three events per year

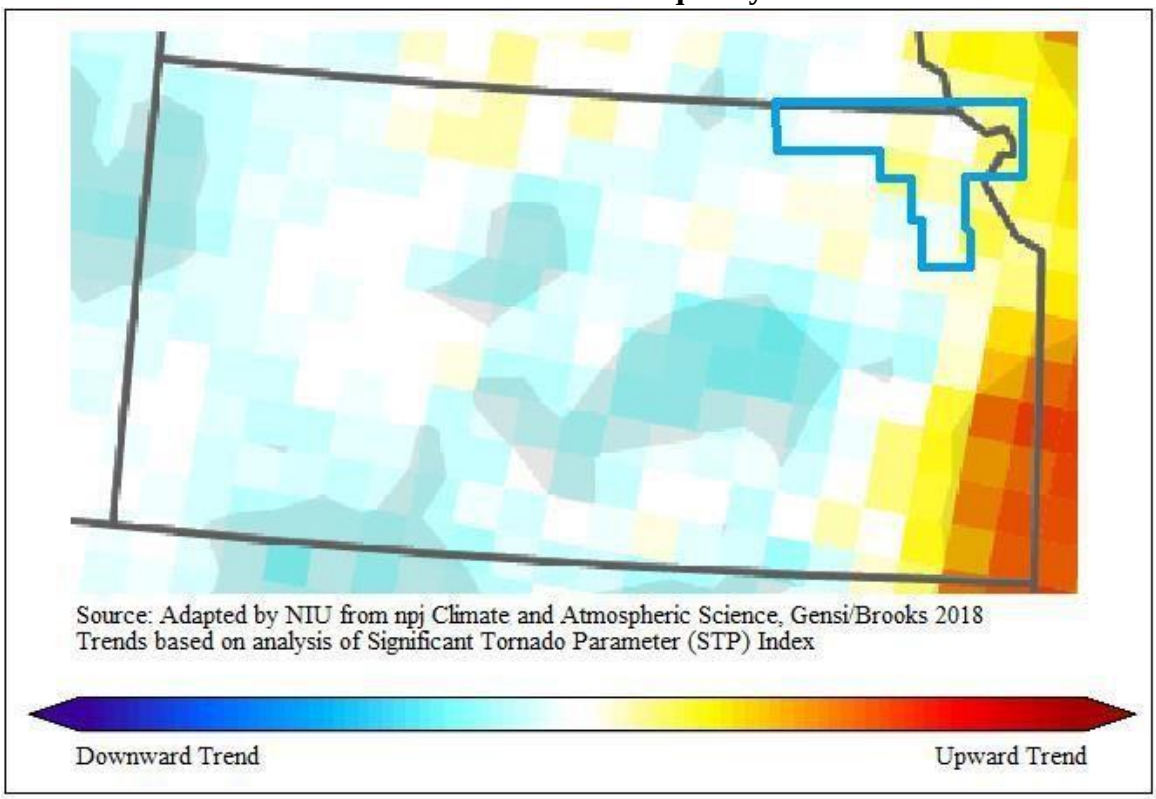
However, if events are normalized for tornados rated above an EF2, we derive the following probability for event occurrence:

- **Probability of an EF2 or greater tornado:** <1 event per year

In addition, Kansas Region K has had 10 Presidentially Declared Disasters relating to tornados (and other concurrent events such as flooding) in the last 20 years. This represents an average of one declared tornado disaster per year.

Research conducted by the National Severe Storms Lab looked at Significant Tornado Parameter (STP) to help determine future tornado probability. STP is a measurement of the major parameters of tornado conditions, including wind speed and direction, wind at differing altitudes, unstable air patterns, and humidity. The following map, generated by Northern Illinois University and compiled from STP data, indicates that Kansas Region K may see a decreasing future number of tornados.

**Tornado Environmental Frequency Trends**




## 4.19.4 – Vulnerability Analysis

For purposes of this assessment, all counties within the region were determined to be at equal risk to tornado events. Counties with a higher or increasing population, high, or increasing, or having a high structural valuation are to be considered to have a potentially greater vulnerability.

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county incurring damage over the period 2009 to 2018 from tornado events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. Building valuations are provided, if

available, for each tribal reservation as a reference against county valuations and percentage damage. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.

**Table 4.150: Kansas Region K Structural Vulnerability Data for Tornados, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $2,077,340,000 | $0 | 0.0% |
| Brown | $1,135,773,000 | $0 | 0.0% |
| Doniphan | $953,610,000 | $0 | 0.0% |
| Douglas | $12,489,840,000 | $0 | 0.0% |
| Iowa Tribal Reservation* | $7,712,800 | - | - |
| Jackson | $1,477,185,000 | $25,000 | 0.002% |
| Jefferson | $2,239,834,000 | $0 | 0.00% |

**Table 4.150: Kansas Region K Structural Vulnerability Data for Tornados, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Kickapoo Tribal Reservation | $6,000,000 | - | - |
| Marshall | $1,231,049,000 | $0 | 0.00% |
| Nemaha | $1,282,096,000 | $0 | 0.00% |
| Washington | $650,841,000 | $27,739 | 0.004% |

Source: NCEI, HAZUS and Tribal data
-: Data unavailable

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.151: Kansas Region K Population Vulnerability Data for Tornados**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data allows us to quantify the monetary impact of tornados on the agricultural sector. In general, the higher the percentage loss, the higher the vulnerability the county has to tornado events.

**Table 4.152: Tornado Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 0 | 0.00% | $66,913,000 | $0 | 0.00% |
| Brown | 258,601 | 0 | 0.00% | $112,057,000 | $0 | 0.00% |
| Doniphan | 144,927 | 0 | 0.00% | $76,581,000 | $0 | 0.00% |
| Douglas | 159,261 | 0 | 0.00% | $65,867,000 | $0 | 0.00% |
| Jackson | 168,682 | 0 | 0.00% | $40,215,000 | $0 | 0.00% |
| Jefferson | 153,276 | 0 | 0.00% | $44,922,000 | $0 | 0.00% |
| Marshall | 361,473 | 0 | 0.00% | $92,882,000 | $0 | 0.00% |
| Nemaha | 268,088 | 61 | 0.02% | $76,127,000 | $2,774 | 0.00% |

**Table 4.152: Tornado Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Washington | 336,673 | 0 | 0.00% | $87,087,000 | $0 | 0.00% |

Source: USDA

Between 2001 and 2010 51% of those killed by tornados were living in mobile homes, according to the NOAA. A 2012 “Kansas Severe Weather Awareness Week” report indicates that people living in mobile homes are killed by tornados at a rate 20 times higher than people living in permanent homes. Additionally, a new study from Michigan State University reported that the two biggest factors related to tornado fatalities were housing quality (measured by mobile homes as a proportion of housing units) and income level. When a tornado strikes, a county with double the number of mobile homes as a proportion of all homes will experience 62% more fatalities than a county with fewer mobile homes, according to the study data.

The following participating jurisdictions may have increased vulnerability to tornado events due to having greater than 20% of housing stock as mobile homes:

- **Huron** (Atchison County)
- **Elwood** (Doniphan County)
- **Lecompton** (Douglas County)
- **Soldier** (Jackson County)
- **Wetmore** (Nemaha County)

## 4.19.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.153: Tornado Consequence Analysis**

| Subject | Impacts of Tornado |
|---|---|
| Health and Safety of the Public | 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. |
| Health and Safety of Responders | Impact to responders is expected to be minimal unless responders live within the affected area. |
| Continuity of Operations | Temporary to permanent relocation may be necessary if government facilities experience damage. |
| Property, Facilities, and Infrastructure | Localized impact could be severe in the trajectory path. Roads, buildings, and communications could be adversely affected. Damage could be severe. |
| Environment | Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area. |
| Economic Conditions | Impacts to the economy will greatly depend on the trajectory of the tornado. If a jurisdiction takes a direct hit then the economic conditions will be severe. With an indirect hit the impact could be low to severe. |

**Table 4.153: Tornado Consequence Analysis**

| Subject | Impacts of Tornado |
|---|---|
| Public Confidence in the Jurisdiction's Governance | Response and recovery will be in question if not timely and effective. Warning systems and warning time will also be questioned. |

# 4.20 – Wildfire

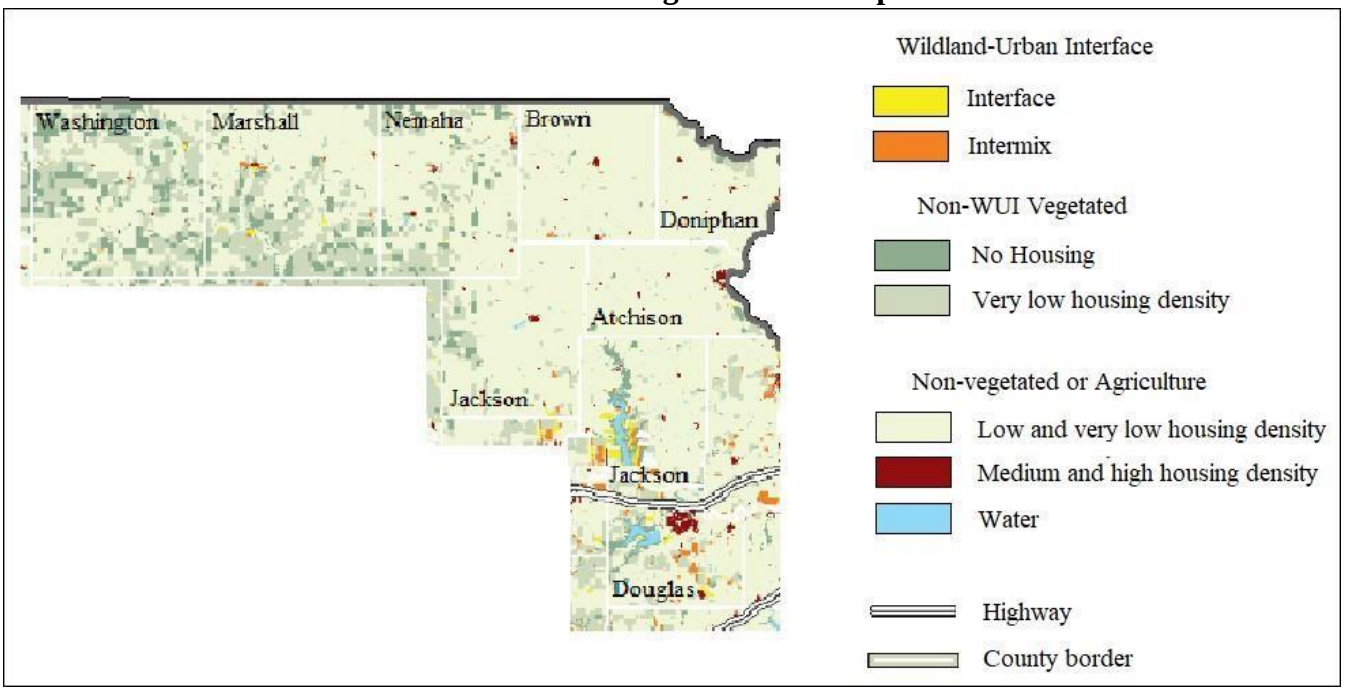
The NWS defines a wildfire as any free burning uncontainable wildland fire not prescribed for the area which consumes the natural fuels and spreads in response to its environment. They can occur naturally, by human accident, and on rare occasions by human action. Population de-concentration in the U.S. has resulted in rapid development in the outlying fringe of metropolitan areas and in rural areas with attractive recreational and aesthetic amenities, especially forests. This expansion has increased the likelihood that wildfires will threaten life and property.

## 4.20.1 – Location and Extent

Wildfires in Kansas Region K typically originate in pasture or prairie areas following the ignition of dry grasses (by natural or human sources). According to the 2011 Kansas Forest Action Plan, with the exception of Eastern Redcedar, most forest types in Kansas do not pose significant fire management issues. However, grasslands, which make up a majority of the open areas in Kansas Region K, do pose fire management issues due to the expansion of the Wildland Urban Interface (WUI) in recent decades.

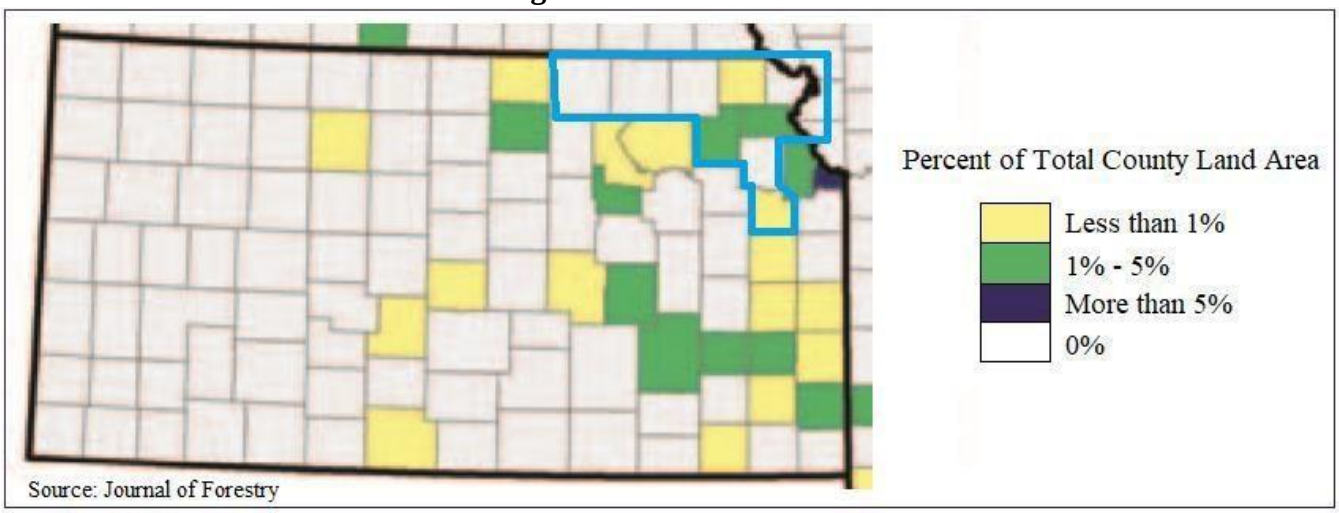
The WUI creates an environment in which fire can move readily between structural and vegetation fuels. Two types of WUI are mapped: intermixed and interface. Intermix WUI are areas where housing and vegetation intermingle; interface WUI are areas with housing in the vicinity of dense, contiguous wildland vegetation. The following maps detail WUI areas and information for Kansas Region K.

**SILVIS Labs Regional WUI Map**




The Eastern Redcedar is of concern to Kansas Region K. This invasive evergreen species can take over fence rows and un-planted fields, adding to wildfire fuel and risk. The following 2012 map, from the Journal of Forestry, indicates the percent of the total regional acreage impacted by Eastern Redcedar.

**Percent of Total Regional Land Area of Eastern Redcedar**




## 4.20.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been no Presidential Disaster Declarations or Fire Management Assistance Declarations for Kansas Region K for wildfires.

