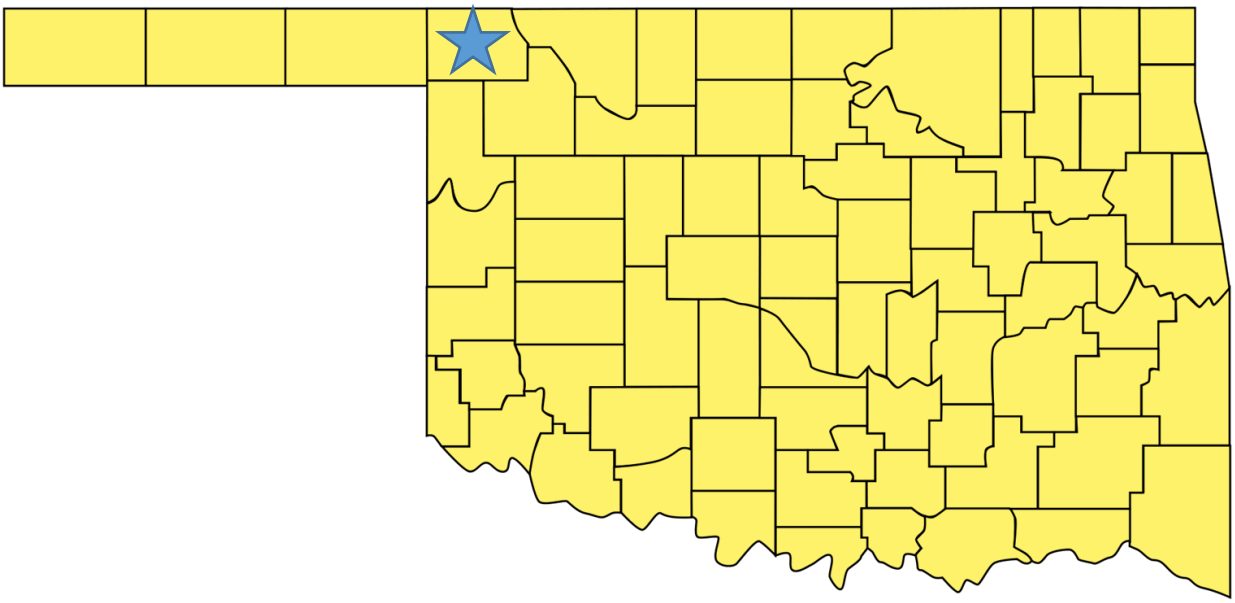
Oklahoma Department of Emergency Management



Hazard Mitigation Plan Update

HARPER COUNTY OK

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CHAPTER ONE: INTRODUCTION

1.1 Overview of Planning Area

Harper County is located in the northwest part of the state of Oklahoma and lies in a transition zone between a humid subtropical region of eastern Oklahoma and the semi-arid steppe to the west. Part of the Central Great Plains geographic region, western Harper County also lies in the Southwestern Tablelands. Average annual precipitation ranges from about 21 inches in the west to 27 inches on the east. May and June are typically the wettest months. Virtually every winter has at least one inch of snow, with one year in three having ten or more inches (Harper County Ok, 2019).

The Beaver River flows through the southwestern part of the county and drains the southern part. The Cimarron River flows across the northwestern part of the county, then along the northeastern edge of the county and drains the northern and eastern parts of the county. Buffalo Creek flows easterly, draining the center part of the county, and connects with the Cimarron River in Woodward County (NRCS 2019).

Agriculture is the basis for much of the economy in Harper County. Small grains, livestock, hay, and alfalfa are the main products. Livestock is usually beef cattle and swine, dairy cattle, and sheep. Several commercial feedlots are located in the county. The oil and gas industry provides a number of jobs in the county. There is an extensive network of oil and natural gas wells and pipelines throughout the county. A large natural gas plant is located near Laverne.

Population

As of the 2017 American Community Survey conducted by the US Census Bureau (ACS), the population was estimated to be 3,943. The county seat is Buffalo.

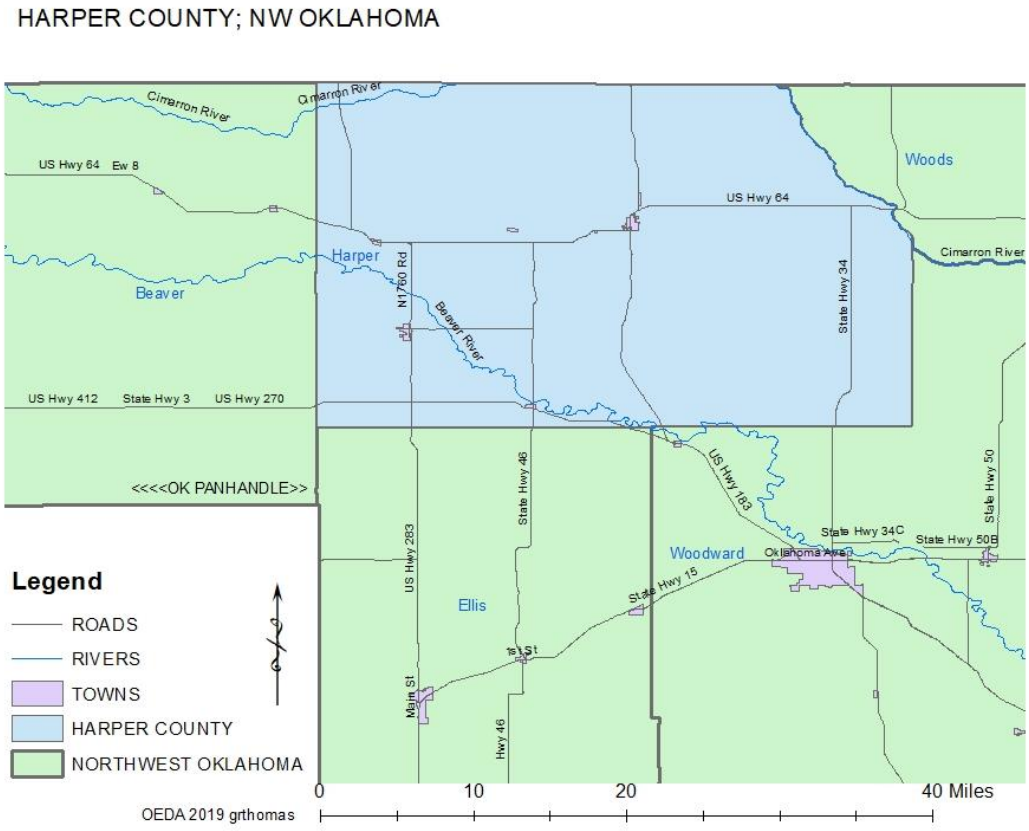
2017	Median Age	Median Household Income	Percent of Individuals in poverty
Harper County	43	46,915	13.2
Oklahoma	35	49,767	16.2

The population density is stated by the Census Bureau to be about 3 persons per square mile. There were 1,895 housing units, of which 1348 were occupied and 547 were vacant at an average density of 1.3 occupied housing units and 3.5 people per square mile.

These general facts do not fully represent conditions when the distribution of population and housing is considered. According to the US Census Bureau, the county has a total land area of 1,041 square miles, of which 1,039 is land and 2 mi^2 water. Of total population, 1,299 live in Buffalo and 1,344 live in Laverne, accounting for 71% of total population within about 1.6 square miles of land. Another 400 people live in population clusters such as May, Rosston and Selman. This shows the rural population to be less than 1 person per square mile; 900 people/1039 mi^2, or .86 persons, and about 409 occupied dwellings for a density of .4 DU's per square mile and 2.2 persons per rural household; one occupied home per about two square miles.

1.2 Participating Jurisdictions

Participating jurisdictions include Harper County, the Town of Buffalo, Town of Laverne, Town of May, Town of Rosston and the unincorporated community of Selman. Other participating local stakeholders including the Buffalo and Laverne School Districts; Buffalo, Laverne, May and Rosston Volunteer Fire Departments.



CHAPTER TWO: PLANNING PROCESS

2.1 Overview of Planning Process

The Harper County Hazard Mitigation Plan was developed through data collection, review of other plans, community outreach and a series of stakeholder meetings. The planning team followed the guidance of the Oklahoma Emergency Management Toolbox in establishing the agenda for each meeting. The team chose to follow a condensed version of a meeting schedule for two reasons; Harper County is a rural community, and the project is an update to a previous plan.

Time line			
Contract date: 6/03/2019	Time elapsed	Target date	Date complete
Preparatory activities, meetings, surveys	Initiate project	6/05/2019	8/3/2019
Data collection, assessments	60 days	8/3/2019	8/6/2019
Draft plan, establish Goals and Mitigation strategies	120 days	10/3/2019	10/25/2019 12/10/2019
Comments & coordinate w agencies, plan adoption	180 days	12/3/2019	
OEM acceptance of the Update	240 days	2/3/2020	

2.2 Planning Committee Members

Below is a list of planning team members. Meetings were posted and open to the Public.

Participating Jurisdiction	Name	Title	Contribution to Planning Process
Harper Co	Dale Spradlin	EM/Buffalo School Supt	Organize and coordinate meetings; grant administration; OEM; contracts; Provided information
Harper Co	Karen Hickman	Buffalo Co Clerk	Provided information; participate in meetings, review draft plan
Harper Co	Gary Nielsen	Co Commissioner	Provided information; participated in meetings, reviewed plan components
Harper Co	Rex Brewer	Co Commissioner D1	Provided information; participate in meetings, review draft plan
Harper Co	Clifford Davis	District 3	Provided information; participate in meetings, review draft plan
Buffalo	Brian Bowles	City Manager	Provided information; participate in meetings, review draft plan
Harper Co	Kerri Love	District 1	Provided information; participate in meetings, review draft plan
Harper Co	Gaylon Love	Citizen	Provided information; participate in meetings, review draft plan
Harper Co	Larry England	District 1	Provided information; participate in meetings, review draft plan
OEM	Lynn Gould	Oklahoma Emergency Management	Provided information; participate in meetings, review draft plan
Selman	Steve Myatt	Selman FD	Provided information; participate in meetings, review draft plan

2.3 Other Stakeholders

Organizations and agencies contacted are listed in the table below. Other comments were recorded from surveys and contact with citizens throughout the County.