The Office of the State of Kansas Fire Marshall's Office (KSFM) was contacted concerning the size and origin of reported wildfires for the region. The following table lists all recorded wildfires, by county, for the six-year period 2013-2018 (currently available data, with 2013 and 2018 being full data set years).

**Table 4.154: Kansas Region K State Fire Marshall Recorded Wildfire Events, 2013-2018**

| County | Number of Reported Fires | Deaths | Injuries | Buildings Burned | Burned Acres |
|---|---|---|---|---|---|
| Atchison | 72 | 0 | 0 | 0 | 1,775 |
| Brown | 72 | 0 | 0 | 0 | 1,775 |
| Doniphan | 25 | 0 | 0 | 0 | 1,585 |
| Douglas | 155 | 0 | 4 | 2 | 6,228 |
| Jackson | 182 | 0 | 5 | 0 | 10,262 |
| Jefferson | 134 | 0 | 0 | 0 | 4,442 |
| Marshall | 108 | 0 | 0 | 0 | 6,826 |
| Nemaha | 96 | 0 | 0 | 0 | 6,811 |
| Washington | 27 | 0 | 0 | 0 | 1,405 |

Source: KSFM

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of wildfires on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates nine wildfire related claims on 126 acres for $7,490.

**Table 4.155: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Wildfires**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 0 | 0 | $0 |
| Brown | 0 | 0 | $0 |
| Doniphan | 0 | 0 | $0 |
| Douglas | 0 | 0 | $0 |
| Jackson | 0 | 0 | $0 |
| Marshall | 0 | 0 | $0 |
| Jefferson | 0 | 0 | $0 |
| Nemaha | 0 | 0 | $0 |
| Washington | 0 | 0 | $0 |

Source: USDA

## 4.20.3 – Hazard Probability Analysis

The following table summarizes wildfire probability data for **Atchison County**.

**Table 4.156: Atchison County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 72 |

| | |
|---|---|
| Average Events per Year | 12 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |

**Table 4.156: Atchison County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 1,775 |
| Average Burned Acres per Year | 296 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Atchison County can expect on a yearly basis, relevant to wildfire events:

- Four events
- No death or injuries
- No buildings burned
- 101 acres burned

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Brown County**.

**Table 4.157: Brown County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 72 |
| Average Events per Year | 12 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 1,775 |

| | |
|---|---|
| Average Burned Acres per Year | 296 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |

**Table 4.157: Brown County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Brown County can expect on a yearly basis, relevant to wildfire events:

- 12 events
- No death or injuries
- No buildings burned  296 acres burned

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Doniphan County**.

**Table 4.158: Doniphan County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 25 |
| Average Events per Year | 4 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 1,585 |
| Average Burned Acres per Year | 264 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Doniphan County can expect on a yearly basis, relevant to wildfire events:

- Four events
- No deaths or injuries
- No buildings burned
- 264 acres burned

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Douglas County**.

**Table 4.159: Douglas County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 155 |
| Average Events per Year | 26 |
| Number Deaths or Injuries (2009-2018) | 4 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 1 |
| Total Reported Burned Buildings (2009-2018) | 2 |
| Average Burned Buildings per Year | <1 |
| Total Reported Burned Acres (2009-2018) | 6,228 |
| Average Burned Acres per Year | 1,038 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Douglas County can expect on a yearly basis, relevant to wildfire events:

- 26 events
- One death or injury
- <1 building burned
- 1,038 acres burned

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Jackson County**.

**Table 4.160: Jackson County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 182 |
| Average Events per Year | 30 |
| Number Deaths or Injuries (2009-2018) | 5 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 1 |
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 10,262 |
| Average Burned Acres per Year | 1,710 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Jackson County can expect on a yearly basis, relevant to wildfire events:

- 30 events
- One death or injury
- No buildings burned
- 1,710 acres burned

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Jefferson County**.

**Table 4.161: Jefferson County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 134 |
| Average Events per Year | 22 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 4,442 |
| Average Burned Acres per Year | 740 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |

**Table 4.161: Jefferson County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Jefferson County can expect on a yearly basis, relevant to wildfire events:

- 22 events
- No deaths or injuries
- No buildings burned
- 740 acres burned

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Marshall County**.

**Table 4.162: Marshall County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 108 |
| Average Events per Year | 18 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported Burned Buildings (2009-2018) | 0 |

| | |
|---|---|
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 6,826 |
| Average Burned Acres per Year | 1,138 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Marshall County can expect on a yearly basis, relevant to wildfire events:

- 18 events
- No death or injuries

- No buildings burned
- 1,138 acres burned

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Nemaha County**.

**Table 4.163: Nemaha County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 96 |
| Average Events per Year | 16 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 6,811 |
| Average Burned Acres per Year | 1,135 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |

| | |
|---|---|
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Nemaha County can expect on a yearly basis, relevant to wildfire events:

- 16 events
- No death or injuries
- No buildings burned
- 1,135 acres burned

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

The following table summarizes wildfire probability data for **Washington County**.

**Table 4.164: Washington County Wildfire Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of KSFM Reported Events (2009-2018) | 27 |
| Average Events per Year | 5 |
| Number Deaths or Injuries (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported Burned Buildings (2009-2018) | 0 |
| Average Burned Buildings per Year | 0 |
| Total Reported Burned Acres (2009-2018) | 1,405 |
| Average Burned Acres per Year | 234 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 0 |
| Average Number of Claims per Year | 0 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 0 |
| Average Number of Acres Damaged per Year | 0 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $0 |
| Average Crop Damage per Year | $0 |

Source: KSFM and NOAA

Data from the KSFM indicates that Washington County can expect on a yearly basis, relevant to wildfire events:

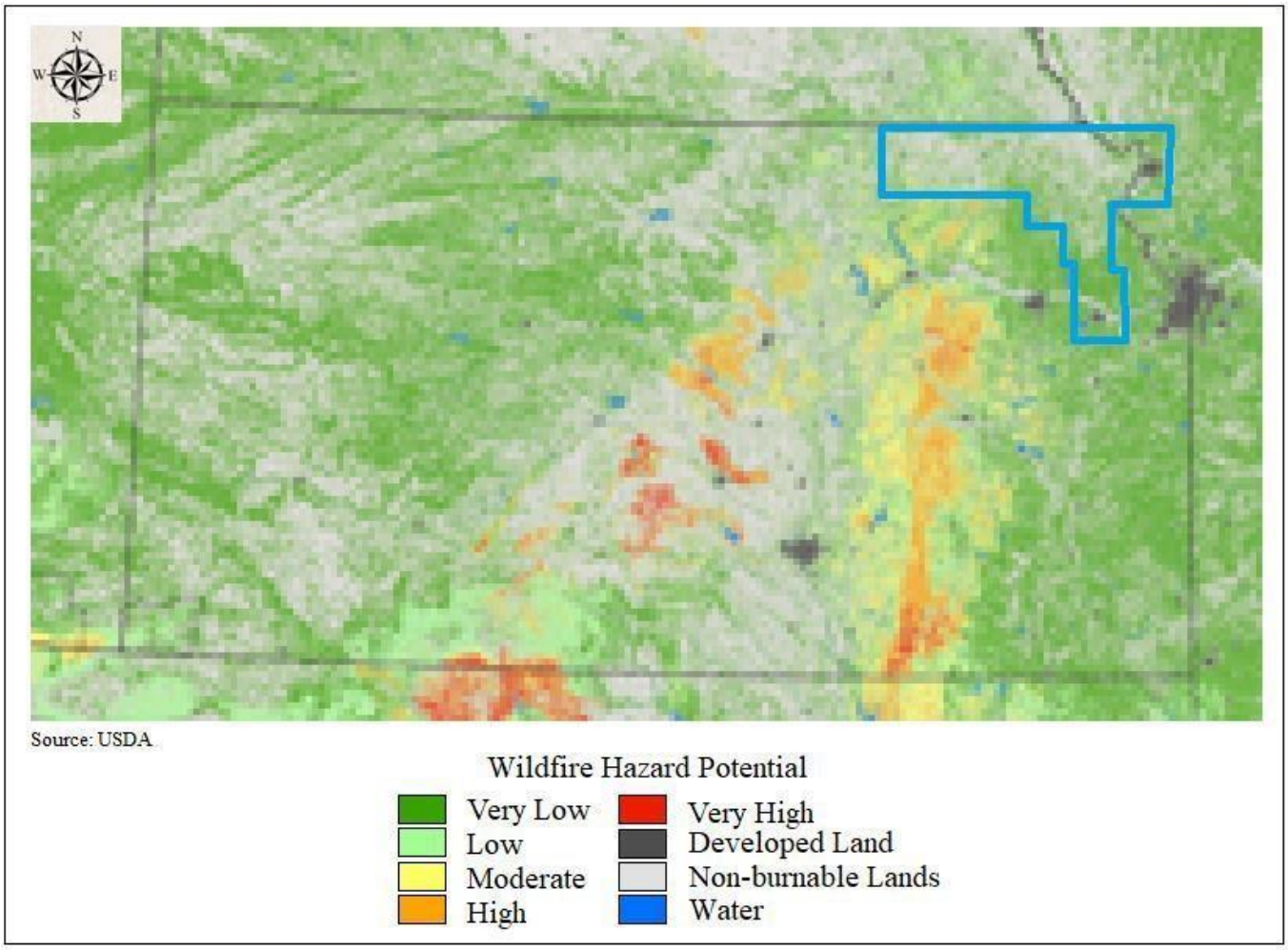
- Five events
- No deaths or injuries
- No buildings burned
- 324 acres burned

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to wildfire occurrences:

- No insurance claims
- No acres impacted
- $0 in insurance claims

Mapping created by the USDA in 2018 indicates the Wildfire Hazard Potential for the United States. In general, the map indicates that Kansas Region K is the low and moderate/high potential class.

**USDA Wildfire Potential Map**




## 4.20.4 – Vulnerability Analysis

For purposes of this assessment, all counties within the region were determined to be at equal risk to wildfire events. Counties with a higher or increasing population, high, or increasing, or having a high structural valuation are to be considered to have a potentially greater vulnerability. It is worth highlighting

the majority of Kansas Region K counties may have increased vulnerability to wildfire events due to a projected increase in the number of structures.

The following table presents data from HAZUS and KSFM concerning the structures and the percentage of structures for each Kansas Region K county incurring damage over the six-year period of 2013 to 2018 (current available data) from wildfire events. As KSFM did not assign a value to the structures burned, an estimate of $32,000 per structure (value determined using a commercial cost calculator for an 800 square foot general purpose barn at $40 per square foot) was used as reports indicate the majority of structures burned were farm out-buildings. In general, the greater the percentage of structures damaged the greater overall vulnerability going forward.

**Table 4.165: Kansas Region K Structural Vulnerability Data for Wildfires, 2009-2018**

| County | HAZUS Building Valuation | KSFM Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $6,664,946,000 | $0 | 0.0% |
| Brown | $3,626,310,000 | $0 | 0.0% |
| Doniphan | $779,563,000 | $0 | 0.0% |
| Douglas | $3,863,763,000 | $32,000 | 0.001% |
| Jackson | $1,041,969,000 | $0 | 0.0% |
| Jefferson | $3,766,723,000 | $0 | 0.0% |
| Marshall | $1,538,178,000 | $0 | 0.0% |
| Nemaha | $7,100,181,000 | $0 | 0.0% |
| Washington | $1,198,508,000 | $0 | 0.0% |

Source: NCEI and HAZUS

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.166: Kansas Region K Population Vulnerability Data for Wildfires**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data allows us to quantify the monetary impact of wildfires on the agricultural sector. In general, the higher the percentage loss, the higher the vulnerability the county has to wildfire events.

**Table 4.167: Wildfire Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 0 | 0.0% | $66,913,000 | $0 | 0.0% |
| Brown | 258,601 | 0 | 0.0% | $112,057,000 | $0 | 0.0% |
| Doniphan | 144,927 | 0 | 0.0% | $76,581,000 | $0 | 0.0% |

**Table 4.167: Wildfire Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Douglas | 159,261 | 0 | 0.0% | $65,867,000 | $0 | 0.0% |
| Jackson | 168,682 | 0 | 0.0% | $40,215,000 | $0 | 0.0% |
| Jefferson | 153,276 | 0 | 0.0% | $44,922,000 | $0 | 0.0% |
| Marshall | 361,473 | 0 | 0.0% | $92,882,000 | $0 | 0.0% |
| Nemaha | 268,088 | 0 | 0.0% | $76,127,000 | $0 | 0.0% |
| Washington | 336,673 | 0 | 0.0% | $87,087,000 | $0 | 0.0% |

Source: USDA

Potentially lessening future vulnerability to wildfires are Community Wildfire Protection Plans (CWPPs). A CWPP is the most effective way to take advantage of various Federal programs to include the Healthy Forests Restoration Act. By having a CWPP, communities are given priority for funding of Healthy Forests Restoration Act hazardous fuels reduction projects. The three main components of a CWPP are:

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

Currently the following Kansas Region K counties have approved CWPPs.

- Douglas County

## 4.20.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.168: Wildfire Consequence Analysis**

| Subject | Impacts of Wildfire |
|---|---|
| Health and Safety of the Public | Impact could be severe for people living and working in the immediate area. Surrounding communities may also be impacted by evacuees. |
| Health and Safety of Responders | Impact to responders could be severe depending on the size and scope of the fire, especially for firefighters. Impact will be low to moderate for support responders with the main threat as smoke inhalation. |
| Continuity of Operations | Temporary relocation may be necessary if government facilities experience damage. |
| Property, Facilities, and Infrastructure | Delivery of services could be affected if there is any disruption to the roads and/or utilities due to damages sustained. |
| Environment | Impact will be severe for the immediate area with regards to trees, bushes, animals, and crops. Impact will lessen as distance increases. |
| Economic Conditions | Impacts to the economy could be moderate in the immediate area. |
| Public Confidence in the Jurisdiction's Governance | Response and recovery will be in question if not timely and effective. Evacuation orders and shelter availability could be called in to question. |

## 4.21 – Windstorm

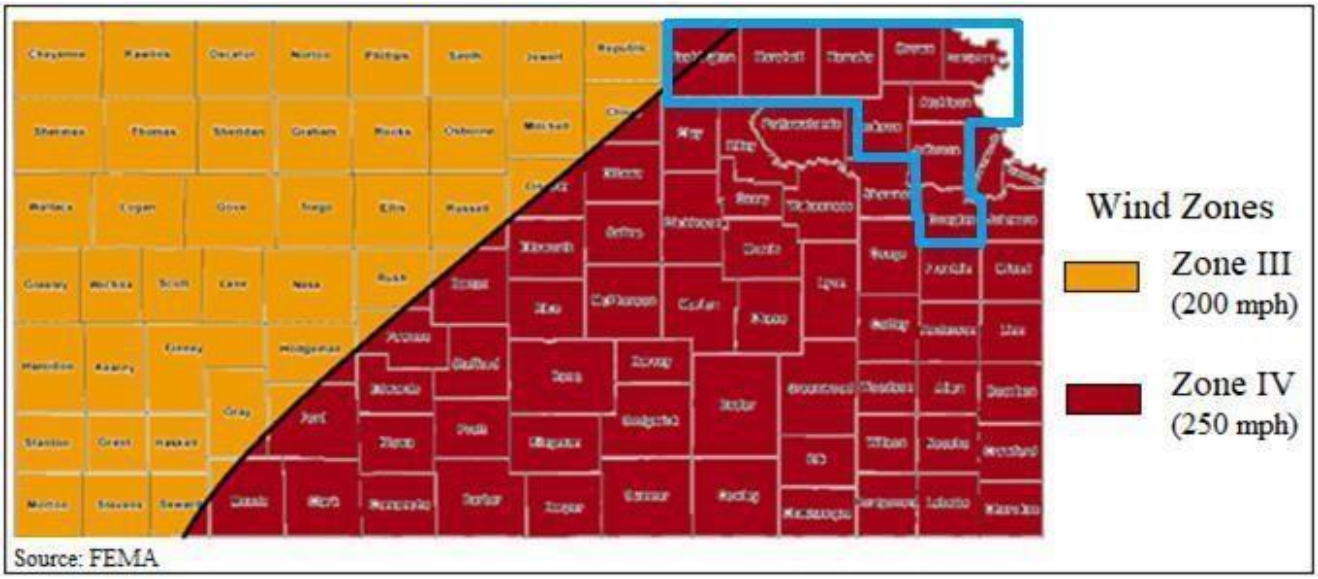
Straight-line winds are generally any thunderstorm wind that is not associated with rotation. It is these winds, which can exceed 100 mph that represent the most common type of severe weather and are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornados, the associated wind damage can be extensive and affect entire counties or regions. 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.

### 4.21.1 – Location and Extent

High winds occur over broad geographic regions. The entire Kansas Region K planning area, including all participating jurisdictions, is at risk to high wind events.

The following figure shows the wind zones of the United States based on maximum wind speeds. Kansas Region K is located within wind zone IV, the highest inland category.

Wind Zones in the Unites States



Source: FEMA

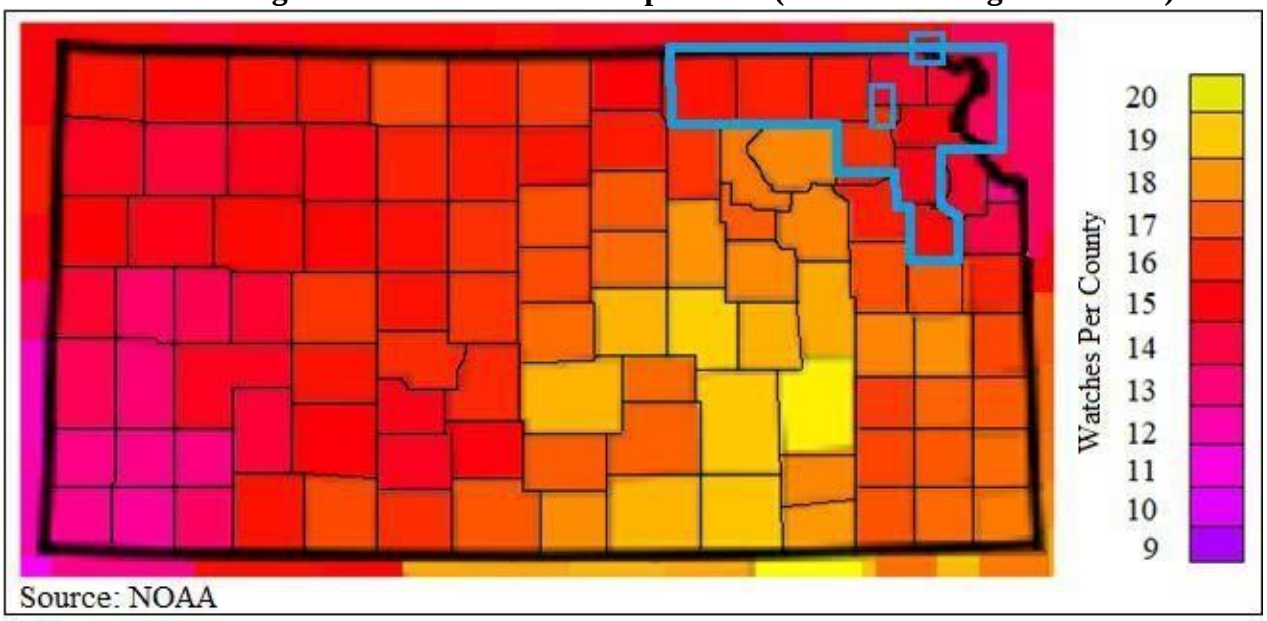
Severe thunderstorms strike Kansas Region K regularly, with accompanying high wind that can cause injury, death, and property damage. The widespread and frequent nature of thunderstorms makes high wind a relatively common occurrence. The NWS classifies thunderstorms, often the generator of high winds, using the following categories.

- **Marginal:** Isolated severe thunderstorms, limited in duration and/or coverage and/or intensity
- **Slight:** Scattered severe storms possible, Short-lived and/or not widespread, isolated intense storms possible

- **Enhanced:** Numerous severe storms possible, more persistent and/or widespread, a few intense
- **Moderate:** Widespread severe storms likely, long-lived, widespread and intense
- **High:** Widespread severe storms expected, long-lived, very widespread and particularly intense

The following map, generated by NOAA, indicates the average number severe thunderstorm watches per year for Kansas Region K.

**Annual Average Thunderstorm Watches per Year (20-Year Average 1993-2012)**




To measure wind speed and its correlating potential for damage, experts use the Beaufort scale as shown below.

**Table 4.169: Beaufort Scale**

| Beaufort Number | Wind Speed (mph) | Effects on Land |
|---|---|---|
| 0 | Under 1 | Calm, smoke rises vertically |
| 1 | 1-3 | Smoke drift indicates wind direction, vanes do not move |
| 2 | 4-7 | Wind felt on face, leaves rustle, vanes begin to move |
| 3 | 8-12 | Leaves, small twigs in constant motion. Light flags extended. |
| 4 | 13-18 | Dust, leaves and loose paper raised up, small branches move |
| 5 | 19-24 | Small trees begin to sway |
| 6 | 25-31 | Large branches of trees in motion, whistling heard in wires |
| 7 | 32-38 | While trees in motion, resistance felt in walking against the wind |
| 8 | 39-46 | Twigs and small branches broken off trees |
| 9 | 47-54 | Slight structural damage occurs, slate blown from roofs |
| 10 | 55-63 | Seldom experienced on land, trees broken, structural damage occurs |
| 11 | 64-72 | Very rarely experienced on land, usually with widespread damage |
| 12 | 73 or higher | Violence and destruction |

## 4.21.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been five Presidential Disaster Declarations for Kansas Region K for Straight-Line Winds (along with other associates hazard events). The following 20-year information (with 1999 and 2018 being full data years) on past declared disasters is presented to provide a historical perspective on high wind events that have impacted Kansas Region K. Declaration numbers in bold indication declared disaster that have occurred since the previous mitigation plan update in 2014.

**Table 4.170: Kansas Region K FEMA Straight-Line Winds Disaster and Emergency Declarations, 1999 -2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| 4230 | 07/20/2015 (05/04/2015 – 06/21/2015) | Severe Storms, Tornados, **Straight-Line Winds**, and Flooding | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, McPherson, Nemaha, Neosho, and Washington. | $13,848,325 |
| 4150 | 10/22/2013 (07/22/2013 – 08/15/2013) | Severe Storms, **Straight-Line Winds**, Tornados, and Flooding | Washington | $11,412,827 |
| 4010 | 07/29/2011 (5/19-6/4/2011) | Severe Storms, **Straight-Line Winds**, Tornados and Flooding | Washington | $8,259,620 |
| 1849 | 06/25/2009 (4/25-5/16/2009) | Severe Storms, Flooding, **Straight-Line Winds**, and Tornados | Marshall | $15,013,488 |
| 1638 | 4/14/2006 (3/12-13/2006) | Severe Storms, Tornados, and **Straight-Line Winds** | Douglas | $6,233,044 |

Source: FEMA
-: Data unavailable

The following provides details of the two Presidential Disaster Declaration for Kansas Region K related to severe storms (and potentially lightning) since the last plan update in 2014.

**Kansas – Severe Storms, Straight-Line Winds, and Flooding FEMA-4230-DR**
Declared November 7, 2017

On August 31, 2017, Governor Sam Brownback requested a major disaster declaration due to severe storms, straight-line winds, and flooding during the period of July 22-27, 2017. The Governor requested a declaration for Public Assistance for two counties and Hazard Mitigation statewide. During the period of August 18-24, 2017, joint federal, state, and local government Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that Federal assistance is necessary.

On November 7, 2017, President Trump declared that a major disaster exists in the State of Kansas. This declaration made Public Assistance requested by the Governor available to state and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms, straight- line winds, and flooding in Johnson and Wyandotte Counties. This declaration also made Hazard Mitigation Grant Program assistance requested by the Governor available for hazard mitigation measures statewide.

In addition to the above reported events, the following table presents NOAA NCEI identified high wind events (High Wind and Thunderstorm Wind) and the resulting damage totals in Kansas Region K for the period 2009 - 2018 (with 2009 and 2018 being full data set years).

**Table 4.171: Kansas Region K NCEI High Wind Events, 2009 - 2018**

| County | Number of Days with Events | Property Damage | Deaths | Injuries | Highest Recorded Wind Speed |
|---|---|---|---|---|---|
| Atchison | 17 | $17,000 | 0 | 0 | 72 Knots |
| Brown | 20 | $20,000 | 0 | 0 | 70 Knots |
| Doniphan | 16 | $220,000 | 0 | 0 | 65 Knots |
| Douglas | 48 | $61,500 | 0 | 0 | 77 Knots |
| Jackson | 27 | $11,500 | 0 | 0 | 78 Knots |
| Jefferson | 38 | $12,000 | 0 | 0 | 78 Knots |
| Marshall | 34 | $24,500 | 0 | 0 | 70 Knots |
| Nemaha | 30 | $31,000 | 0 | 0 | 70 Knots |
| Washington | 26 | $8,000 | 0 | 0 | 70 Knots |

Source: NOAA NCEI

The following provides both **local accounts** and NOAA NCEI descriptions of notable recorded events:

- **July 18, 2012: Doniphan County**

  High winds caused several barns to be destroyed, including the historic Round Barn landmark. Thunderstorm wind gusts were estimated up to 70 mph. Property damage was recorded at $200,000.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of high on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates 12 high wind related claims on 751 acres for $48,485.

**Table 4.172: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, High Winds**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 8 | 327 | $17,534 |
| Brown | 19 | 3,101 | $356,105 |
| Doniphan | 13 | 3,956 | $1,021,071 |
| Douglas | 5 | 1,043 | $123,212 |
| Jackson | 7 | 105 | $11,874 |
| Jefferson | 2 | 451 | $22,227 |
| Marshall | 31 | 3,170 | $356,191 |

**Table 4.172: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, High Winds**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Nemaha | 15 | 2,289 | $184,314 |

| | | | |
|---|---|---|---|
| Washington | 25 | 2,954 | $475,545 |

Source: USDA

### 4.21.3 – Hazard Probability Analysis

The following table summarizes high wind probability data for **Atchison County**.

**Table 4.173: Atchison County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 17 |
| Average Events per Year | 2 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $17,000 |
| Average Property Damage per Year | $1,700 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 8 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 327 |
| Average Number of Acres Damaged per Year | 33 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $17,534 |
| Average Crop Damage per Year | $1,753 |

Source: NCEI and USDA

Data from the NCEI indicates that Atchison County can expect on a yearly basis, relevant to high wind events:

- Two events
- No deaths or injuries
- $1,700 in property damages

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to high wind occurrences:

- One insurance claim
- 33 acres impacted
- $1,753 in insurance claims

The following table summarizes high wind probability data for **Brown County**.

**Table 4.174: Brown County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 20 |
| Average Events per Year | 2 |

**Table 4.174: Brown County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $20,000 |
| Average Property Damage per Year | $2,000 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 19 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 3,101 |
| Average Number of Acres Damaged per Year | 310 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $356,105 |
| Average Crop Damage per Year | $35,610 |

Source: NCEI and USDA

Data from the NCEI indicates that Brown County can expect on a yearly basis, relevant to high wind events:

- Two events
- No deaths or injuries
- $2,000 in property damages

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to high wind occurrences:

- Two insurance claims
- 310 acres impacted
- $35,610 in insurance claims

The following table summarizes High wind probability data for **Doniphan County**.

**Table 4.175: Doniphan County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 16 |
| Average Events per Year | 2 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $220,000 |
| Average Property Damage per Year | $22,000 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 19 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 3,956 |
| Average Number of Acres Damaged per Year | 396 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,021,071 |
| Average Crop Damage per Year | $102,107 |

Source: NCEI and USDA

Data from the NCEI indicates that Doniphan County can expect on a yearly basis, relevant to high wind events:

- Two events
- No deaths or injuries
- $22,000 in property damages

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to high wind occurrences:

- Two insurance claims
- 396 acres impacted
- $102,107 in insurance claims

The following table summarizes high wind probability data for **Douglas County**.

**Table 4.176: Douglas County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 48 |
| Average Events per Year | 5 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $61,500 |
| Average Property Damage per Year | $6,150 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 5 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,043 |
| Average Number of Acres Damaged per Year | 104 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $123,212 |
| Average Crop Damage per Year | $12,321 |

Source: NCEI and USDA

Data from the NCEI indicates that Douglas County can expect on a yearly basis, relevant to high wind events:

- Five events
- No deaths or injuries
- $6,150 in property damages

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to high wind occurrences:

- One insurance claim

- 104 acres impacted
- $12,321 in insurance claims

The following table summarizes high wind probability data for **Jackson County**.

**Table 4.177: Jackson County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 27 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $11,500 |
| Average Property Damage per Year | $1,150 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 7 |
| Average Number of Claims per Year | 1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 105 |
| Average Number of Acres Damaged per Year | 10 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $11,874 |
| Average Crop Damage per Year | $1,187 |

Source: NCEI and USDA

Data from the NCEI indicates that Jackson County can expect on a yearly basis, relevant to high wind events:

- Three events
- No deaths or injuries
- $1,150 in property damages

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to high wind occurrences:

- One insurance claim
- 10 acres impacted
- $1,187 in insurance claims

The following table summarizes high wind probability data for **Jefferson County**.

**Table 4.178: Jefferson County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 38 |
| Average Events per Year | 4 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $12,000 |
| Average Property Damage per Year | $1,200 |

| | |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 2 |
| Average Number of Claims per Year | <1 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 451 |
| Average Number of Acres Damaged per Year | 45 |

**Table 4.178: Jefferson County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $22,227 |
| Average Crop Damage per Year | $2,223 |

Source: NCEI and USDA

Data from the NCEI indicates that Jefferson County can expect on a yearly basis, relevant to high wind events:

- Four events
- No deaths or injuries
- $1,200 in property damages

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to high wind occurrences:

- <1 insurance claim
- 45 acres impacted
- $2,223 in insurance claims

The following table summarizes High wind probability data for **Marshall County**.