Each of these participants provided information and helped with capability and risk assessments, hazard assessments and priorities:

Laverne	Mary C. Barth	Laverne City Manager
Laverne	Kendra Allen	Laverne School Supt.
May	Liz Dotson	Mayor
Rosston	Kevin Terry	Rosston FD
Laverne	Ted Bozarth	Laverne FD
May	CJ Breon	May FD
Buffalo	Steve Wilson	Buffalo FD
Harper Co	Clif Brinson	Harper Co SO Chief
Laverne	Chad Scoggins	Laverne PD
Buffalo	Bill Buss	Harper County Hospital
Selman	Richard Manass	RWD #1
Buffalo	Robin Daley	Trustee-EM
Laverne	Jan Love	Parkview Pointe Senior living
Rosston	Roxie Luckie	Town of Rosston
Harper County	Diann Adams	Citizen
Harper Co	Jacob Lemms	Phillips 66
Buffalo	Amy Yauk	Harper Co Comm Hospital
Harper Co	Kerry Stafford	Health Dept
Buffalo	Steve Wilson	Buffalo Fire Dept
Buffalo	Melissa Headlee	Harper Co Comm Hospital
State of OK	Raylene Somerlott	OEM

Neighboring Communities, Businesses, and Non-Profit Agencies Contacted

Name	Title	Agency Represented	How Agency Was Invited	Contributions to Plan
Keith Shadden	Emergency Manager	Beaver County	Personal contact	Provided information
Tom Sheats	Regional Fire Coordinator	OEDA	Personal contact	Capability, risk assessments

State and Federal Agencies Contacted

Name	Title	Agency Represented	How Agency Was Invited	Contributions to Plan
Matt Rollins	Hazard Mitigation Planner	State Agency: OEM	Email	Guidance on document preparation, Grant requirements
Joe Remondini	USACE (RETIRED)	OFMA	Personal contact	Information on Flood
Jon Philipps	Planner	OWRB	Personal contact	Information on Flood
Rick Smith	Meteorologist	National Weather Service	Email	Provided information
Troy Collier	Conservationist	NRCS	Email, phone	Provided information and data
Drew Daily	Fire Staff	Oklahoma Forestry Services	Email Correspondence	Provided data and information

2.4 Public Involvement

The public was given the opportunity to be involved in the planning process and their feedback was incorporated into the plan. A Press Release was published to inform a greater number of stakeholders. Public meetings were posted in accordance with Oklahoma Open Meetings Law and were held on the following schedule:

Public participation activity	Date
Harper Co Commissioners approve project contract	6/03/2019
Public Notice of planning project; Press Release	7/26/2019
Meeting dates: Working Group formed	8/6/2019
Introductory meeting; Capability assessment meeting	8/6/2019
Risk assessment; discussion of local hazards and survey	8/6/2019
Risk assessment review; mitigation strategy development	10/25/2019
Mitigation strategy review; Plan maintenance section	10/25/2019
Review draft plan; initiate 30-day Public comment period	12/20/2019
Harper Co Commissioners approve plan for submission to OEM	
Final acceptance of Plan by OEM	

Public comments were collected by personal contacts and use of a survey. Public concerns were addressed in the mitigation strategies that were developed and adopted, on pages 51-63 of this plan.

Table Of Citizen Participation	Activity	Date	Comments
Interviews	Business Owners & Various Citizens	From 6/03/2019 to 12/03/2019	More than 30 Individuals were Interviewed
News Media	Press Release	10/28/2019	Harper County Journal
Presentations to Governing Bodies	HarperCo Commissioners	6/3/2019 11/25/2019	Commissioners meeting

	Town of Buffalo	1119/2019	Public meeting
	Town of Laverne	11/19/2019	Public meeting
	Town of May	11/19/2019	Public meeting
Flyers posted	Harper Co Courthouse	12/20/2019	
	Town of Laverne	12/20/2019	
	Town of Buffalo	12/20/2019	
	Laverne Chamber of Com	12/20/2019	
Presentation			
Surveys	Surveys were distributed & collected by staff & committee members throughout the County	From 6/3/2019 to 10/3/2019	_28_ Surveys collected and Tabulated. Comments preserved & incorporated
Forum/Roundtable	Stakeholders invited & attended	11/19/2019	Public meeting
Social Media	Beaver County FB Page, Town Laverne FB page	12/20/2019	Posted
Area-specific meetings	County-wide FD mtg		
Website	OEDA	8/03/2019 thru 1/31/2019	Information about the Hazard Mitigation Planning update was posted on the OEDA website

2.5 Plans, Documents, and Literature Reviewed

During development of the Harper County Hazard Mitigation Plan Update, several existing plans and documents were reviewed. Data and information from these documents was incorporated into the plan. Of particular importance was disaster history and strategies recommended to mitigate the effects of such disasters. Location of critical infrastructure was reviewed and updated.

2.5.1 Literature and Resources Reviewed

Agency/Document	**Relevant Information Incorporated into Plan**
US Census Bureau Population Data	Demographic, economic, housing data, ACS 2017
National Climatological Data Center (NCDC)	Storm history, Climate data 2000-2019
OWRB Panhandle Watershed Region Report	Watershed and Groundwater information, 2019
OWRB Hydrologic Drought 2011 Report	Drought information 2012
OK State University Extension Service	*Drought and Its Impact on Agricultural Water Resources* February 2018
Oklahoma Conservation Commission	Watershed Fact Sheet; Harper County 2018
US Department of Environmental Quality	Hazardous waste permit sites 2019
	WaterWeb, Impaired waters 2019
	NPDES Discharge sites 2019
	Brownfields 2019
FEMA Map Service Center	Flood data, maps, NFIP information
NRCS, Woodward office	Flood data, information; Red Cedar
US Geological Survey	Data on seismic activity 2000-2017
State University Agricultural Extension Service	Drought, Land management
State Department of Transportation	Disaster history, Roads and Bridges

2.5.2 Plans Reviewed

During development of this Update of the HCHMP, other State and regional plans were reviewed for information on known hazards and disaster history in Oklahoma. A list of those plans is shown in the table below.

Plan Title	Relevant Information Incorporated into Plan
Harper Co Hazard Mitigation Plan	Storm history 1950 to 2009, risk assessment, mitigation strategies; 2009
Oklahoma State Hazard Mitigation plan	Hazards affecting the State, Disaster history, Mitigation strategies; 2019
Harper County Emergency Operations Plan	Comments HCEM
Capital Improvement Plans (CIP); Buffalo 2016, Laverne 2019	Mapping of critical infrastructure and public safety features such as communications and sirens
Oklahoma Comprehensive Water Plan 2012	Water availability, long term needs projection
School Emergency Action Plan	Buffalo, Laverne Schools

2.6 Continued Public Involvement

The Harper County Emergency Manager with the assistance of OEDA and the planning team will conduct an annual review of the Plan. The plan will be updated every five years. The public will be able to directly comment on and provide feedback about the Plan by contacting the Harper County Emergency Manager or OEDA directly. Public meetings will be publicized and open for public comment.

After the Plan is adopted, a copy of the plan will be available at the Harper County Court House and available to the publc. Copies of the Plan will be distributed to each City/Town Hall, Emergency Management Director, School Superintendent and local Library. The public will be invited to become involved in fund raising for specific Hazard Mitigation activities and educational opportunities over the life of the plan.

2.7 Plan Update Review, Evaluation, and Implementation

The plan will be monitored by Harper County Emergency Management, Harper County Commissioners, and the Local Emergency Planning Committee (LEPC) over a five-year period.

Responsible entity	Harper County EM	OEDA Staff	LEPC
Monitor	X		X
Evaluate	X	X	X
Update	X	X	

Monitoring – tracking the implementation of the entire plan over time.
Evaluating - assessing the effectiveness of the plan in achieving its stated purpose and goals.
Updating - reviewing and revising the plan at least once every five years.

Monitoring. The Harper County Emergency Management Director will perform monitoring of the plan and any site visits on as needed basis. The EM will also be the primary contact for phone calls and the scheduling of meetings.

- Monitor the hazard analysis for changes and additions; record new data as events occur
- Monitor objectives and determine if they continue to meet hazardous conditions
- Determine if there are implementation problems, such as financial, technical, political, legal, or issues of coordination with other agencies

Evaluate. The plan will be reviewed annually to ensure progress on mitigation objectives. Post disaster reviews will be utilized to evaluate the effectiveness of stated objectives as implemented. The planning committee members will meet annually to evaluate the risk assessment to ensure the vulnerabilities and hazards originally addressed are still valid. The planning committee will also evaluate the goals and the mitigation strategies to ensure they continue to address the priorities of each participating jurisdiction.

Implementation. The EM will maintain contact with a representative of each jurisdiction who will monitor the progress of the mitigation actions and seek out grant funding as programs announce availability.

Update. Two years before this plan expires, the plan update process will begin with the Harper County Emergency Manager and the Local Emergency Planning Committee (LEPC). The emergency manager and the planning committee will reconvene the plan development meetings for the Harper County Hazard Mitigation Plan Update, to discuss the progress made on this plan, update the capability and risk assessments, and revise the objectives and strategies as needed. A draft plan will be submitted to Oklahoma Emergency Management for review twelve months before the current plan expiration. Any revisions will be incorporated into the document as necessary, and the plan resubmitted to FEMA for approval. Once approved, participating jurisdictions will adopt the plan by resolution.

CHAPTER THREE: HAZARD IDENTIFICATION AND RISK ASSESSMENT

3.1 List of Identified Hazards included and excluded

Hazards that were considered for this update and jurisdictions likely to be affected are listed below in alphabetical order, and are prioritized in Chapter 4, Mitigation Strategies. The hazards included are identical to those addressed in the Oklahoma State Hazard Mitigation Plan with the exception of Dam Failure, Expansive soils, Landslide and Subsidence.

Hazards not addressed. *Dam Failure.* One small water control dam is on Paint Creek, in the SW quadrant of the county where failure would result in low to no loss of life and property damage would be limited to the dam itself. Low residential density in rural areas and few structures with basements indicate a very low risk from *Expansive soils*. There is little evidence of any risk associated with *Landslide* and no significant events have been recorded. *Land subsidence* is primarily a concern in Eastern Oklahoma; areas associated with historic mining activity (OKHMP, 2019).

Committee members and stakeholders discussed the frequency and severity of past disasters and completed the Hazard Vulnerability Assessment. Presidential disaster declarations, fire data, weather events, climate history, flood conditions, soil types and geological records were evaluated and recorded in this plan. Public comments and surveys were used to identify known risks and set the priorities of the community.

Hazards considered

Highlighted hazards are very low risk or not applicable to Harper County. No mitigation strategies were developed for those hazards.

Hazard	Jurisdictions Affected
Dam Failure	SW county (Mitigation not included in Update)
Drought	Entire county
Earthquake	Entire county
Expansive Soils	Low risk, Entire county (Mitigation not included in Update)
Extreme Heat	Entire county
Flood	Cimarron and Beaver River floodplains; areas of Laverne
Hail	Entire county
High Wind	Entire county
Landslides	Low risk entire county (Mitigation not included in this Update)
Lightning	Entire county
Subsidence	Low risk entire county (Mitigation not included in this Update)
Tornado	Entire county
Wildfire	Entire county
Winter Storm	Entire county

3.2 Disaster History

Thirteen Federally-declared disasters have occurred in Harper County since the year 2000. Seven were severe storms, three were severe ice storms, 2 fires, and 1 hurricane evacuation (Disaster Declarations by State & County, 2019). Information on Federally Declared disasters prior to 2000 in Harper County were documented in the previous Plan.

FEDERALLY DECLARED DISASTERS		
Date	Disaster #	Event
2017	5177	Wildfire outbreaks
2017	4299	Severe winter storms
2011	3316	Severe winter storms
2010	3308	Severe winter storms
2008	1775	Severe storms & flooding
2008	1803	Severe storms, tornados & flooding
2007	1712	Severe storms, tornados & flooding
2007	3280	Severe winter storms
2007	3272	Severe winter storms & flooding
2006	1623	Extreme wildfire threat
2005	3219	Hurricane Katrina Evacuation
2002	1401	Severe winter ice storm
2001	1384	Severe storms, tornados & flooding

3.3 Hazard Probability Rating

Probability means the likelihood of the hazard occurring and may be defined in a variety of terms. The method used to determine the probability of future hazard events was to take the number of events of each type and divide by the number of years being assessed. In this case, the Storm and event data was drawn from the National Center for Climate Data (NCDC), a division of the National Oceanic and Atmospheric Administration (NOAA).

Probability was determined by calculating the:

Total number of events (# per category) = Probability % of event occurring each year
Total number of years (19 years)
Based on the above calculation, probability is quantified as follows:

High	=	Event has 1 in 1 year chance of occurring ……. 100%
Medium	=	Event has 1 in 3 years chance ……. 33%
Low	=	Event has 1 in 5 years chance ……. 20%
Very Low	=	Event has 1 in 10 years chance …….. 10%

On the following pages, under each heading is a definition of the hazard and a description of what defines an "Event" for the purposes of this assessment.

Hazard Rating Matrix:

Hazard	Percent probability Events/years	Probability Rating
Drought	>Than 33%	Medium
Earthquake	0 of mag 3 or greater	Very Low
Expansive Soils	0	Very Low/None
Extreme Heat	23/1= >100%	High

Flood	1/100 = 1%	Very Low
Hail	149/19 = >100%	High
High Wind	114/20 = >100%	High
Landslides	0	Very Low/None
Lightning	6/11 = 60%	Medium
Subsidence	0	Very Low/None
Tornado	28/68 = 40%	High
Wildfire		High
Winter Storm	45/19 = >100%	High

3.4 Profiled Hazards

Each hazard listed in the plan must be profiled individually, and should include the following sections: Description, Location, Extent, Previous Occurrences, Probability of Future Events, Vulnerability, and Impact.

3.4.1 Drought

Drought. A drought is a period of drier-than-normal conditions. If dry weather persists and water supply problems develop, the dry period can become a drought.

The Oklahoma State Extension website states that "Drought is different from other natural hazards such as flood or wildfire, where negative impacts are felt very quickly. Drought follows a slow and accumulating process . . . This characteristic makes drought preparedness very challenging (OKState 2018)." The article points out three types of drought, Meteorological, Agricultural and Hydrological. Together, these contribute to social (economic) effects of drought.

Meteorological drought is lower precipitation than is typical for a specific area, and precedes the other types. The terms Agricultural drought and Hydrological drought are most pertinent to this assessment. *Agricultural drought* depends not only on precipitation, but soil conditions, groundwater or surface water as well. Crops are also more susceptible to insufficient moisture at certain stages of development. *Hydrological drought* refers to the impact of precipitation deficiency on water levels in streams, lakes, reservoirs and groundwater. This is a long-term type of drought that can have an impact on wells and public water supplies.

Location

Drought is a threat throughout the county, with the potential to impact agribusiness, other business and industry, municipal water supplies and residential properties dependent on wells. On farms and ranches, both crops and livestock may be compromised during periods of extended drought. Because of the semi-arid ecological zone, northwest Oklahoma is more vulnerable to drought than the eastern parts of the state. A 2011 drought and heat wave in the Regional southern plains and southwest states caused more than $12 billion in damages and 95 deaths (not including wildfires).

Extent

Palmer Drought Scale:

Palmer Drought Severity Index		
	< -4.0	Extreme Drought
	-3.99 to -3.0	Severe Drought
	-2.99 to -2.0	Moderate Drought
	-1.99 to -1.0	Mild Drought
	-0.99 to -0.5	Incipient Drought
	-0.49 to 0.49	Near Normal
	0.5 to 0.99	Incipient Moist Spell
	1.0 to 1.99	Moist Spell
	2.0 to 2.99	Unusual Moist Spell
	3.0 to 3.99	Very Moist Spell
	> 4.0	Extreme Moist Spell

Previous Occurrences

Drought has always been part of Oklahoma's climate because of highly variable precipitation patterns. The history of drought and the history of Oklahoma go hand and hand. In the early 1930's, a combination of drought conditions combined with poor soil management practices resulted in a devastating situation that people endured from 1931 until 1939. Known as the Dust Bowl this period represents the worst drought in American history. Oklahoma was especially hard hit. As a consequence of those disastrous years, soil conservation became a priority.

Records reveal several other periods of devastating rainfall deficits for much of western Oklahoma. Recent and historic data indicate that hydrologic droughts in Oklahoma have occurred in Water Years (WY) 1929-41, 1952-56, 1961-72, and 1976-81 (OWRB, Drought Fact Sheet, 2011). In 2001-2002 the Panhandle climate division experienced its second-driest June-through-July-of-the-following-year on record, recording just 59% of normal rainfall over the 14-month span. The only similar period for which the division observed less rain occurred during the Dust Bowl of the 1930's (Arndt, 2002).

Extreme hydrologic drought was also experienced during WY 2006 (October 1, 2005, through September 30, 2006). The severity of drought during WY 2006 and again in 2011 becomes especially evident when compared to the four previous major hydrologic droughts of the 20th century. Statewide, WY 2011 ranks as the 16th driest year in 87 years of streamflow records (OWRB, Drought Fact Sheet, 2011).

Probability of Future Events

Oklahomans must be prepared for severe and extended future drought episodes. The CPRI Index value for drought in the State of Oklahoma is 3.1 (Critical), which indicates a 33% chance of occurrence. Figures for Harper County may be higher due to its location in the western and drier part of the State. At the same time, water demand is projected to rise and aquifer levels are projected to fall (See Aquifer map below).

According to the State of Oklahoma HMP, "Droughts are projected to increase in severity and frequency due to climate change. Even if annual precipitation amounts do not change much, higher temperatures will increase evaporation from lakes, soils, and plants, stressing agricultural and natural systems. Models project that Oklahoma will experience a decrease in soil moisture across all seasons by the end of the century, with the greatest decrease in the summer (Wehner et al. 2017). Further, rising temperatures will lead to increased demand for water and energy, which could stress natural resources (Shafer et al. 2014)" (SCIPP, 2018).