**Table 4.179: Marshall County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 34 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $24,500 |
| Average Property Damage per Year | $2,450 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 31 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 3,170 |
| Average Number of Acres Damaged per Year | 317 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $356,191 |
| Average Crop Damage per Year | $35,619 |

Source: NCEI and USDA

Data from the NCEI indicates that Marshall County can expect on a yearly basis, relevant to high wind events:

- Three events
- No deaths or injuries
- $2,450 in property damages

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to high wind occurrences:

- Three insurance claims
- 317 acres impacted
- $35,619 in insurance claims

The following table summarizes high wind probability data for **Nemaha County**.

**Table 4.180: Nemaha County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 30 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $31,000 |
| Average Property Damage per Year | $3,100 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 15 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 2,289 |
| Average Number of Acres Damaged per Year | 229 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $184,314 |
| Average Crop Damage per Year | $18,431 |

Source: NCEI and USDA

Data from the NCEI indicates that Nemaha County can expect on a yearly basis, relevant to high wind events:

- Three events
- No deaths or injuries
- $3,100 in property damages

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to high wind occurrences:

- Two insurance claims
- 229 acres impacted
- $18,431 in insurance claims

The following table summarizes high wind probability data for **Washington County**.

**Table 4.181: Washington County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 26 |
| Average Events per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |

**Table 4.181: Washington County High Wind Probability Summary**

| Data | Recorded Impact |
|---|---|
| Average Number of Days with Death or Injury | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $8,000 |
| Average Property Damage per Year | $800 |
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 25 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 2,954 |
| Average Number of Acres Damaged per Year | 295 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $475,545 |
| Average Crop Damage per Year | $47,555 |

Source: NCEI and USDA

Data from the NCEI indicates that Washington County can expect on a yearly basis, relevant to high wind events:

- Three events
- No deaths or injuries
- $8,000 in property damages

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to high wind occurrences:

- Three insurance claims
- 295 acres impacted
- $47,555 in insurance claims

In addition, Kansas Region K has had five Presidentially Declared Disaster relating to straight-line winds (and other concurrent events) in the last 20 years. This represents an average of less than one declared straight-line wind disaster per year.

## 4.21.4 – Vulnerability Analysis

For purposes of this assessment, all counties within the region were determined to be at equal risk to high wind events. In general, counties with a higher or increasing population, and/or a high or increasing structural valuation are to be considered to have a potentially greater vulnerability. However, these assumed vulnerabilities should be viewed as theoretical due to the tremendous number of variables

involved in a potential high wind event. It is worth highlighting the majority of Kansas Region K counties may have increased vulnerability to high wind events due to a projected increase in the number of structures.

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county incurring damage over the period 2009 to 2018 from high wind events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. Building valuations are provided, if available, for each tribal reservation as a reference against county valuations and percentage damage. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.

**Table 4.182: Kansas Region K Structural Vulnerability Data for High Winds, 2009 -2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Atchison | $2,077,340,000 | $17,000 | 0.001% |
| Brown | $1,135,773,000 | $20,000 | 0.002% |
| Doniphan | $953,610,000 | $220,000 | 0.023% |
| Douglas | $12,489,840,000 | $61,500 | 0.000% |
| Iowa Tribal Reservation | $7,712,800 | - | - |
| Jackson | $1,477,185,000 | $11,500 | 0.001% |
| Jefferson | $2,239,834,000 | $12,000 | 0.001% |
| Kickapoo Tribal Reservation | $6,000,000 | - | - |
| Marshall | $1,231,049,000 | $24,500 | 0.002% |
| Nemaha | $1,282,096,000 | $31,000 | 0.002% |
| Washington | $650,841,000 | $8,000 | 0.001% |

Source: NCEI, HAZUS and Tribal data
-: Data unavailable

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.183: Kansas Region K Population Vulnerability Data for High Winds**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data allows us to quantify the monetary impact of high wind on the agricultural sector. In general, the higher the percentage loss, the higher the vulnerability the county has to high wind events.

**Table 4.184: High Wind Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 33 | 0.02% | $66,913,000 | $1,753 | 0.00% |
| Brown | 258,601 | 310 | 0.12% | $112,057,000 | $35,610 | 0.03% |
| Doniphan | 144,927 | 396 | 0.27% | $76,581,000 | $102,107 | 0.13% |
| Douglas | 159,261 | 104 | 0.07% | $65,867,000 | $12,321 | 0.02% |
| Jackson | 168,682 | 10 | 0.01% | $40,215,000 | $1,187 | 0.00% |
| Jefferson | 153,276 | 45 | 0.03% | $44,922,000 | $2,223 | 0.00% |
| Marshall | 361,473 | 317 | 0.09% | $92,882,000 | $35,619 | 0.04% |
| Nemaha | 268,088 | 229 | 0.09% | $76,127,000 | $18,431 | 0.02% |
| Washington | 336,673 | 295 | 0.09% | $87,087,000 | $47,555 | 0.05% |

Source: USDA

As with tornados, the following participating jurisdictions may have increased vulnerability to windstorm events due to having greater than 20% of housing stock as mobile homes:

- **Huron** (Atchison County)
- **Elwood** (Doniphan County)
- **Lecompton** (Douglas County)
- **Soldier** (Jackson County)
- **Wetmore** (Nemaha County)

## 4.21.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.185: High Wind Consequence Analysis**

| Subject | Impacts of High Winds |
|---|---|
| Health and Safety of the Public | Impact of the immediate area could be severe depending on whether individuals were able to seek shelter. Casualties are dependent on warning systems and warning times. |
| Health and Safety of Responders | Impact to responders is expected to be minimal unless responders live within the affected area. |
| Continuity of Operations | Temporary to permanent relocation may be necessary if government facilities experience damage. |

| | |
|---|---|
| Property, Facilities, and Infrastructure | Localized impact could be severe in the wind path. Roads, buildings, and communications could be adversely affected. Damage could be severe. |
| Environment | Impact will be severe for the immediate impacted area. Impact will lessen as distance increases from the immediate incident area. |
| Economic Conditions | Impacts to the economy will greatly depend on the wind severity. Potential economic impact conditions could be minor to severe. |
| Public Confidence in the Jurisdiction's Governance | Response and recovery will be in question if not timely and effective. Warning systems and warning time will also be questioned. |

## 4.22 – Winter Storms

Winter weather in Kansas Region K usually come in the form of light to heavy snow or freezing rain. A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. 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.

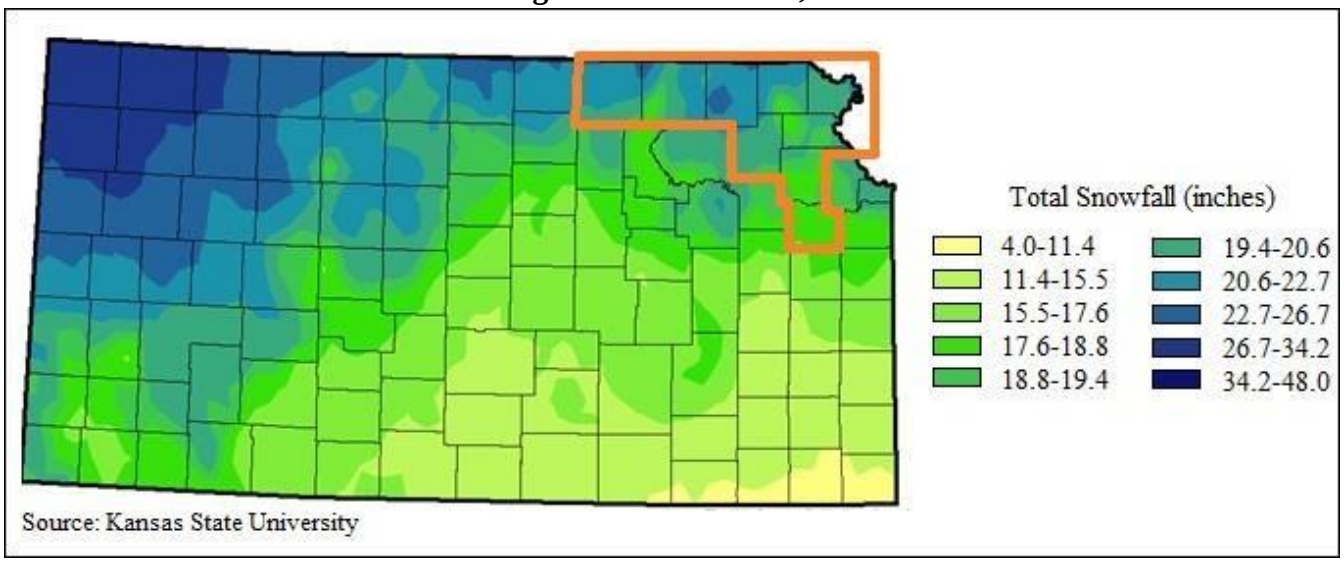
### 4.22.1 – Location and Extent

All of Kansas Region K is susceptible to severe winter storms. For winter weather, the NWS describes the different types of 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:** Rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces 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.

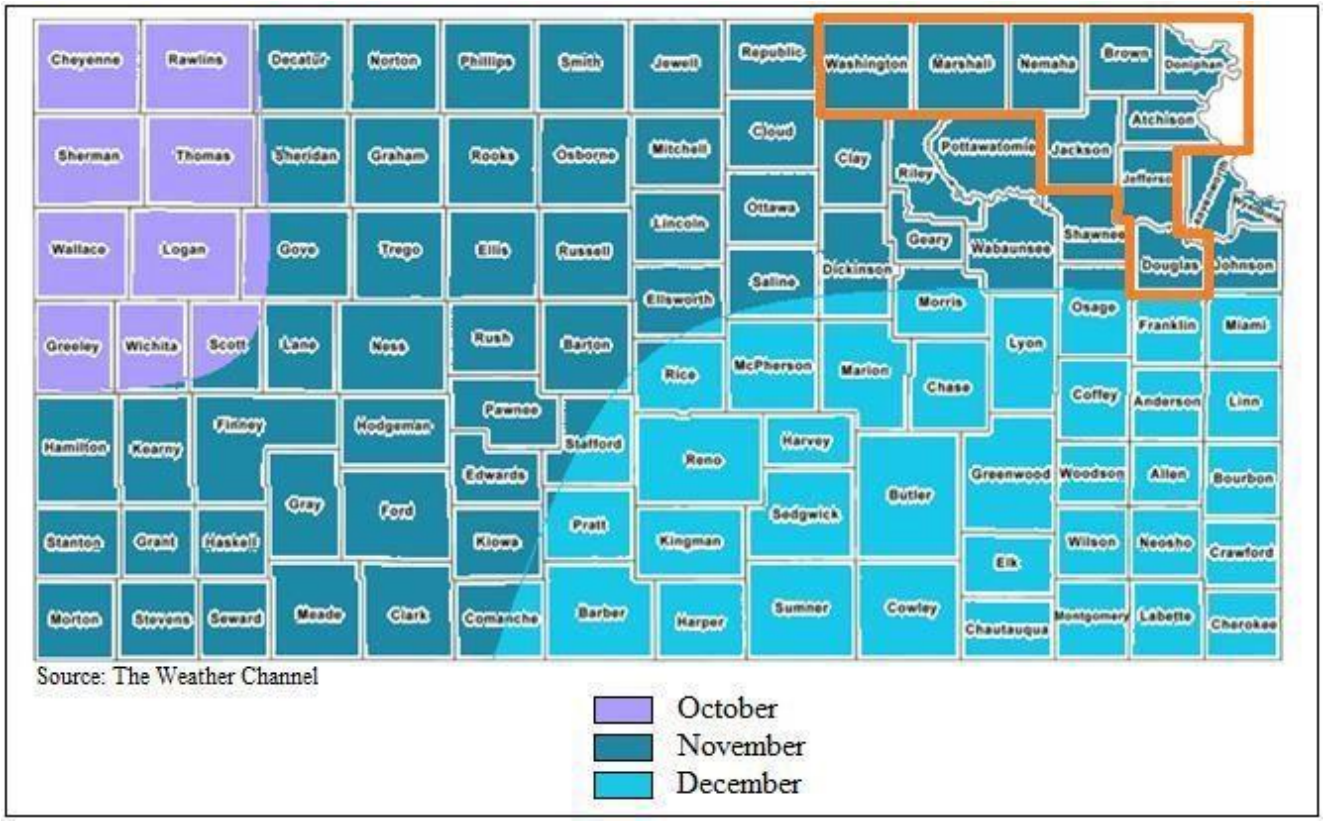
The following map, generated Kansa State University, using the latest available data, indicates the average annual snowfall for Kansas Region K for a given year.

**Average Annual Snowfall, 1981-2010**




Additionally, as indicated by the map below, Kansas Region K can expect to receive the first measurable snow in December of each year.

**Average Date of First Measurable Snow**



## 4.22.2 – Previous Occurrences

In the 20-year period from 1999 to present, there have been five Presidential Disaster Declarations for Kansas Region K for severe winter storms. The following 20-year information (with 1999 and 2018 being full data years) on past declared disasters is presented to provide a historical perspective on winter storm events that have impacted Kansas Region K. Declaration numbers in bold indication declared disaster that have occurred since the previous mitigation plan update in 2014.

**Table 4.186: Kansas Region K FEMA Severe Winter Storms Disaster and Emergency Declarations, 1999 - 2018**

| Declaration Number | Incident Period | Disaster Description | Regional Counties Involved | Dollars Obligated |
|---|---|---|---|---|
| 1885 | 03/09/2010 (12/9/2009-1/8/2010) | Severe Winter Storms and Snowstorm | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, Nemaha and Washington | $19,100,658 |
| 1868 | 12/23/2009 (11/14-11/16/2009) | Severe Winter Storm | Marshall and Washington | $43,217,690 |
| 1741 | 02/01/2008 | Severe Winter Storms | Atchison, Brown, Doniphan, Jackson, Jefferson, Marshall, Nemaha and Washington | $359,557,345 |
| 1579 | 2/8/2005 (1/4-6/2005) | Severe Winter Storm, Heavy Rains, and Flooding | Atchison, Brown, Douglas, Jackson and Jefferson, | $106,873,672 |
| 1402 | 2/6/2002 (1/29-2/15/2002) | Ice Storm | Douglas and Jefferson, | $60,185,754 |

Source: FEMA

The following presents NOAA NCEI data concerning winter storm events in Kansas Region K. It is worth noting that the NCEI data is regional, and sometimes statewide. As such reported damage is not specific to a regional county nor to any of the participating jurisdictions.

**Table 4.187: Kansas Region K NCEI Winter Storm Events, 2009 - 2018**

| Event Type | Number of Days with Events | Property Damage | Deaths | Injuries |
|---|---|---|---|---|
| Blizzards | 6 | $0 | 0 | 0 |
| Ice Storm | 2 | $0 | 0 | 0 |
| Winter Storms | 26 | $0 | 0 | 0 |

Source: NOAA NCEI

The following provides both **local accounts** and NOAA NCEI descriptions of notable recorded events:

- **January 20,2016: Regional**

  A compact storm system moved slowly across Kansas and dumped 5-8 inches of snow across parts of north central and central Kansas.

**November 26, 2015: Regional**

Law Enforcement reported ice on roads county wide and provided a rough estimate of anywhere from .20 to .30 of ice on elevated surfaces including vehicles.