Projected water demand

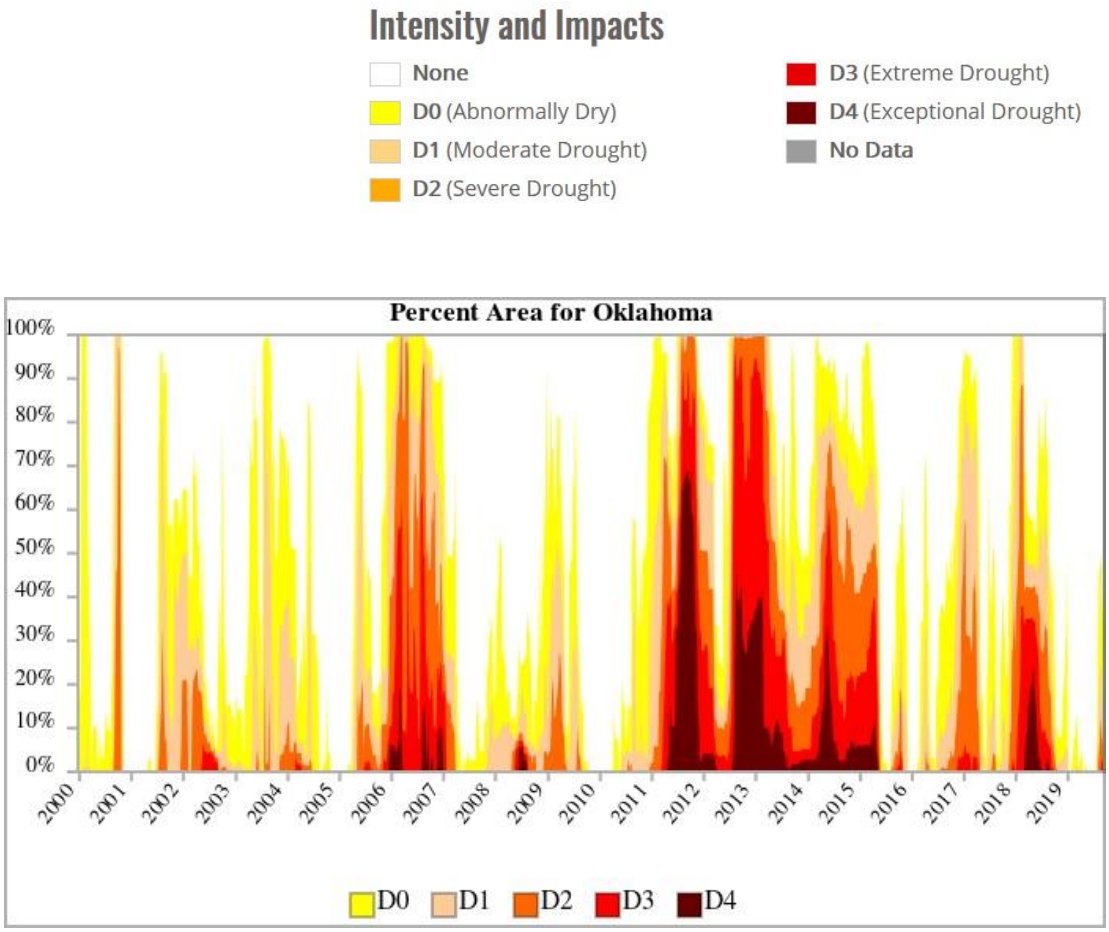
Water demands are expected to increase over the next few decades. That situation would result in an intensified vulnerability to drought.

Table 28 - Summary of Water Demands by County, All Sectors (AcreFoot/Year)*

County	2007	2010	2020	2030	2040	2050	2060
Harper	13,112	13,416	14,311	15,238	16,210	17,105	18,326

(OWRB, Oklahoma Comprehensive Water Plan, 2011)

The table below shows the history of drought conditions in Oklahoma during the period between 2000 and 2019.



The U.S. Drought Monitor started in 2000. Since 2000, the longest duration of drought (D1-D4) in Oklahoma lasted 239 weeks beginning on November 2, 2010 and ending on May 26, 2015. The most intense period of drought occurred the week of October 4, 2011 where D4 affected 69.82% of Oklahoma land (Drought in OK, 2019).

Vulnerability

Source of municipal drinking water in Buffalo, May, Laverne: Public wells. *Rosston:* private wells. *Selman RWD #1:* well located in Woodward County.

Crops. Agricultural activity is always susceptible to the negative effects of drought. Crops at critical stages of development can show a loss of productivity or become a total loss when precipitation is severely limited. In Northwest Oklahoma, many farmers make use of irrigation from groundwater wells to mitigate the impacts of low precipitation levels.

Over time, this heavy draw on groundwater supplies has had a long term impact on the Ogallala Aquifer that underlies a massive land area stretching from southern South Dakota to north Texas. During the 1990s, the aquifer held some three billion acre-feet of groundwater used for crop irrigation as well as drinking water in urban areas. The combined effect of agricultural irrigation of thousands of acres of farmland in eight states may become unsustainable at some point. The depletion between 2001 and 2008, inclusive, was about 32% of the cumulative depletion during the entire 20th century (USGS 20012). Since 2008, the number of irrigated acres has only increased.

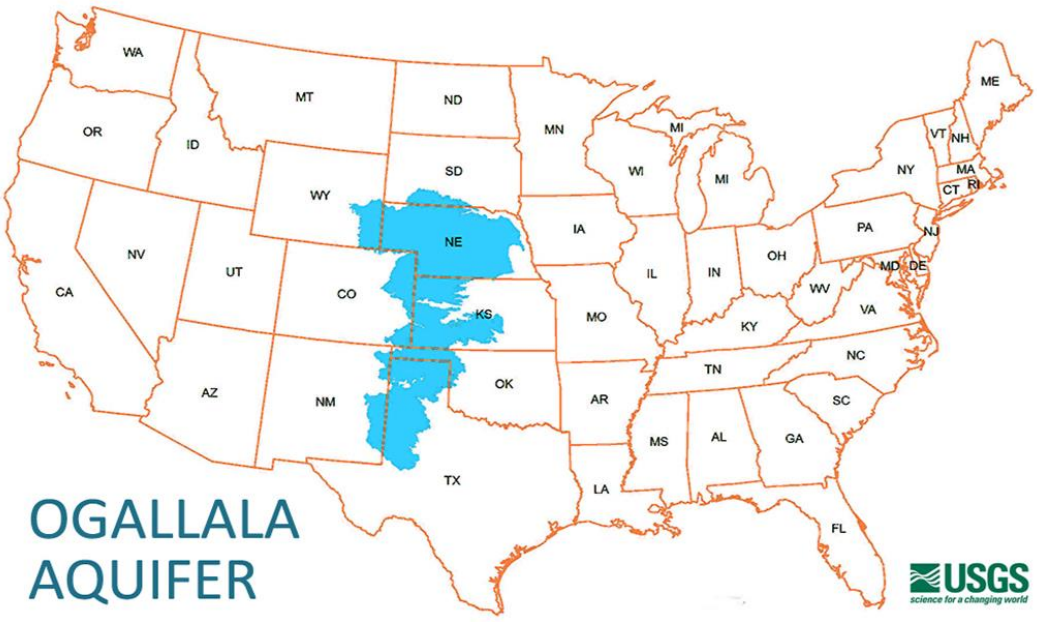
The water level is particularly on the decline in Texas and New Mexico. Continued long-term use of the aquifer is "troublesome and in need of major reevaluation," according to the historian Paul H. Carlson, professor-emeritus from Texas Tech University in Lubbock.

Livestock suffer when drought impacts the availability of vegetation suitable for grazing and hay production. When extreme, drought can affect the quantity and quality of surface water available to livestock. Wells pumped by windmill may be affected, depending on the depth of the well and the groundwater strata with which it intersects.

Public water supply. The aquifer system supplies drinking water to 82% of the 2.6 million people who live within the boundaries of the High Plains study area (USGS 2008).

Special Considerations

Flow at stream gages in Harper County and upstream on the Cimarron River and the Beaver River show a trend of less water annually over the last few decades. This may indicate an increasing vulnerability to drought. See graphs Chapter 5, page 66 that illustrate flow data.



Groundwater recharge. The rate at which recharge water enters the aquifer is limited by several factors. Much of the plains region is semiarid, with steady winds that hasten evaporation of surface water and precipitation. In many locations, the aquifer is overlain, with a shallow layer of caliche that is practically impermeable; this limits the amount of water able to recharge the aquifer from the land surface.

During drought, many water systems fail under the strain of greatly increased customer demand for water. The following statements are drawn from the OWRB Hydrologic Drought Report published in 2012.

> Older facilities are especially vulnerable. State and federal funding programs—such as the Oklahoma Water Resources Board's Financial Assistance Program, which has provided more than $2.7 billion in water/sewer infrastructure projects—have done much to increase the drought resistance of Oklahoma's local water treatment and distribution systems.
>
> An analysis conducted for the 2012 Update of the Oklahoma Comprehensive Water Plan (OCWP) estimates that Oklahoma faces an $82 billion need in such financing over the next 50 years.

Fire. In addition to municipal water supply and agricultural effects, drought poses a significant risk in increased fire danger.

Impact

The impacts of drought are a safety and economic threat to Harper County. In addition to potentially drastic reductions in streamflow and lake and aquifer levels, which can severely impact domestic and municipal water supplies, drought can reduce significantly the amount of water available for hydropower generation, trigger deadly wildfires, and devastate the environment. The economic impacts can be staggering. The 2011 drought and heat wave in the southern plains and southwest states caused more than $12 billion in damages and 95 deaths (not including wildfires) (OWRB, Drought Fact Sheet, 2011)

3.4.2 Earthquake

Earthquake. An earthquake occurs when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane. The location below the earth's surface where the earthquake starts is called the hypocenter, and the location directly above it on the surface of the earth is called the epicenter.

Most earthquakes occur as the result of slowly accumulating pressure that causes the ground to slip abruptly along a geological fault plane on or near a plate boundary. The resulting waves of vibration within the earth create ground motion at the surface that vibrates in a very complex manner.

The Oklahoma Geological Survey (OGS) is a state agency for research and public service charged with studying the state's land, water, mineral and energy resources. OGS began earthquake monitoring 40 years ago with its first seismic station that is still in operation near Leonard, Oklahoma. In April 2015, the OGS determined that the majority of recent earthquakes in central and north-central Oklahoma are very likely triggered by the injection of produced water in disposal wells (Earthquakes in Oklahoma, 2019).

Location

All locations in Harper County are at risk of earthquake. Earthquakes do not appear to correlate with fault lines. Areas of greater damage potential are residential clusters, roads, bridges and other infrastructure such as electrical equipment such as transformers and utility poles.

Extent

During the last two decades, Harper County has experienced 38 earthquakes with magnitudes of from 2 to 3. Many of these are very mild earthquakes which are picked up on seismic instruments and may go unnoticed by the population. See Richter Scale on the following page.