Available crop loss data from the USDA Risk Management Agency detailing cause of loss was researched to determine the financial impacts of winter storms on the region's agricultural base. Crop loss data for the years 2009 - 2018 (with 2009 and 2018 being full data years), for the region, indicates 368 winter storm related claims on 136,595 acres for $8,439,848.

**Table 4.188: USDA Risk Management Agency Cause of Loss Indemnities 2009-2018, Winter Storms**

| County | Number of Reported Claims | Acres Lost | Total Amount of Loss |
|---|---|---|---|
| Atchison | 32 | 5,954 | $436,398 |
| Brown | 40 | 4,007 | $296,370 |
| Doniphan | 9 | 806 | $30,683 |
| Douglas | 21 | 2,712 | $119,413 |
| Jackson | 33 | 4,145 | $248,863 |
| Marshall | 24 | 1,794 | $51,852 |
| Jefferson | 97 | 16,377 | $1,533,177 |
| Nemaha | 63 | 6,020 | $446,910 |
| Washington | 102 | 29,400 | $2,521,564 |

Source: USDA

## 4.22.3 – Hazard Probability Analysis

For probability purposes, each component of severe winter storms was examined and combined. The following table summarizes winter storm event data for Kansas Region K.

**Table 4.189: Kansas Region K Winter Storm Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Days with NCEI Reported Event (2009-2018) | 34 |
| Average Event Days per Year | 3 |
| Number of Days with Event and Death or Injury (2009-2018) | 0 |
| Average Number of Yearly Deaths and Injuries (2009-2018) | 0 |
| Total Reported NCEI Property Damage (2009-2018) | $0 |
| Average Property Damage per Year | $0 |

Source: NCEI

Data from the NCEI indicates that Kansas Region K can expect on a yearly basis, relevant to winter storm events:

- Three events
- No deaths or injuries

- $0 in property damages

The following table summarizes USDA Risk Management Agency winter storm event data for **Atchison County**.

**Table 4.190: Atchison County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 32 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 5,954 |
| Average Number of Acres Damaged per Year | 595 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $436,398 |
| Average Crop Damage per Year | $43,640 |

Source: USDA

According to the USDA Risk Management Agency, Atchison County can expect on a yearly basis, relevant to winter storm occurrences:

- Three insurance claims
- 595 acres impacted
- $43,640 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Brown County**.

**Table 4.191: Brown County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 40 |
| Average Number of Claims per Year | 4 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 4,007 |
| Average Number of Acres Damaged per Year | 401 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $296,370 |
| Average Crop Damage per Year | $29,637 |

Source: USDA

According to the USDA Risk Management Agency, Brown County can expect on a yearly basis, relevant to winter storm occurrences:

- Four insurance claims
- 401 acres impacted
- $29,637 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Doniphan County**.

**Table 4.192: Doniphan County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 40 |
| Average Number of Claims per Year | 4 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 806 |
| Average Number of Acres Damaged per Year | 81 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $30,683 |
| Average Crop Damage per Year | $3,068 |

Source: USDA

According to the USDA Risk Management Agency, Doniphan County can expect on a yearly basis, relevant to winter storm occurrences:

- Four insurance claims
- 81acres impacted
- $3,068 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Douglas County**.

**Table 4.193: Douglas County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 21 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 2,712 |
| Average Number of Acres Damaged per Year | 271 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $119,413 |
| Average Crop Damage per Year | $11,941 |

Source: USDA

According to the USDA Risk Management Agency, Douglas County can expect on a yearly basis, relevant to winter storm occurrences:

- Two insurance claims
- 271 acres impacted
- $11,941 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Jackson County**.

**Table 4.194: Jackson County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|

| | |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 33 |
| Average Number of Claims per Year | 3 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 4,145 |
| Average Number of Acres Damaged per Year | 415 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $248,863 |

**Table 4.194: Jackson County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| Average Crop Damage per Year | $24,886 |

Source: USDA

According to the USDA Risk Management Agency, Jackson County can expect on a yearly basis, relevant to winter storm occurrences:

- Three insurance claims
- 415 acres impacted
- $24,886 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Jefferson County**.

**Table 4.195: Jefferson County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 24 |
| Average Number of Claims per Year | 2 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 1,794 |
| Average Number of Acres Damaged per Year | 179 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $51,852 |
| Average Crop Damage per Year | $5,185 |

Source: USDA

According to the USDA Risk Management Agency, Jefferson County can expect on a yearly basis, relevant to winter storm occurrences:

- Two insurance claims
- 179 acres impacted
- $5,185 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Marshall County**.

**Table 4.196: Marshall County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|

| | |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 97 |
| Average Number of Claims per Year | 10 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 16,377 |
| Average Number of Acres Damaged per Year | 1,638 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $1,533,177 |
| Average Crop Damage per Year | $153,318 |

Source: USDA

According to the USDA Risk Management Agency, Marshall County can expect on a yearly basis, relevant to winter storm occurrences:

- Ten insurance claims
- 1,638 acres impacted
- $153,318 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Nemaha County**.

**Table 4.197: Nemaha County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 63 |
| Average Number of Claims per Year | 6 |
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 6,020 |
| Average Number of Acres Damaged per Year | 602 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $446,910 |
| Average Crop Damage per Year | $44,691 |

Source: USDA

According to the USDA Risk Management Agency, Nemaha County can expect on a yearly basis, relevant to winter storm occurrences:

- Six insurance claims
- 602 acres impacted
- $44,691 in insurance claims

The following table summarizes USDA Risk Management Agency winter storm event data for **Washington County**.

**Table 4.198: Washington County Winter Storm Probability Summary (Agricultural)**

| Data | Recorded Impact |
|---|---|
| USDA Farm Service Agency Number of Crop Damage Claims (2009-2018) | 102 |
| Average Number of Claims per Year | 10 |

| | |
|---|---|
| USDA Farm Service Agency Number of Acres Damaged (2009-2018) | 29,400 |
| Average Number of Acres Damaged per Year | 2,940 |
| USDA Farm Service Agency Crop Damage Claims Amount (2009-2018) | $2,521,564 |
| Average Crop Damage per Year | $252,156 |

Source: USDA

According to the USDA Risk Management Agency, Washington County can expect on a yearly basis, relevant to winter storm occurrences:

- Ten insurance claims
- 2,940 acres impacted
- $252,156 in insurance claims

In addition, Kansas Region K has had five Presidentially Declared Disasters relating to winter storms (and other concurrent events) in the last 20 years. This represents an average of less than one declared winter storm related disaster per year.

### 4.22.4 – Vulnerability Analysis

For purposes of this assessment, all counties within the region were determined to be at equal risk to winter storm events. In general, counties with a higher or increasing population, and/or a high or increasing structural valuation are to be considered to have a potentially greater vulnerability. However, these assumed vulnerabilities should be viewed as theoretical due to the tremendous number of variables involved in a potential high wind event. It is worth highlighting the majority of Kansas Region K counties may have increased vulnerability to winter storm events due to a projected increase in the number of structures.

The following table presents data from the NOAA NCEI and HAZUS concerning the value of structures and the percentage of structures for each Kansas Region K county (in total, due to the regional nature of both storms and NCEI reporting) incurring damage over the period 2009 to 2018 from winter storm events. NCEI does not provide data for tribal reservations, rather data for the tribal reservation is included in the county or counties it resides within. The greater the percentage of structures damaged the greater overall potential vulnerability to future events.

.

**Table 4.199: Kansas Region K Structural Vulnerability Data for Winter Storms, 2009-2018**

| County | HAZUS Building Valuation | NCEI Structure Damage | Percentage of Building Valuation Damaged |
|---|---|---|---|
| Regional Counties | $23,545,280,800 | $0 | 0.0% |

Source: NCEI and HAZUS

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.200: Kansas Region K Population Vulnerability Data for Winter Storms**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

The USDA 2017 Census of Agriculture (the latest available data) provides data on the crop exposure value, the total dollar value of all crops, for each Kansas Region K County. USDA Risk Management Agency crop loss data allows us to quantify the monetary impact of winter storms on the agricultural sector. The higher the percentage loss, the higher the vulnerability the county has to winter storm events.

**Table 4.201: Winter Storm Acres Impacted and Crop Insurance Paid per County from 2009-2018**

| Jurisdiction | Farm Acreage | Annualized Acres Impacted | Percentage of Total Acres Impacted Yearly | Market Value of Products Sold | Annualized Crop Insurance Paid | Percentage of Market Value Impacted Yearly |
|---|---|---|---|---|---|---|
| Atchison | 174,297 | 595 | 0.34% | $66,913,000 | $43,640 | 0.07% |
| Brown | 258,601 | 401 | 0.15% | $112,057,000 | $29,637 | 0.03% |
| Doniphan | 144,927 | 81 | 0.06% | $76,581,000 | $3,068 | 0.00% |
| Douglas | 159,261 | 271 | 0.17% | $65,867,000 | $11,941 | 0.02% |
| Jackson | 168,682 | 415 | 0.25% | $40,215,000 | $24,886 | 0.06% |
| Jefferson | 153,276 | 179 | 0.12% | $44,922,000 | $5,185 | 0.01% |
| Marshall | 361,473 | 1,638 | 0.45% | $92,882,000 | $153,318 | 0.17% |
| Nemaha | 268,088 | 602 | 0.22% | $76,127,000 | $44,691 | 0.06% |
| Washington | 336,673 | 2,940 | 0.87% | $87,087,000 | $252,156 | 0.29% |

Source: USDA

## 4.22.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.202: Winter Storm Consequence Analysis**

| Subject | Impacts of Winter Storm |
|---|---|

| | |
|---|---|
| Health and Safety of the Public | Severity and location dependent. Impacts on persons in the areas of snow and ice are expected to be severe if caught without proper shelter. |
| Health and Safety of Responders | Impacts will be predicated on the severity of the event. Damaged infrastructure will likely result in hazards such as downed utility lines, main breakages and debris on roadways. . |
| Continuity of Operations | Temporary relocation may be necessary if government facilities experience damage. Services may be limited to essential tasks if utilities are impacted. |
| Property, Facilities, and Infrastructure | Impact to property, facilities, and infrastructure could be minimal to severe, depending on the location and structural capacity of the facility. Loss of structural integrity of buildings and infrastructure could occur. Utility lines, roads, residential and business properties will be affected. |
| Environment | 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 | Impacts to the economy will be dependent severity of the event and the impact on structures and infrastructure. Impacts could be severe if roads/utilities are affected. |
| Public Confidence in the Jurisdiction's Governance | Response and recovery will be in question if not timely and effective. The timeliness warnings could be questioned. |

## 4.23 – Civil Disorder

Civil disorder is a term that generally refers to a public disturbance by three or more people involving acts of violence that cause immediate danger, damage, or injury to others or their property. However, it is important to remember that gatherings in protest are recognized rights of any person or group, and this right is protected under the United States Constitution.

### 4.23.1 – Location and Extent

Historically civil disorder has been most commonly associated with urban areas and college campuses. And while the entire planning area may be affected by civil disorder, with its generally small population and low population density, the magnitude of such an event would likely be limited to the major cities within the region.

In general, civil unrest usually accompanies, or is started by, a gathering of people for an event. And while most events occur with no violence, violence can occur with little warning or cause. Unfortunately, large crowds can be subject to control by skillful troublemakers who are often able to incite behavior from members of the crowd that they usually would not consider. . In general, when a crowd begins to exhibit signs of disorder, it can be categorized in three categories:

- **Public disorder:** Public disorder is a basic breach of civic order. Individuals or small groups assembling have a tendency to disrupt the normal flow of things around them.
- **Public disturbance:** Public disturbance is designed to cause turmoil on top of the disruption. Individuals and groups assembling into a crowd begin chanting, yelling, singing, and voicing individual or collective opinions.

- **Riot:** A riot is a disturbance that turns violent. Assembled crowds become a mob that violently expresses itself by destroying property, assaulting others, and creating an extremely volatile environment.

While civil disorder is not an everyday occurrence in the planning area, when they do occur they are extremely disruptive and difficult to control. Should a civil disorder event occur in the planning area the result could be measured in loss of life, economic upheaval, and destruction of property.

### 4.23.2 – Previous Occurrences

There have been no documented cases of civil unrest of disorder in Kansas Region K during the past five years.

### 4.23.3 – Hazard Probability Analysis

By nature, acts of civil disorder are difficult to foresee. However, the probability of a major civil disorder event in Kansas Region K is considered very low due the lack of any recent documented historical events. Again, it is worth noting that no previous occurrences in no way guarantees no future occurrences.

### 4.23.4 Vulnerability Analysis

Due to the unknown location and nature of civil disorder, all participating jurisdictions with Kansas Region K are vulnerable. Additionally, and again related to the capricious nature of civil disorder, all buildings and citizens are vulnerable.

Economic impacts and human injury or death are the primary concern with civil disorder. Increases in population or the hosting of major political, economic or social events could increase the likelihood and severity of a civil disturbance.

In general, it is difficult to quantify potential losses of Civil Disorder due to the many variables and human elements and lack of historical precedence. Therefore, for the purposes of this plan, a **hypothetical scenario** is included for illustrative purposes only.

> **Event:** City organizers set up a two-block long fan zone near the local community sports field for an important sporting event. The population density in the fan zone is 6,000 people, with at least five persons per 25 square feet.
>
> **Riot:** The riot began to take shape as the game came to a close, with some spectators throwing bottles and other objects. Small fires were started and soon some rioters overturned a vehicle and set it alight. Fist fights broke out and in a nearby parking lot and two police cars were also set on fire. Riot police eventually managed to disperse the rioters and all fires were extinguished.
>
> **Results:** The following table presents potential event results:

**Table 4.203: Hypothetical Riot Outcomes**

| Category | Result |
|---|---|
| **Total Traumatic Injuries** | 250 persons |
| **Total Urgent Care Injuries** | 1,000 persons |
| **Injuries not Requiring Hospitalization** | 2,500 persons |
| **Damage to Vehicles** | Glass replacement cost for approximately 200 vehicles: $ 8,000<br>Repair / repainting cost for approximately 200 vehicles: $800,000 |
| **Damage to Buildings** | Window replacement cost for approximately 50 buildings: $80,000 |

Source: Kansas State Hazard Mitigation Plan

## 4.23.5 – Impact and Consequence Analysis

As per EMAP standards, the following table provides the consequence analysis for drought conditions.

**Table 4.204: Civil Disorder Consequence Analysis**

| Subject | Civil Disorder Potential Impacts |
|---|---|
| Health and Safety of the Public | Impact could be severe for persons in the incident area. |
| Health and Safety of Responders | 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. |

**Table 4.204: Civil Disorder Consequence Analysis**

| Subject | Civil Disorder Potential Impacts |
|---|---|
| Continuity of Operations | 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 | Impact within the incident area could be severe, depending on the extent of the event. (minimal to severe) |
| Environment | Localized impact within the incident area could be severe depending on the type of human caused incident. |
| Economic Conditions | Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation (minimal to severe). |
| Public Confidence in the Jurisdiction's Governance | 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) |

# 4.24 – Hazardous Materials

Hazardous materials (HazMat) are any substances that pose a risk to health, life, or property when released or improperly handled. Generally, the term refers to materials with hazardous chemical or physical properties, though sometimes biological agents can fall under this category. The basic types of hazardous materials may be categorized according to more than six different systems; but the categories of U.S. Emergency Planning and Community Right-to-Know Act (42 U.S.C. 11002) provide a general guide to hazardous materials:

- ***Extremely Hazardous Substances:*** Materials that have acutely toxic chemical or physical properties and may cause irreversible damage or death to people or harm the environment if released or used outside their intended use.
- ***Hazardous Substances:*** Materials posing a threat to human health and/or the environment, or any substance designated by the EPA to be reported if a designated quantity of the substance is spilled into waterways, aquifers, or water supplies or is otherwise released into the environment.

## 4.24.1 – Location and Extent

In Kansas Region K, HazMat incidents are generally classified as:

- **Fixed Facility Incidents:** Commercial Facilities and Superfund Sites
- **Transportation Incidents:** Highway, Railway, Pipeline, Air, and Water

### *Fixed Facilities*

When facilities have hazardous materials in quantities at or above the threshold planning quantity, they must submit Tier II information to appropriate federal and state agencies to facilitate emergency planning in accordance with the Community Right to Know Act. The forms are known as Tier II reports and the facilities included are referred to as Tier II facilities. According to data provided by KDEM, there are 292 Tier II Facilities housing hazardous chemicals in Kansas Region K. The following table details the number of Tier II facilities by county.

**Table 4.205: Kansas Region K Tier II Facilities by County**

| County | Tier II Facilities |
|---|---|
| Atchison | 22 |
| Brown | 27 |
| Doniphan | 25 |
| Douglas | 98 |
| Jackson | 10 |

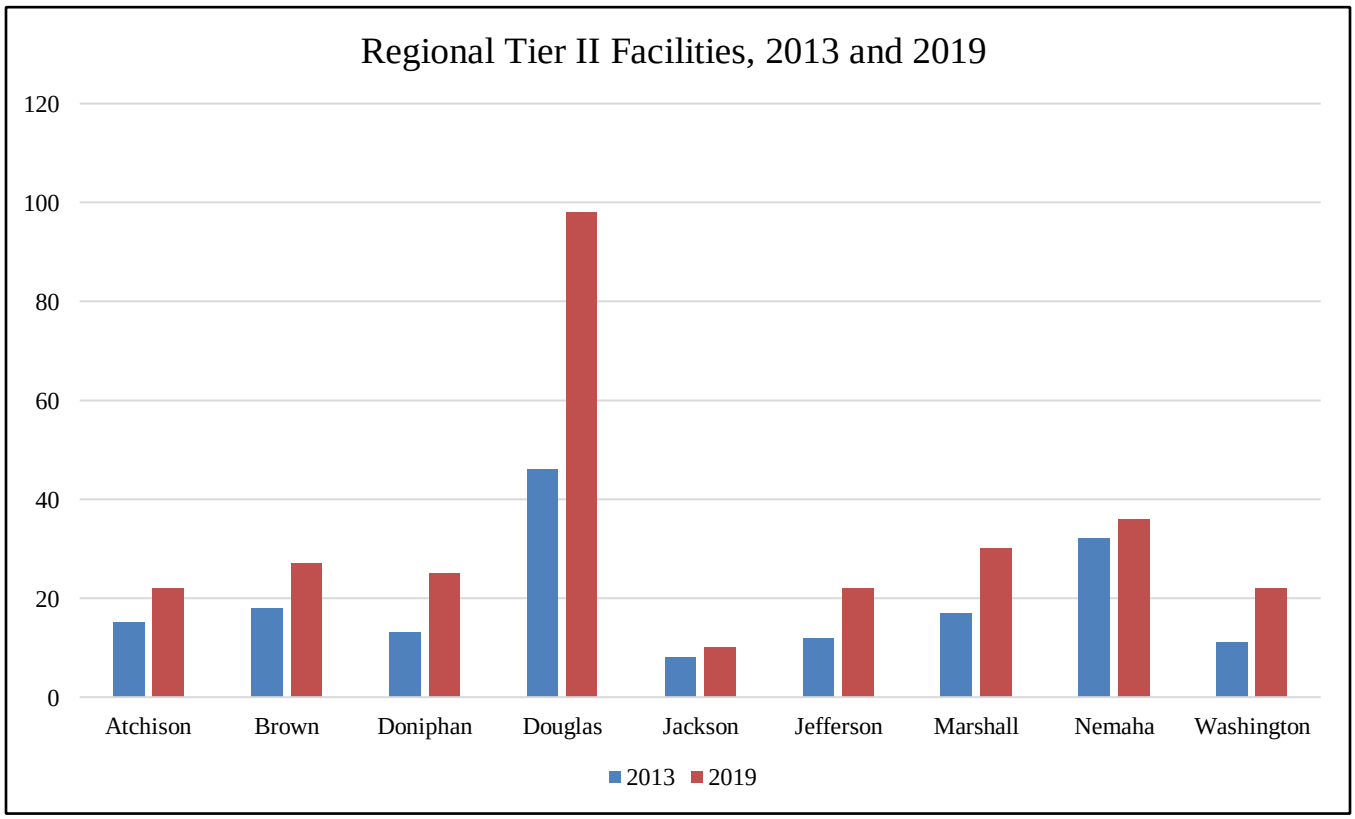
| | |
|---|---|
| Jefferson | 22 |
| Marshall | 30 |

**Table 4.205: Kansas Region K Tier II Facilities by County**

| County | Tier II Facilities |
|---|---|
| Nemaha | 36 |
| Washington | 22 |

Source: KDEM

As illustrated in the following graph, the number of Tier II facilities has increased for the region, primarily to due to an extensive outreach effort by KDHE to facilities that house hazardous chemicals




The National Priorities List (NPL) is a published list of hazardous waste sites in the country that are eligible for extensive, long-term cleanup under the Superfund program. A Superfund site is an uncontrolled or abandoned location where hazardous waste is located which may affect local ecosystems and/or people. The EPA has indicated no Superfund sites are located with Kansas Region K.

***Transportation***

The following table, from Kansas Department of Transportation (KDOT), presents total roadway mileage by county and tribal reservation.

**Table 4.206: Kansas Region K Total Roadway Mileage by County and Tribal Reservation**

| County | Roadways (Miles) |
|---|---|

| | |
|---|---|
| Atchison | 938 |
| Brown | 1,238 |
| Doniphan | 735 |

**Table 4.206: Kansas Region K Total Roadway Mileage by County and Tribal Reservation**

| County | Roadways (Miles) |
|---|---|
| Douglas | 1,391 |
| Iowa Tribal Reservation | 23 |
| Jackson | 1,254 |
| Jefferson | 1,232 |
| Kickapoo Tribal Reservation | 59 |
| Marshall | 1,705 |
| Nemaha | 1,452 |
| Washington | 1,727 |

Source: KDOT

Kansas Region K is served by numerous railroad companies. Railroads are generally defined by three classes, predicated on revenue and size, with Class I (Freight) being the largest. Class I railroads are of the greatest concern due to the type of freight carried, with categories including There are three Class I railroads in Kansas Region K providing service with long-haul deliveries to national market areas and intermodal rail/truck service providers:

- Burlington Northern and Santa Fe Railway
- Kansas City Southern Railway  Union Pacific Railroad

The following table, with information from KDOT, provides the total railroad track mileage of for each county within Kansas Region K.

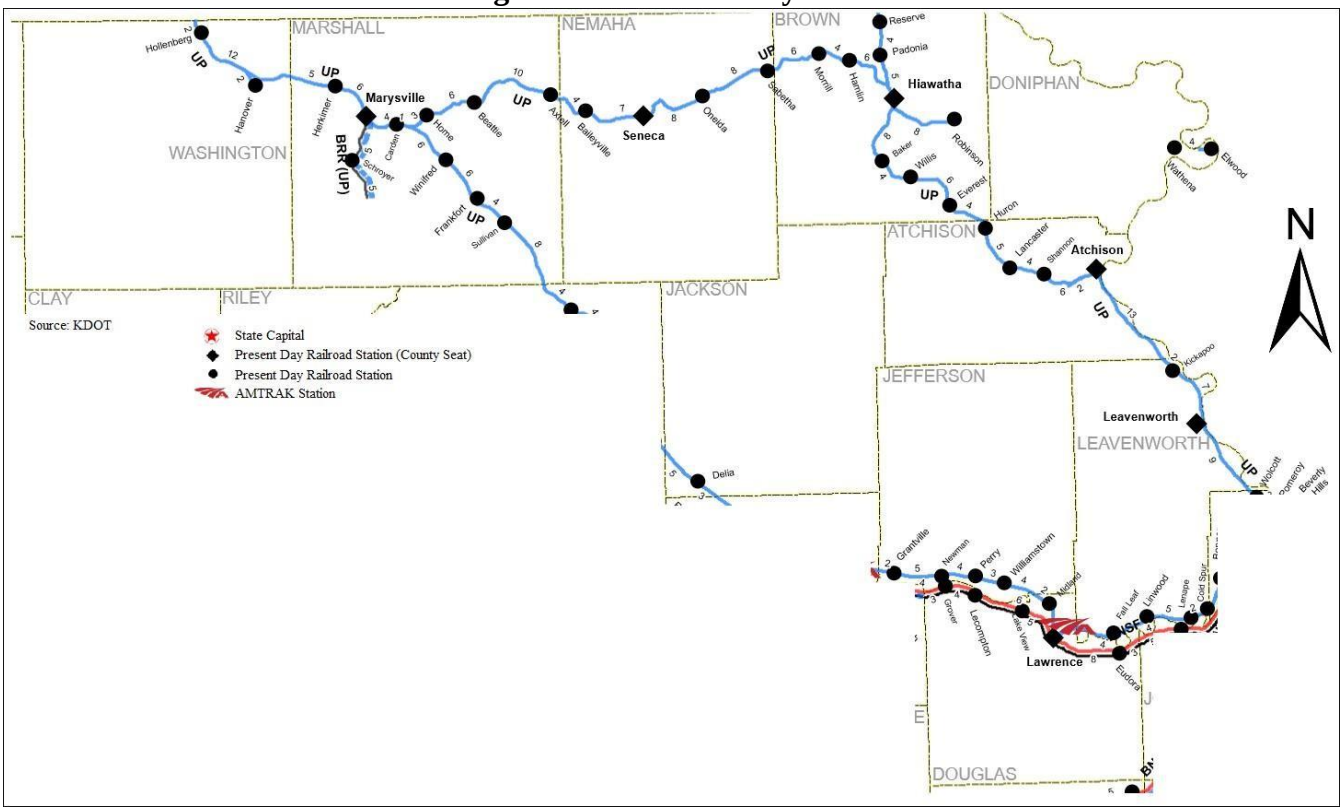
**Table 4.207: Kansas Region K Total Class I Railroad Mileage by County**

| County | Railroad Track (Miles) |
|---|---|
| Atchison | 34 |
| Brown | 56 |
| Doniphan | 5 |
| Douglas | 36 |
| Jackson | 8 |
| Jefferson | 18 |
| Marshall | 69 |
| Nemaha | 28 |
| Washington | 18 |

Source: KDOT

The following map, from KDOT, shows Class I track locations in Kansas Region K.

**Regional Class I Railway Lines**




## *Pipelines*

The following data, provided by KDEM and the United States Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA), indicates the total number of gas and liquid pipeline mileage per county.

**Table 4.208: PHMSA Pipeline Mileage by County**

| County | Gas (miles) | Liquid (miles) |
|---|---|---|
| Atchison | 40 | 95 |
| Brown | 132 | 93 |
| Doniphan | 22 | 81 |
| Douglas | 88 | 42 |
| Jackson | 37 | 55 |
| Jefferson | 77 | 65 |
| Marshall | 94 | 90 |
| Nemaha | 78 | 64 |
| Washington | 349 | 214 |

Source: KDEM and PHMSA

## 4.24.2 – Previous Occurrences

The following table, with data from KDEM, lists the number of hazardous materials incidents, injuries, fatalities and people evacuated from the public and facilities for each Kansas Region K county over the three-year period 2013-2015 (due to system changes, the most current data available).

**Table 4.209: Kansas Region K HazMat KDEM Reported Incidents, 2013-2015**

| Jurisdiction | Incidents | Injuries | Fatalities | People Evacuated |
|---|---|---|---|---|
| Atchison | 2 | 0 | 0 | 0 |
| Brown | 3 | 1 | 0 | 2 |
| Doniphan | 1 | 0 | 0 | 15 |
| Douglas | 1 | 0 | 0 | 0 |
| Jackson | 0 | 0 | 0 | 0 |
| Jefferson | 1 | 0 | 0 | 14 |
| Marshall | 1 | 1 | 0 | 0 |
| Nemaha | 1 | 0 | 0 | 0 |
| Washington | 1 | 0 | 0 | 0 |

Source: KDEM

Hazardous Materials Regulations (49 CFR Parts 171-180) require certain types of HazMat incidents be reported, with data tracked by PHMSA's Office of Hazardous Materials Safety (OHMS) by transportation category type (Air, Highway, Rail and Water). The OHMS Incident Report Database from 2010 to 2018 indicated 11 reported incidents within Kansas Region K. The following charts detail the number of events per year per transportation category.

**Table 4.210: Kansas Region K OHMS HazMat Incidents, 2000-2018**

| Jurisdiction | Highway | Air | Rail | Damages | Injuries | Deaths |
|---|---|---|---|---|---|---|
| **Atchison County** | | | | | | |
| City of Atchison | 2 | 0 | 1 | $109,708 | 1 | 0 |
| **Brown County** | | | | | | |
| Hiawatha | 1 | 0 | 0 | $0 | 0 | 0 |
| **Doniphan County** | | | | | | |
| - | - | - | 0 | - | - | - |
| **Douglas County** | | | | | | |
| Lawrence | 5 | 0 | 0 | $161,095 | 0 | 0 |
| **Jackson County** | | | | | | |
| Mayetta | 1 | 0 | 0 | $0 | 0 | 0 |
| **Jefferson County** | | | | | | |
| McLouth | 1 | 0 | 0 | $237,718 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Marshall County** | | | | | | |
| - | - | - | 0 | - | - | - |
| **Nemaha County** | | | | | | |
| - | - | - | 0 | - | - | - |
| **Washington County** | | | | | | |
| - | - | - | 0 | - | - | - |

Source: PHMSA OHMS

Data from PHMSA provides significant incident reports for the pipeline systems in Kansas Region K. Data from the period 2013 to 2017 indicate that there were ten pipeline incidents that no fatalities, no injuries and $2,209,467 in damages. The following table details reported pipeline incident details for each county with a reported event.