Previous Occurrences

Data gleaned from geographic shapefiles downloaded from the Oklahoma Geological Survey; University of Oklahoma indicate that in the last 8 year period, 38 earthquakes have occurred in Harper County, virtually all of which were in magnitudes between 2 and 3; only three were of magnitude equal to or greater than 3 (slight to moderate) (Data, 2018). One OGS record indicates an earthquake of magnitude 3 occurred in 1999. See Map below; Table, Appendix XXX

The Richter Scale

Magnitude	Mercalli	Description	Earthquake Effects
2	I	Instrumental	Not felt except by a very few under especially favorable conditions.
	II	Feeble	Felt only by a few persons at rest, especially on upper floors of buildings.
3	III	Slight	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
	IV	Moderate	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
4	V	Rather Strong	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5	VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
	VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
6	VIII	Destructive	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
7	IX	Ruinous	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
	X	Disastrous	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
8	XI	Very Disastrous	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
	XII	Catastrophic	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: http://earthquake.usgs.gov/learn/topics/mercalli.php

Probability of Future Events

Thirty-eight mild to moderate earthquakes (magnitude 2 to 3) were recorded in Harper County over the most recent eight year period. These type of seismic earthquakes are so mild that residents nearby may not even notice them. There is a 100% probability of 4 or 5 of these per year (38/8 = 4.75).

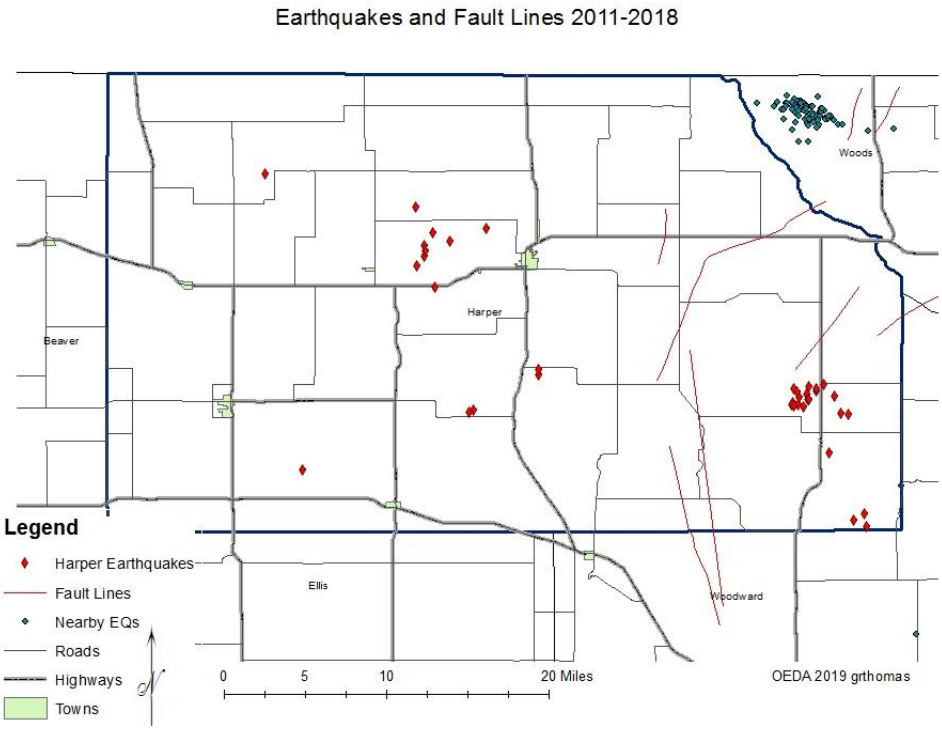
The probability of a damaging earthquake is Low.

Vulnerability

The entire county is vulnerable to potential earthquakes. Of special concern are infrastructure, such as roads, bridges, water or sewer structures and electrical installations. Vulnerable populations include people in schools, hospitals and nursing homes.

Impact

Most earthquakes in Harper County are of low magnitude and have negligible impact. In the event of a larger quake, vulnerable buildings and infrastructure could be impacted.

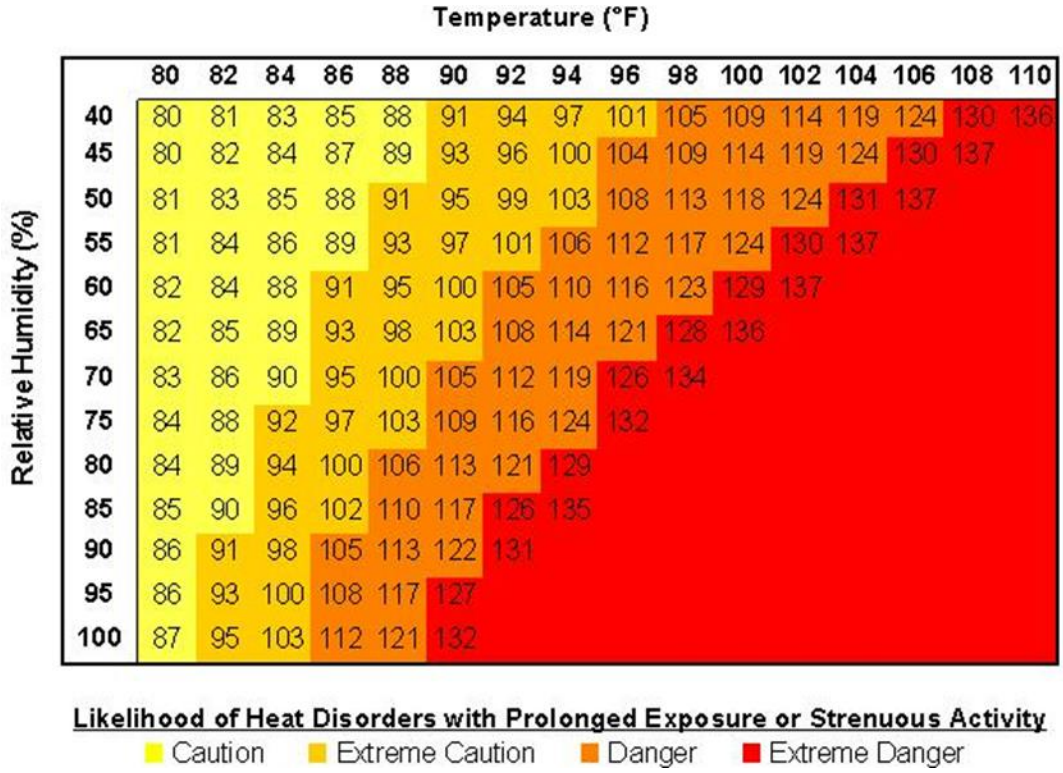


Earthquakes Nearby. In one eight-month period, between 7/21/2017 and 3/16/2019, a cluster of 28 mild to moderate earthquakes occurred in NW Woods County within 15 miles of the Northeastern boundary of Harper County. Ranging in magnitude from 2.5 to 3.1, these quakes occurred at depths of 8.1 kilometers to as shallow as .1 km (most were at depth of about 4 to 5 km), but were too mild to be damaging. See Map above.

3.4.3 Extreme Heat

Extreme Heat. Summertime temperatures routinely climb above the 100-degree mark, which can create very uncomfortable conditions when combined with high dew point. Temperatures that hover 10 degrees or more above the average high temperature for an area, and last for several days or longer, is one measure of extreme heat. In addition, humid or muggy conditions can persist and air quality can deteriorate during the summer when a dome of high atmospheric pressure creates a temperature inversion that traps a stagnant air mass near the ground.

A combination of high temperatures with high humidity creates a dangerous environment for humans and livestock. As shown below, even a temperature of 90’ can be dangerous if the humidity is 70 percent. Oklahoma humidity is typically between 43% and 83% during summer days.



Average Humidity

In the sample table (right) the humidity levels shown here are averages for the years 1961 to 1990. In this table, the Daily number for the month or year is the average of humidity readings taken every three hours throughout the day. Morning percentages are for 6 am; afternoon measures are for 3 pm local standard time.

1961 to 1990 AVERAGE HUMIDITY IN OKLAHOMA (%)			
Daily		Morning	Afternoon
67	January	77	51
66	February	77	51
61	March	75	46
61	April	77	45
68	May	83	51
67	June	84	51
61	July	80	44
62	August	80	43
67	September	83	49
64	October	79	46
67	November	79	50
68	December	78	52
65	Annual	79	48
Average relative humidity (%) for Oklahoma City, OK			
https://www.currentresults.com/Weather/Oklahoma/humidity-by-month.php			

Location

Extreme heat events affect the entire planning area.

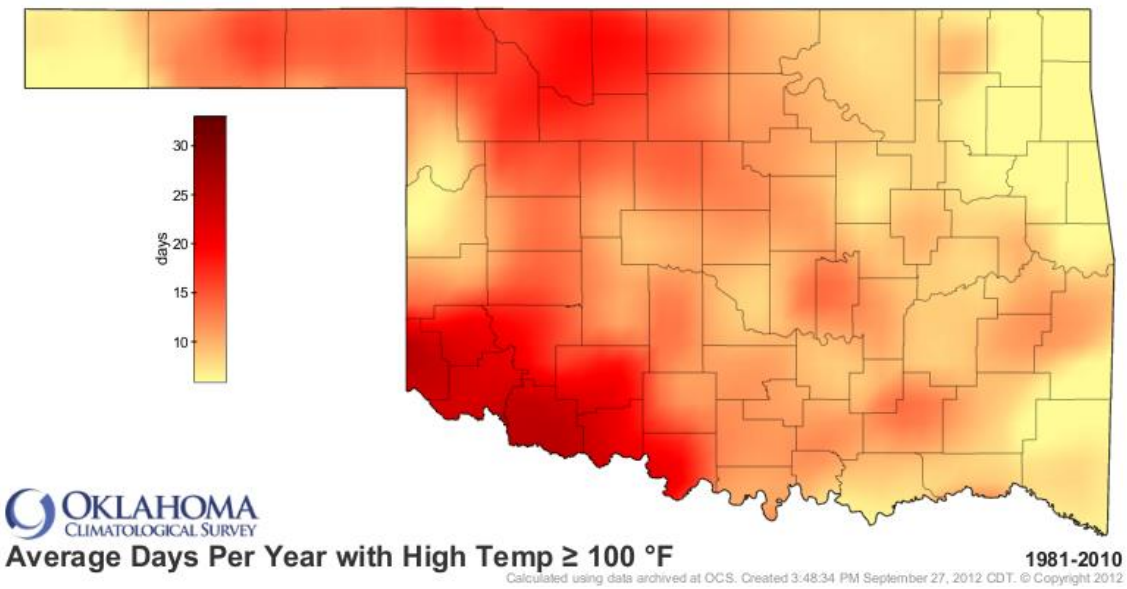
Extent

It is common for temperatures of more than 90 or 100 degrees Fahrenheit to be recorded during the summer in Northwest Oklahoma. The table below illustrates the average and extreme temperatures for Harper County Oklahoma between 1971 and 2003. The highest recorded temperatures were 115', in 1986 and 1936. (Climate, 2019)