**Table 4.211: Kansas Region K PHMSA Reported Pipeline Incidents by County, 2013 to 2017**

| County | Number of Incidents | Fatalities | Injuries | Total Damage | Gross Barrels Spilled |
|---|---|---|---|---|---|
| Atchison | 0 | 0 | 0 | $0 | 0 |
| Brown | 1 | 0 | 0 | $217,618 | 0 |
| Doniphan | 0 | 0 | 0 | $0 | 0 |
| Douglas | 0 | 0 | 0 | $0 | 0 |
| Jackson | 0 | 0 | 0 | $0 | 0 |
| Jefferson | 1 | 0 | 0 | $142,000 | 5 |
| Marshall | 0 | 0 | 0 | $0 | 0 |
| Nemaha | 0 | 0 | 0 | $0 | 0 |
| Washington | 1 | 0 | 0 | $96,972 | 25 |

Source: PHMSA

- **October 21, 2016: City of Atchison, Atchison County**

  Sulfuric Acid and Sodium Hypochlorite were inadvertently mixed resulting in a cloud on Chlorine gas that covered a 5.5 square mile area causing 146 injuries.

- **September 17, 2015: Douglas County**

  Crude oil was released into the berm and area surrounding the oil lease. KCC was called and worked with the owner and operator. The leak and was cleaned up in 2016.

- **July 29, 2015: Douglas County**

  Well pump dysfunctional. 40+ barrels of crude oil released into crop fields, culverts and to the top of the berm.

- **July 12, 2014: Douglas County**

  919 lbs. of chlorine gas were released within the facility due to a faulty valve. This was the second release at this facility, the first being 34 lbs lost on 7/13. On the initial alarm on 7/13, the water plant was shut down as the building was evacuated.

### 4.24.3 – Hazard Probability Analysis

HazMat incidents are not predictable. However, probabilities can be estimated using past occurrence data as a guide.

The following tables summarize occurrence data and probability for HazMat events for **Atchison County** using data from KDEM.

**Table 4.212: Atchison County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 2 |
| Average Events per Year | 1 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 0 |
| Average Evacuations per Year | 0 |

Source: KDEM and PHMSA

Data indicates that Atchison County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- One event
- No deaths
- No injury
- No evacuations

The following tables summarize occurrence data and probability for HazMat events for **Brown County** using data from KDEM.

**Table 4.213: Brown County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 3 |
| Average Events per Year | 1 |
| Number of Reported Injuries (2013-2015) | 1 |
| Average Injuries per Year | <1 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 2 |
| Average Evacuations per Year | 1 |

Source: KDEM and PHMSA

Data indicates that Brown County can expect on a yearly basis, relevant to fixed facility related HazMat events:

The following tables summarize occurrence data and probability for HazMat events for

- One event
- No deaths
- <1 injury
- One evacuation

**Doniphan County** using data from KDEM.

**Table 4.214: Doniphan County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 1 |
| Average Events per Year | <1 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 15 |
| Average Evacuations per Year | 5 |

Source: KDEM and PHMSA

Data indicates that Doniphan County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- <1 event
- No deaths
- No injury
- Five evacuations

The following tables summarize occurrence data and probability for all related HazMat events for **Douglas County** using data from KDEM and PHMSA.

**Table 4.215: Douglas County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 1 |
| Average Events per Year | <1 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |

The following tables summarize occurrence data and probability for HazMat events for

| | |
|---|---|
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 0 |
| Average Evacuations per Year | 0 |

Source: KDEM and PHMSA

Data indicates that Douglas County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- <1 event
- No deaths
- No injury
- No evacuations

**Jackson County** using data from KDEM.

**Table 4.216: Jackson County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 0 |
| Average Events per Year | 0 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 0 |
| Average Evacuations per Year | 0 |

Source: KDEM and PHMSA

Data indicates that Jackson County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- No events
- No deaths
- No injury
- No evacuations

The following tables summarize occurrence data and probability for HazMat events for **Jefferson County** using data from KDEM.

The following tables summarize occurrence data and probability for HazMat events for

**Table 4.217: Jefferson County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 1 |
| Average Events per Year | <1 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 14 |
| Average Evacuations per Year | 5 |

Source: KDEM and PHMSA

Data indicates that Jefferson County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- <1 event
- No deaths
- No injury
- Five evacuations

**Marshall County** using data from KDEM.

**Table 4.218: Marshall County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 1 |
| Average Events per Year | <1 |
| Number of Reported Injuries (2013-2015) | 1 |
| Average Injuries per Year | <1 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 0 |
| Average Evacuations per Year | 0 |

Source: KDEM and PHMSA

Data indicates that Marshall County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- <1 event

The following tables summarize occurrence data and probability for HazMat events for

- No deaths
- <1 injury
- No evacuations

The following tables summarize occurrence data and probability for HazMat events for **Nemaha County** using data from KDEM.

**Table 4.219: Nemaha County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 1 |
| Average Events per Year | <1 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 0 |
| Average Evacuations per Year | 0 |

Source: KDEM and PHMSA

Data indicates that Nemaha County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- <1 event
- No deaths
- No injury
- No evacuations

**Washington County** using data from KDEM.

The following tables summarize occurrence data and probability for HazMat events for

**Table 4.220: Washington County HazMat Incident Probability Summary**

| Data | Recorded Impact |
|---|---|
| Number of Reported Events (2013-2015) | 1 |
| Average Events per Year | <1 |
| Number of Reported Injuries (2013-2015) | 0 |
| Average Injuries per Year | 0 |
| Number of Reported Deaths (2013-2015) | 0 |
| Average Deaths per Year | 0 |
| Number of Reported Evacuations (2013-2015) | 0 |
| Average Evacuations per Year | 0 |

Source: KDEM and PHMSA

Data indicates that Washington County can expect on a yearly basis, relevant to fixed facility related HazMat events:

- <1 event
- No deaths
- No injuries
- No evacuations

## 4.24.4 – Vulnerability Analysis

Special populations are particularly vulnerable to the impacts of a hazardous materials incident because of the potential difficulties involved in the evacuation. The following table details the number of special population facilities in each Kansas Region K county 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, health facilities data is from HAZUS, aging facilities is from KDEM and childcare facilities is from KDHE.

**Table 4.221: Kansas Region K Special Population Facilities Within 0.5 Miles of a Chemical Facility**

| County | Health Facilities | Colleges | Educational Facilities | Aging Facilities | Child Care | Correctional Institutions |
|---|---|---|---|---|---|---|
| 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 |

Source: KDEM

Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards. The following table indicates the total county population and registered growth over the period 2000 to 2017.

**Table 4.222: Kansas Region K Population Vulnerability Data for HazMat Event**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

## 4.24.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.223: HazMat Incident Consequence Analysis**

| Subject | Impacts of Hazardous Materials Incident |
|---|---|
| Health and Safety of Persons in the Area of the Incident | Impact in the immediate area could be severe and long lasting. |
| Responders | Impact to responders is expected to be moderate to severe, potentially even with required safety equipment. |
| Continuity of Operations | Long term relocation may be necessary if government facilities experience contamination or damage. |
| Property, Facilities, and Infrastructure | Localized impact could be severe in the incident area. Facilities may need to be abandoned and razed. Large areas may become inaccessible. |
| Environment | Impact could be severe for the immediate area. Impact will lessen with distance. The proximity of open bodies of water could compound the impact. |
| Economic Conditions | Local economy and finances may be adversely affected, depending on the nature, extent and duration of the event. |
| Public Confidence in Governance | Response and recovery will be in question if not timely and effective. Warning systems and the timeliness of those warnings could be questioned. |

# 4.25 – Major Disease

For this plan, major disease is classified as infectious diseases caused by microscopic agents, including viruses, bacteria, parasites, and fungi or by their toxins, that may impact humans. They may be spread by direct contact with an infected person or animal, ingesting contaminated food or water, vectors such as mosquitoes or ticks, contact with contaminated surroundings such as animal droppings, infected droplets, or by aerosolization.

## 4.25.1 – Location and Extent

Human transmissible disease and infectious diseases are illnesses caused by microscopic agents, including viruses, bacteria, parasites, and fungi or by their toxins. They may be spread by direct contact with an infected person or animal, ingesting contaminated food or water, vectors such as mosquitoes or ticks, contact with contaminated surroundings such as animal droppings, infected droplets, or by aerosolization.

The entire planning area is susceptible to a transmissible disease outbreak. However, more densely populated areas may be more susceptible.

## 4.25.2 – Previous Occurrences

The KDHE was contacted concerning the epidemiological tracking of contagious and/or human transmissible diseases. Data was solicited concerning the following diseases of concern:

- Haemophilus Influenzae Invasive Disease
- Measles (Rubeola)
- Meningococcal Infections
- Mumps
- Pertussis
- Streptococcus pneumoniae, Invasive
- West Nile Virus
- Zika Virus

A review of available data indicates there have been no unusual or concerning spikes in these diseases. Additionally, no new novel pathogens of concern have been tracked or reported.

## 4.25.3 – Hazard Probability Analysis

Each year the Centers for Disease Control (CDC) produces a report detailing the legally reportable diseases in the United States. While over time this report can serve as a predictor of the likelihood of future disease, it is impossible to predict outbreaks. Data from the CDC report does not indicate any areas of concern for Kansas Region K. Based on the relatively limited/controlled outbreak history in Kansas Region K, the possibility of a large-scale major disease outbreak to be limited.

## 4.25.4 – Vulnerability Analysis

For purposes of this assessment, no facilities or agricultural commodities are considered vulnerable to the major disease hazard.

Due to the person to person transmission of many diseases of concern Counties or tribal reservations with a higher identified population are to be considered to have a potentially greater vulnerability. The following table indicates the total county population and registered growth over the period 2000 to 2017. Counties or tribal reservations with a higher identified and/or increasing population are to be considered to have a potentially greater vulnerability to hazards.

**Table 4.224: Kansas Region K Population Vulnerability Data for Major Disease**

| County or Tribe | 2017 Population | Percent Population Change 2000 to 2017 |
|---|---|---|
| Atchison | 16,193 | -3.5% |
| Brown | 9,736 | -9.2% |
| Doniphan | 7,790 | -5.6% |
| Douglas | 17,844 | 17.9% |
| Iowa Tribe | 191 | 48.1% |
| Jackson | 13,322 | 5.3% |
| Jefferson | 18,856 | 2.3% |
| Kickapoo Tribe | 1,610 | 26.7% |
| Marshall | 9,859 | -10.1% |
| Nemaha | 10,095 | -5.8% |
| Washington | 5,572 | -14.1% |

Source: US Census Bureau and Tribal Government

Additionally, there is an increased likelihood of mortality for very young and very old populations due to transmissible disease. However, these assumed vulnerabilities should be viewed as theoretical due to the tremendous number of variables involved in a potential major disease event. The following table indicates the percentage of the total county population that may be considered especially vulnerable to a major disease.

**Table 4.225: Kansas Region K Vulnerable Population Vulnerability Data for Major Disease**

| County | Percentage of Population 5 and Under (2017) | Percentage of Population 65+ (2017) |
|---|---|---|
| Atchison | 6.0% | 16.8% |
| Brown | 6.6% | 19.8% |
| Doniphan | 5.9% | 19.1% |
| Douglas | 5.3% | 11.7% |
| Iowa Tribe | - | - |
| Jackson | 6.7% | 18.6% |
| Jefferson | 5.3% | 18.1% |
| Kickapoo Tribe | - | - |

| | | |
|---|---|---|
| Marshall | 6.8% | 21.3% |
| Nemaha | 7.6% | 20.0% |
| Washington | 7.1% | 23.8% |

Source: US Census Bureau

### 4.25.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.226: Major Disease Consequence Analysis**

| Subject | Impacts of Major Disease Outbreak |
|---|---|
| Health and Safety of Persons in the Area of the Incident | 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, and medical svc. |
| Responders | 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 | Continuity of Operations will be greatly dependent on availability of healthy individuals. COOP is not expected to be exercised. |
| Property, Facilities, and Infrastructure | Access to facilities and infrastructure could be affected until decontamination is completed |
| Environment | 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 | 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 Governance | Response and recovery will be in question if not timely and effective. Availability of medical supplies, vaccines, and treatments will come into question. |

## 4.26 – Radiological Incident

For purposes of this plan, a radiological incident is considered an accident involving a release of radioactive materials from a nuclear reactor. Radiological accidents could cause injury or death, contaminate property and valuable environmental resources, as well as disrupt the functioning of communities and their economies. Since 1980, each utility that owns a commercial nuclear power plant in the United States has been required to have both an onsite and offsite emergency response plan as a condition of obtaining and maintaining a license to operate that plant. Onsite emergency response plans are approved by the U.S. Nuclear Regulatory Commission (NRC).

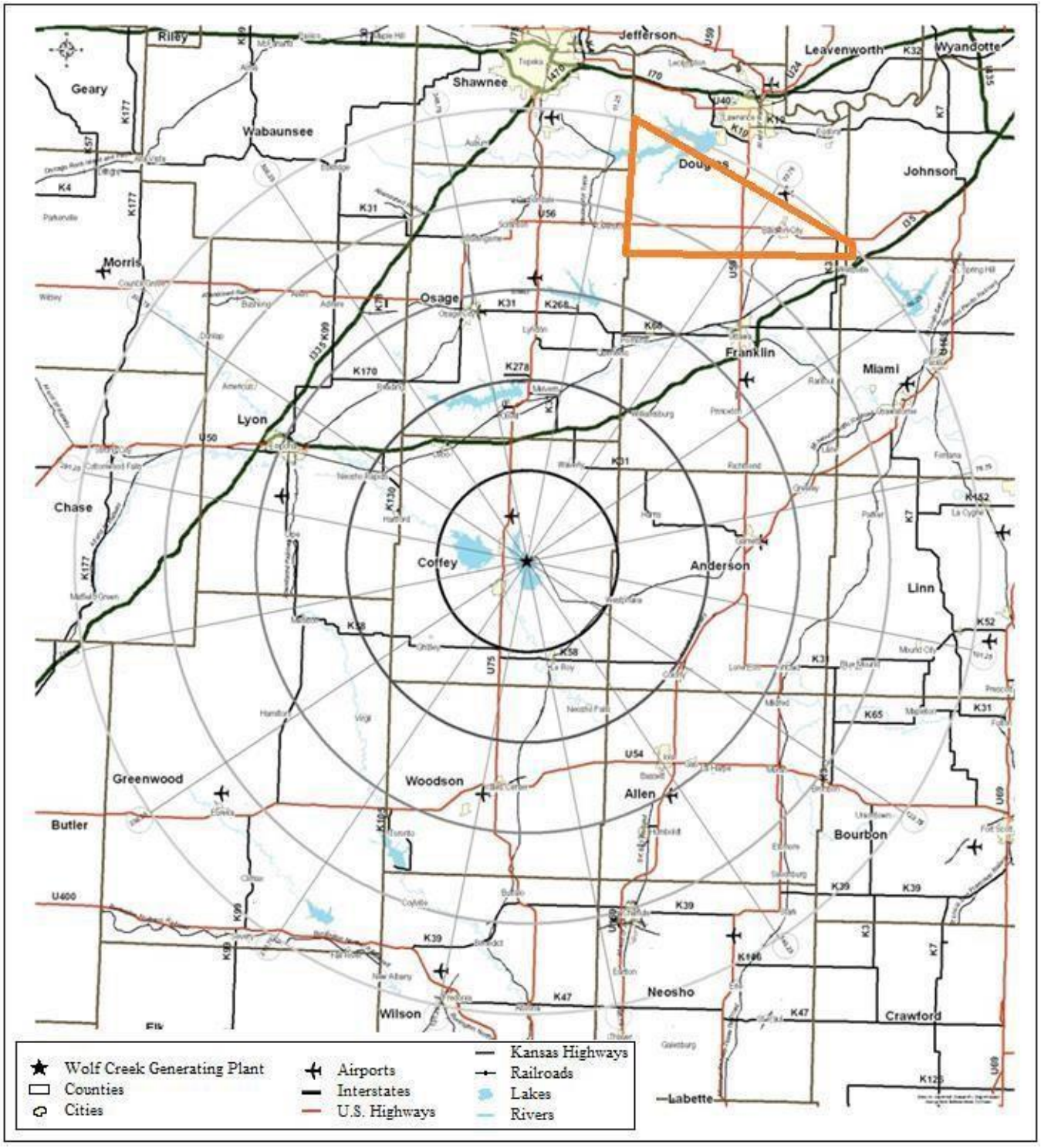
### 4.26.1 – Location and Extent

The only active commercial nuclear reactor within the State of Kansas is the Wolf Creek Nuclear Power Plant (Wolf Creek) in Coffey County. The following information, from the NRC, pertains to Wolf Creek:

- **Location:** Burlington, KS (3.5 miles NE of Burlington, KS)
- **Operator:** Wolf Creek Nuclear Operating Corp.
- **Operating License:** Issued - 06/04/1985
- **Renewed License:** Issued - 11/20/2008
- **License Expires** - 03/11/2045
- **Reactor Type:** Pressurized Water Reactor
- **Licensed MWt:** 3,565
- **Reactor Vendor/Type:** Westinghouse Four-Loop
- **Containment Type:** Dry, Ambient Pressure

The following map, from KDEM, illustrates both the 10-mile 50-mile emergency planning zones (EPZs) for Wolf Creek.