	AVERAGES (1971-2000)			EXTREMES (1907-2003)			
	Daily Max	Daily Min	Daily Avg	Record High		Record Low	
Jan	49.1	20.8	35.0	87	(20th, 1986)	-17	(4th, 1947)
Feb	56.5	26.0	41.3	92	(12th, 1962)	-13	(1st, 1951)
Mar	65.2	34.2	49.7	99	(19th, 1907)	-8	(11th, 1948)
Apr	74.6	43.2	58.9	105	(23rd, 1989)	15	(2nd, 1936)
May	82.3	53.5	67.9	108	(23rd, 1996)	25	(4th, 1907)
Jun	92.0	63.2	77.6	111	(12th, 1917)	35	(2nd, 1907)
Jul	97.9	68.4	83.2	115	(29th, 1986)	45	(4th, 1927)
Aug	96.5	67.0	81.8	115	(13th, 1936)	40	(30th, 1944)
Sep	88.2	58.7	73.4	112	(4th, 2000)	26	(30th, 1984)
Oct	77.1	45.9	61.5	102	(4th, 1954)	12	(30th, 1917)
Nov	60.8	32.6	46.7	93	(8th, 1980)	0	(13th, 1940)
Dec	51.0	23.8	37.4	89	(24th, 1955)	-10	(30th, 1983)
Annual	74.4	44.9	59.6	115	(Aug 13, 1936)	-17	(Jan 4, 1947)

Previous Occurrences

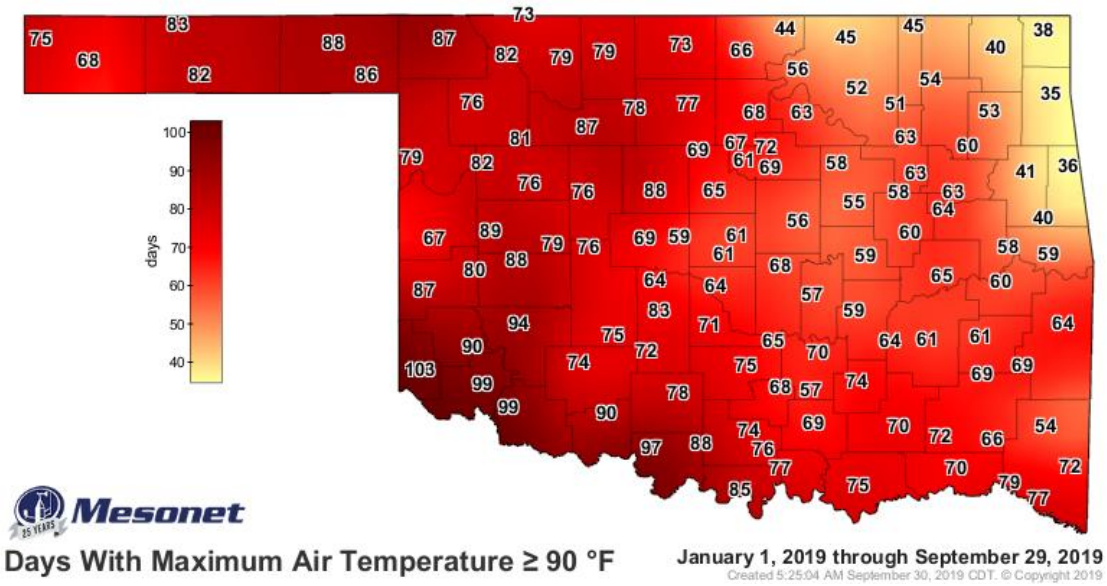
The map below illustrates the average number of days the temperature reached or exceeded 100 degrees during the years between 1981 and 2010.



Probability of Future Events

Referring back to the Temperature & Humidity graph on page 22, we can see that any time the temperature exceeds 98 degrees, there is heat danger to humans and livestock. As the humidity rises, the danger is present even at lower absolute air temperatures.

Summer 2019 data indicates there were 87 days during which the temperature was 90 degrees or higher, and on 23 of those days temperatures exceeded 100 degrees. Therefore, the probability of a dangerous heat event is 100 percent, High.



Vulnerability

Humans, crops and livestock are vulnerable to injury or death from extreme heat, especially people working outdoors, very young children and the elderly.

Impact

In extreme heat situations local emergency responders may accompany fire departments on calls in the event they are needed to rehabilitate fire fighters. Infrastructure such as roads, bridges and electrical lines can be damaged due to expansion and contraction during extreme temperatures.

3.4.4 Flood

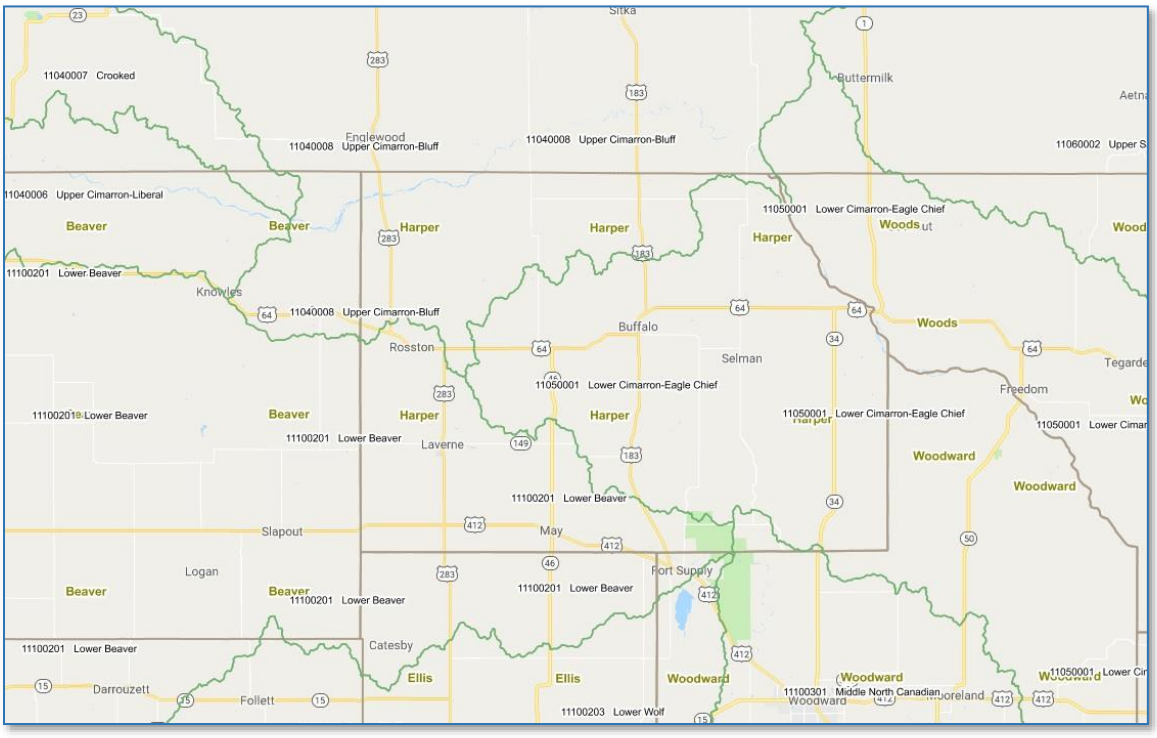
Flood. River flooding is when a river rises to its flood stage and spills over the banks. The amount of flooding is usually a function of the amount of precipitation in an area, the amount of time it takes for rainfall to accumulate, previous saturation of local soils, and the terrain around the river system. A river located in a broad, flat floodplain will often overflow to create shallow and persistent floodwaters in an area that do not recede for extended periods of time. The excess water can be from snowmelt or rainfall far upstream. Flood effects can be local, impacting a neighborhood or community. They can also be very large, affecting entire river basins and multiple states.

Riverine flooding occurs when a stream becomes so full as to overflow onto adjacent lands. Sheet flooding occurs when excessive rainfall exceeds the design capabilities of drainage facilities and ponding occurs.