**Wolf Creek Generating Plant Exclusion Zones**




Because Region K is not located in the 10-mile EPZ, and only the southern half of Douglas County (excluding the major population center of Lawrence) is within the in the 50-mile EPZ, a nuclear incident from Wolf Creek is not considered a hazard.

## 4.26.2 – Previous Occurrences

There have been no previous major radiological events recorded in Kansas Region K.

### 4.26.3 – Hazard Probability Analysis

Historically there have been no nuclear failure and/or release events in Kansas Region K, or at Wolf Creek. The firm regulations imposed by the NRC on Wolf Creek work to ensure its safe operation. The amount of radioactivity released by a nuclear power plant is monitored continuously to be sure it does not go above allowed levels. The same sophisticated monitoring equipment provides exact information about any accidental release. The risk to the public from radioactivity released from nuclear power plants is smaller than the amount, and associated risk, we receive naturally on a daily basis.

### 4.26.4 – Vulnerability Assessment

Assuming the vulnerability to both structures and populations is not possible due to the tremendous number of variables involved in a potential nuclear release event. However, due to the relative distance of Kansas Region K from Wolf Creek, and the strict oversight provided by the NRC, the potential vulnerability to Kansas Region K is considered to be very low.

### 4.26.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.227: Radiological Incident Consequence Analysis**

| Subject | Impacts of Nuclear Incident |
|---|---|
| Health and Safety of Persons in the Area of the Incident | Impact in the immediate area could be severe and long lasting. |
| Responders | Impact to responders is expected to be severe, potentially even with required safety equipment. |
| Continuity of Operations | Long term relocation may be necessary if government facilities experience contamination. |
| Property, Facilities, and Infrastructure | Localized impact could be severe in the incident area. Facilities may need to be abandoned and razed. Large areas may become inaccessible. |
| Environment | Impact could be severe for the immediate area. Impact will lessen with distance. |
| Economic Conditions | Local economy and finances may be adversely affected, depending on the nature, extent and duration of the event. |
| Public Confidence in Governance | Response and recovery will be in question if not timely and effective. Warning systems and the timeliness of those warnings could be questioned. |

## 4.27 – Terrorism

The United States does not have a standardized definition of terrorism that is agreed upon by all agencies. The Federal Bureau of Investigation generally defines terrorism as:

"the unlawful use of force and 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."

### 4.27.1 – Location and Extent

Kansas is home to a wide variety of criminal extremist groups. The Southern Poverty Law Center reported that in 2018 there were three active hate groups in Kansas: one neo-Nazi group, the National Socialist Movement in Lansing, one racist skinhead group, the Midland Hammerskins in Wichita, and one anti-homosexual group, the Westboro Baptist Church in Topeka. Other groups, such as the Animal Liberation Front, Earth Liberation Front, and People for the Ethical Treatment of Animals may have sympathizers in the region. 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.

### 4.27.2 – Previous Occurrences

Kansas Region K has been fortunate to escape a major terrorist incident.

### 4.27.3 – Hazard Probability Analysis

By nature, acts of terrorism are difficult to foresee. However, the probability of a major terrorist event in Kansas Region K is considered very low due the lack of any documented historical events. Again, it is worth noting that no previous occurrences in no way guarantees no future occurrences.

### 4.27.4 – Vulnerability Analysis

For purposes of this assessment, data is not available to quantify vulnerability or estimated losses as a result of terrorism incidents that might impact state-owned facilities.

For this assessment, it is not possible to calculate a specific vulnerability for each county or participating jurisdiction. However, because of the desire for publicity following attacks, it is more likely that counties and jurisdictions with greater population densities and /or larger evet venues have a greater risk.

In general, it is difficult to quantify potential losses of terrorism due to the many variables and human elements and lack of historical precedence. Therefore, for the purposes of this plan, the loss estimates will take into account three hypothetical scenarios. The estimated impact of each event was calculated using the Electronic Mass Casualty Assessment and Planning Scenarios developed by Johns Hopkins University.

Please note that the hypothetical scenarios are included for illustrative purposes only.

**Scenario #1: Mustard Gas Release**

**Event:** 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 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.

**Event Assumptions:** For this scenario the number of people in the stadium is 50,000 with an additional 5,000 persons remain outside the stadium in the adjacent parking areas. The agent used, mustard gas, is extremely toxic and may damage eyes, skin and respiratory tract with death sometimes resulting from secondary respiratory infections. Death rate from exposure estimated to be 3%. The estimated decontamination cost is $12 person. For this scenario it is assumed that all persons with skin injuries will require decontamination.

**Results:** The following table presents the estimated human and economic impacts of the scenario.

**Table 4.228: Estimated Impact of Scenario #1, Mustard Gas Release**

| Impact | Post Exposure Onset Time | Effect |
|---|---|---|
| Severe Eye Injuries (1-2 hours) | 1 -2 Hours | 41,250 persons |
| Severe Airway Injuries (1-2 hours) | 1 - 2 Hours | 41,250 persons |
| Severe Skin Injuries (2 hours to days) | 2 Hours to Days | 49,500 persons |
| Deaths | Immediate to Days | 1,100 persons |
| Cost of Decontamination | N/A | $594,000 |

Source: Electronic Mass Casualty Assessment and Planning Scenarios by Johns Hopkins University

**Scenario #2: Pneumonic Plague**

**Event:** Four Canisters containing aerosolized pneumonic plague bacteria are opened in public bathrooms of heavily populated buildings (airports, stadiums, etc.). 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 attack method would not cause damages to buildings or other infrastructure, only to human populations.

**Event Assumptions:** Each canister contains 650 milliliters of pneumonic plague bacteria. The type of infectious agent used is identified on Day 4. After identification, the fatality rate is 10% for new cases. Pneumonic plague has a 1-15 percent mortality rate in treated cases and a 40-60 percent mortality rate in untreated cases.

**Results:** The following table presents the estimated human impacts of the scenario.

**Table 4.229: Estimated Impact of Scenario #2, Pneumonic Plague Release**

| Impact | Effect |
|---|---|
| Initial Infected Population | 440 persons |
| Secondary Infected Population | 883 persons |

| | |
|---|---|
| Deaths (7% of Infected) | 62 |

Source: Electronic Mass Casualty Assessment and Planning Scenarios by Johns Hopkins University

**Scenario #3: Improvised Explosive Device**

**Event:** An improvised explosive device utilizing an ammonium nitrate/fuel oil 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.

**Event Assumptions:** The quantity of ammonium nitrate/fuel oil mixture used is 4,000 pounds. The population density of the lot is assumed to be 1 person per every 25 square feet for a pre-game crowd. The Lethal Air Blast Range for such a vehicle is estimated to be 50 feet according to the Bureau of Alcohol, Tobacco, Firearms and Explosives Standards. The Falling Glass Hazard distance is estimated at 600 feet according to Bureau of Alcohol, Tobacco, Firearms and Explosives Explosive Standards. In this event, damage would 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. It is estimated that the average replacement cost for a vehicle is $20,000 and the average repair cost for damaged vehicles would be $4,000.

**Results:** The following table presents the estimated human impacts of the scenario.

**Table 4.230: Estimated Impact of Scenario #3, Improvised Explosive Device**

| Impact | Effect |
|---|---|
| Deaths | 1,391 persons |
| Trauma Injuries | 2,438 persons |
| Urgent Care Injuries | 11,935 |
| Injuries not Requiring Hospitalization | 4,467 |
| Repair Costs for 100 Vehicles | $400,000 |
| Replacement Costs for 50 Vehicles | $1,000,000 |

Source: Electronic Mass Casualty Assessment and Planning Scenarios by Johns Hopkins University

## 4.27.5 – Impact and Consequence Analysis

There is no consensus on estimates of potential fatalities and injuries for terrorism events. Injury and death tolls would be dependent on the type, size and weapon used. Areas with higher population densities would likely result in a greater number of casualties.

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.231: Terrorism Consequence Analysis**

| Subject | Impacts of Terrorism |
|---|---|

| | |
|---|---|
| Health and Safety of Persons in the Area of the Incident | Impact could be severe for persons in the incident area. |
| Responders | 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 | Depending on damage to facilities/personnel in the incident area, relocation may be necessary and lines of succession execution. |
| Property, Facilities, and Infrastructure | Impact within the incident area could be severe for explosion, moderate to low for Hazmat. |
| Environment | Localized impact within the incident area could be severe depending on the type of incident. |
| Economic Conditions | Economic conditions could be adversely affected and dependent upon time and length of clean up and investigation. |
| Public Confidence in Governance | Impact dependent on if the incident could have been avoided by government entities, clean-up, investigation times and outcomes. |

# 4.28 – Utility/Infrastructure Failure

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
- Internet/telecommunications systems

Failure of utilities or infrastructure components in south-southwest Kansas can seriously impact public health, functioning of communities and the region's economy. Disruptions to utilities can occur from many of the hazards detailed in this plan, but the most likely causes include:

- Floods
- Lightning
- Tornados and Windstorms
- Winter Storms

In addition to being impacted by another listed hazard, utilities and infrastructure can fail as a result of faulty equipment, lack of maintenance, degradation over time, or accidental damage.

## 4.28.1 – Location and Extent

All of Kansas Region K is at risk for utility and/or infrastructure failure. The following sections discuss the major utilities in further detail.

***Electric Power***

The most common hazards analyzed in this plan that may disrupt the power supply are flood, lightning, tornado, windstorm, and winter weather. In addition, extreme heat can disrupt power supply when air conditioning use spikes during heat waves resulting in brownouts or rolling blackouts.

In general, electricity in Kansas Region K is provided by either investor-owned utilities or rural electric cooperatives (RECs). RECs are not-for-profit, member-owned electric utilities. 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. Information on regional electrical suppliers may be found at www.kec.org/servicearea_map.html. Additionally, locations of electric certified areas and transmission lines may be found at www.kcc.state.ks.us/maps/ks_electric_certified_areas.pdf.

### *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 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 through closures and/or evacuations. Winter weather frequently impacts transportation as roads become treacherous or impassible due to ice and snow. Other hazards that impact transportation routes include dam and levee failures if routes are in inundation areas, extreme temperatures that can cause damage to pavement, land subsidence that can damage roads/railroads, landslides that can cause debris and rock falls onto roadways, terrorism that can target routes, tornados that can directly damage infrastructure or deposit debris in routes, wildfires that can cause decreased visibility on transportation routes due to smoke, and windstorms that can cause vehicle accidents or overturning.

### *Pipelines Systems*

Hazards that can impact natural gas and oil pipelines include earthquakes, expansive soils, land subsidence, landslide, and terrorism

### *Water and Sewer Systems*

The primary hazards that can impact water supply systems include drought, floods, hazardous materials, and terrorism. Water district boundary maps are available for review at https://krwa.net/ONLINE-RESOURCES/RWD-Maps.

### *Internet and Telecommunications*

Internet and telecommunications infrastructure can be impacted by floods, lightning, tornados, windstorms, and winter weather. 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 may 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 and usage volume. A map indicating telephone service providers in Kansas Region K is available at www.kcc.state.ks.us/maps /ks_telephone_certified_areas.pdf.

## 4.28.3 – Hazard Probability Analysis

Minor utility failures occur annually across the region, with larger failures usually tied to other disaster events such as tornados, winter storms and windstorms. As discussed throughout this plan, these concurrent events occur regularly. As such, it is expected that occasional, and largely concurrent utility failure events will occur.

## 4.28.4 – Vulnerability Assessment

Regionally, smaller utility suppliers generally have limited resources for mitigation. Thus, the large number of small utility service providers could mean greater vulnerability in the event of a major, widespread disaster, such as a major flood, severe winter storm or ice storm.

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

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.

**Table 4.232: FEMA Benefit-Cost Analysis**

| Loss of Electric Power | Cost of Complete Loss of Service |
|---|---|
| Total Economic Impact | $131 per person per day |
| Loss of Potable Water Service | Cost of Complete Loss of Service |
| Total Economic Impact | $103 per person per day |
| Loss of Wastewater Service | Cost of Complete Loss of Service |
| Total Economic Impact | $45 per person per day |
| Loss of Road/Bridge Service | Cost of Complete Loss of Service |
| Vehicle Delay Detour Time | $29.63 per vehicle per hour (one-way trips) |
| Vehicle Delay Mileage | $0.54 per mile (or current federal mileage rate) |

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

## 4.28.5 – Impact and Consequence Analysis

As per EMAP requirements, the following table provides the Consequence Analysis.

**Table 4.233: Utility/Infrastructure Failure Consequence Analysis**

| Subject | Impacts of Utility/Infrastructure Failure |
|---|---|
| Health and Safety of Persons in the Area of the Incident | 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 | Impact to responders will be minimal if properly trained and equipped. |
| Continuity of Operations | 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 | Impact is dependent on the nature of the incident, e.g., electric, water, sewage, gas, communication disruptions). (Minimal) |
| Environment | Impact, depending on the nature of the incident, should be minimal. |

**Table 4.233: Utility/Infrastructure Failure Consequence Analysis**

| Subject | Impacts of Utility/Infrastructure Failure |
|---|---|
| Economic Conditions | Economic conditions could be adversely affected depending on damages suffered, extent of damages, etc. (minimal) |
| Public Confidence in Governance | Impact will be dependent on whether or not the government or non-government entities response, recovery, and planning were not timely and effective (minimal). |