Average annual precipitation in Harper County is about 26.2 inches a year. The county has not been mapped by FEMA and therefore is not included in the National Flood Insurance Program (NFIP). The county boundary crosses portions of four watersheds as identified below:

Name of watershed	HUC 8 Number
Upper Cimarron – 1104	11040008
Lower Cimarron – 1105	11050001
Lower Beaver – 1110	11100201
Lower N Canadian – 1110	11100301

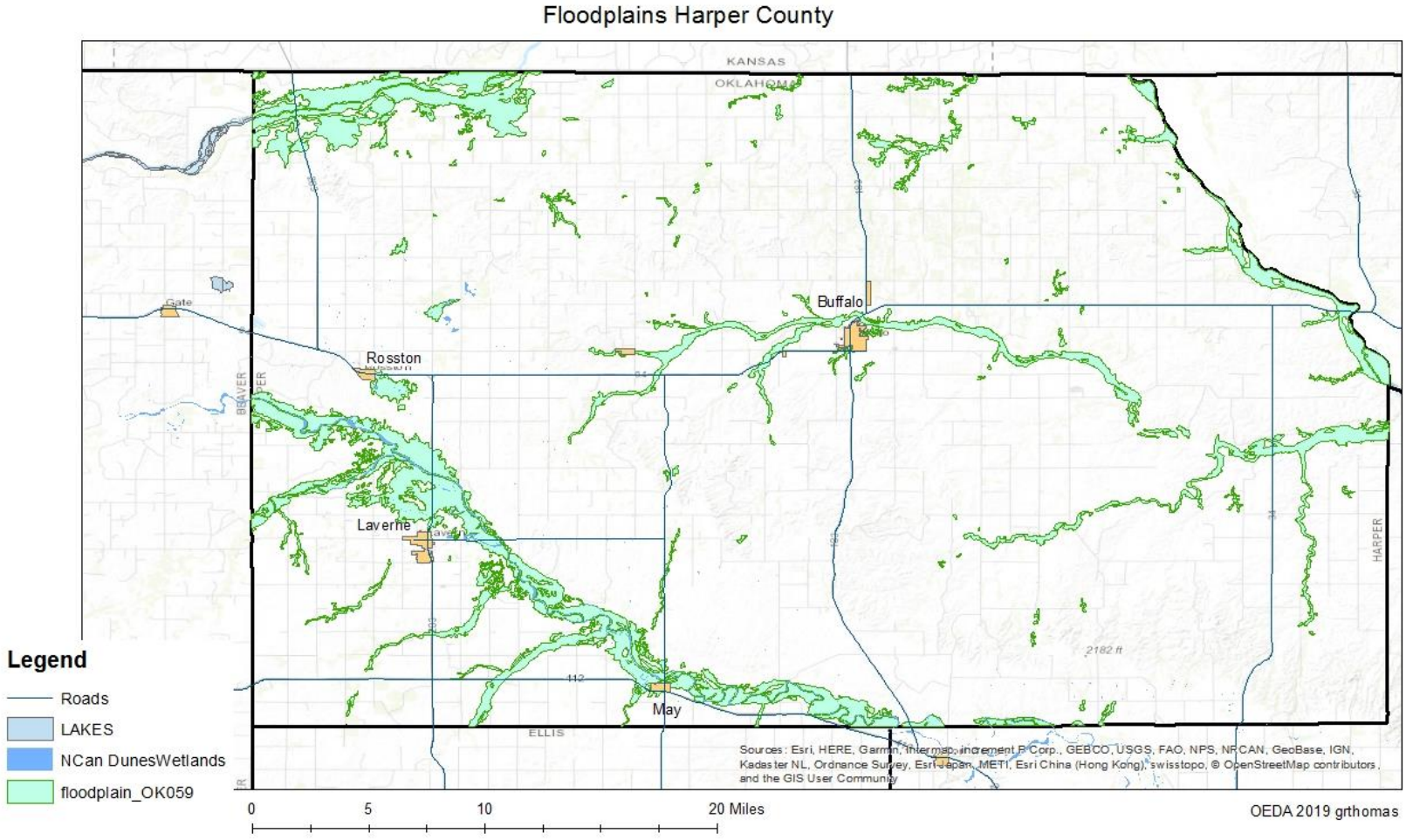
See map below (OK Maps, 2019)



Because the floodplain has not been delineated by FEMA, local data was used to determine the flood hazard area. Information was provided by NRCS and also drawn from local knowledge, topographic maps, water features and a study of soils.

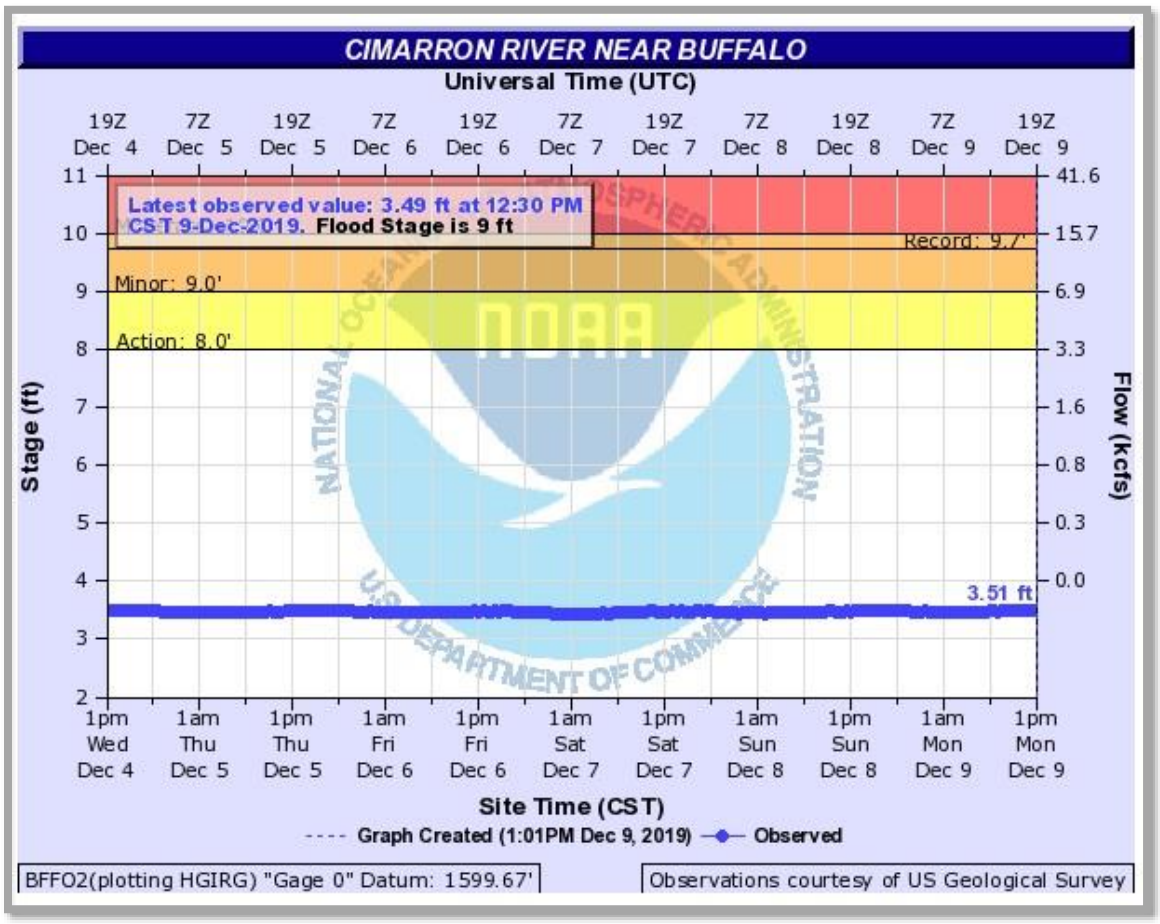
Repetitive and Severe Repetitive Loss Structures in Planning Area. No repetitive loss structures have been identified in the planning area.

Location


Floodplains Harper County
KANSAS
OKLAHOMA
Buffalo
Rosston
Laverne
May
Gate
BEAVER
HARPER
ELLIS
2182 ft
Legend
Roads
LAKES
NCan DunesWetlands
floodplain_OK059
0
5
10
20 Miles
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
OEDA 2019 grthomas

Extent

There is a single stream gage in Harper County, located on the NE edge of the county on the Cimarron River. Flood stage at this point is 9ft. Record Flood level is 9.7ft.



Previous Occurrences

Five flood events were reported between 01/01/2000 and 12/31/2016.

	County/Zone	St.	Date	Time	Dth	Inj	PrD	CrD
5162203	HARPER CO (SELMAN)	OK	10/25/2000	5:00	0	0	1.000M	250K
5386951	HARPER (ZONE)	OK	03/04/2004	16:30	0	3	1.000M	250K
5457082	HARPER (ZONE)	OK	06/10/2005	21:30	0	0	0.00K	0.00K
5456821	HARPER (ZONE)	OK	06/18/2005	12:30	0	0	0.00K	0.00K
42971	HARPER CO. (BUFFALO)	OK	06/14/2007	11:40	0	0	0.00K	0.00K

Probability of Future Events

The areas shown on the Floodplain map above are estimated to have a 1% annual chance of being inundated during a flood event. That measure is known as a Base Flood. Areas closer to the average elevation of the stream will, of course flood more frequently. Four localized floods were recorded in the years between 2000 and 2016. That results in a flood probability of 25%, or Low to Moderate Risk. (4/16 = 25%).

Vulnerability

Harper County does not have a floodplain ordinance for issuance of permits to regulate building within flood zones. Critical facilities and infrastructures within all participating jurisdictions in would be as susceptible to flooding as any other structure in the county that is not in a floodplain.

Impact

Street flooding is likely within all participating jurisdictions in Harper County in areas where poor drainage exists. No critical facilities identified in this Plan are located within the 100 year floodplain. Roads and bridges are subject to erosion from flood events.

3.4.5 Hail

Hail is a form of precipitation that consists of solid lumps of ice, which are individually called hailstones. Hail formation requires an atmospheric environment of strong, upward moving air, called an updraft, within the subfreezing region of a thunderstorm cloud. Large hail stones greater than an inch in diameter (quarter size), can result from a severe thunderstorm and require a very powerful updraft to form. Most large hail is the product of supercell thunderstorms, which have a sustained rotating updraft that moves growing hailstones through the height of the cloud before falling to the ground.

Hail Diameter (Inches)	Description
1/4”	Pea
1/2”	Small Marble
3/4”	Penny or Large Marble
7/8”	Nickel
1”	Quarter
1 1/4”	Half Dollar
1 1/2”	Walnut or Ping Pong Ball
1 3/4”	Golf Ball
2”	Hen’s Egg
2 1/2”	Tennis Ball
2 3/4”	Baseball
3”	Teacup Size
4”	Grapefruit
4 1/2”	Softball

Location

Hail events have the potential to affect the entire county.

Extent:

See Hail Diameter Description Scale, right.

HARPER CO HAIL 2000-2018	
Magnitude (inches)	# Events (149)
0.75	29
0.88	27
1	35
1.25	10
1.5	8
1.75	27
2	3
2.75	5
3	2
3.5	1
4.25	2

Previous Occurrences

One hundred forty-nine hail events of ¾ inch and larger were recorded by NOAA between 2000 and 2018.

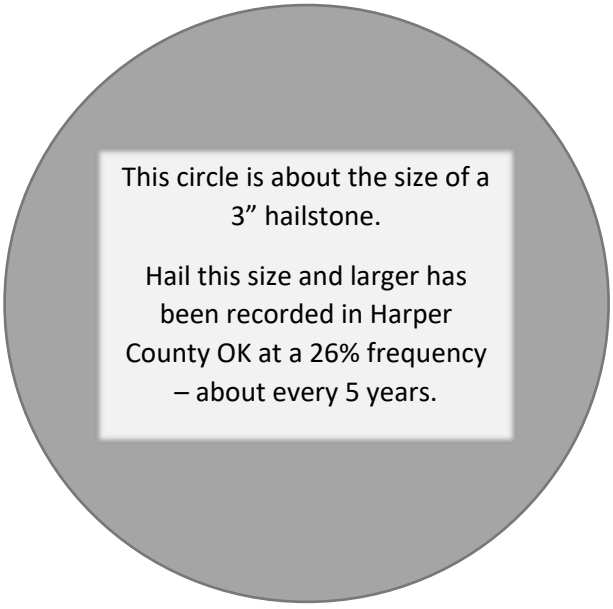
Most hail recorded was between ¾ inch and 1¾ inch diameter. A few storms produced hail of 3 inches diameter and larger. Damage to property and crops has not been included in the NOAA report (Harper Co Storm Events, 2019).

Probability of Future Events

The probability of a Hail event of magnitude greater than ¾ inch size hailstones in any year is greater than 100%; seven or eight such events occur each year. Hail the size of a ping-pong ball (1.25") and larger can be expected to occur about 3 times each year. Events producing hail 3" and larger occur at a 26% probability; an average of once in 5 years.

Vulnerability

Injury to people, damage to crops and structures varies with the size of the hailstones and the duration of the event.



At most stages of growth crops are vulnerable to being knocked down and partially or completely destroyed. Livestock can be injured or even killed by very large hail. Businesses with vehicles stored outside are especially at risk for hail damage. Roofs or windows on business and farm buildings can be impacted.

Because of the population patterns in the county, Laverne, Buffalo, May, Rosston and Selman are most likely to be the locations of property damage or injury reports. Most of the critical infrastructure and businesses are located in or near these population clusters. Utility services such as electric power and communication systems are vulnerable to hail.

Impact

Historic hail events have caused crop losses of 10% to 100%. Damage to vehicles can range from minor dents to total loss of value. Roofs on residential, businesses and schools are often damaged. Utility lines can be damaged.

3.4.6 High Winds

High winds can result from thunderstorms, strong cold front passages, or gradient winds between high and low pressure. Damaging winds are often called “straight-line” winds to differentiate the damage they cause from tornado damage. Downdraft winds are a small-scale column of air that rapidly sinks toward the ground, usually accompanied by precipitation as in a shower or thunderstorm. A downburst is the result of a strong downdraft associated with a thunderstorm that causes damaging winds near the ground.

Extent Scale and Map follow below.

Location

High winds can affect the entire county. Residential clusters and towns are more likely to be the site of most economic damages due to concentration of buildings, but of course crops, barns, utility structures, poles, trees and fences are all subject to potential losses.

Previous Events

Fourteen (14) High Wind events were recorded between 2001 and 2019 that occurred independently of a storm. See Table in Appendix B.2

Another 100 wind events occurred that were associated with Thunderstorms.

Probability of Future Events

Probability: High. 114/20 = 5.7 events a year.

Vulnerability

Utility infrastructure lines and poles are vulnerable to high wind events. Trees may be uprooted or broken, limbs may take down utility lines. Roofs can be damaged. Depending on wind speed, debris may be carried aloft which can cause injury, destroy windows and result in other damage.

Impact

There are direct and indirect impacts of wind. Structures and infrastructure may be directly damaged, while power outages from broken lines impacts communication equipment, and can endanger people who may be dependent on power for medical devices. Downed lines may be present, making it necessary to close roads until power companies can ensure public safety.

Extent

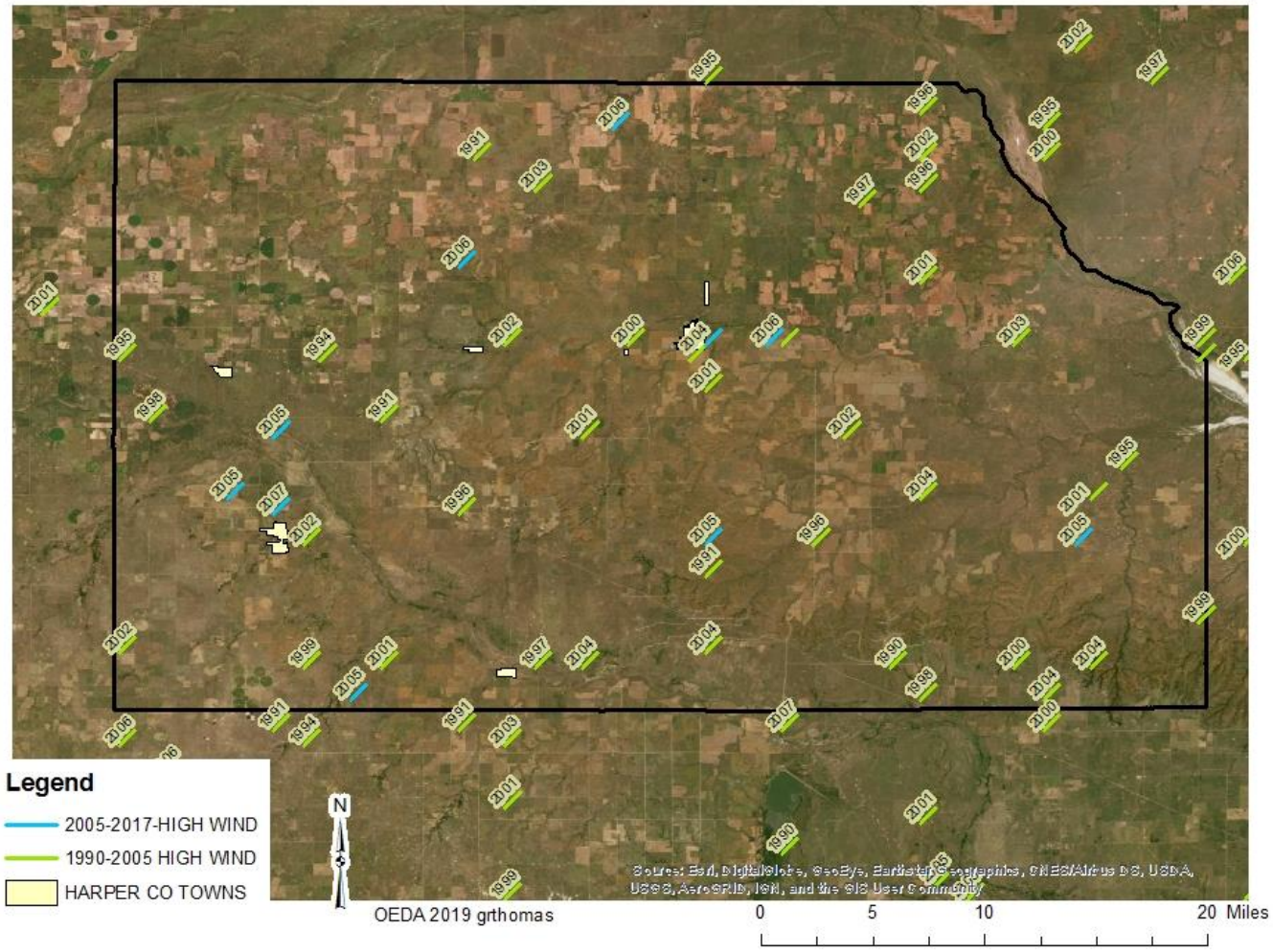
Beaufort Wind Chart – Estimating Winds Speeds

Beaufort Number	MPH Range	MPH Average	Terminology	Description
0	0	0	Calm	Calm. Smoke rises vertically.
1	1-3	2	Light air	Wind motion visible in smoke.
2	4-7	6	Light breeze	Wind felt on exposed skin. Leaves rustle.
3	8-12	11	Gentle breeze	Leaves and smaller twigs in constant motion.
4	13-18	15	Moderate breeze	Dust and loose paper is raised. Small branches begin to move.
5	19-24	22	Fresh breeze	Smaller trees sway.
6	25-31	27	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult.
7	32-38	35	Near gale	Whole trees in motion. Some difficulty when walking into the wind.
8	39-46	42	Gale	Twigs broken from trees. Cars veer on road.
9	47-54	50	Severe gale	**Light structure damage.**
10	55-63	60	Storm	**Trees uprooted. Considerable structural damage.**
11	64-73	70	Violent storm	**Widespread structural damage.**
12	74-95	90	Hurricane	**Considerable and widespread damage to structures.**

Webpage: http://www.weather.gov/iwx
Twitter: @nwsiwx
Facebook: NWSNorthernIndiana

Previous Occurrences. The map below illustrates the location of previous wind events.

HARPER COUNTY HIGH WIND EVENTS 1990-2017



3.4.7 Lightning

Lightning is a discharge of intense atmospheric electricity, accompanied by a vivid flash of light, from one cloud to another or from a cloud to the ground. Lightning is formed by the separation of positive and negative charges that occur when ice crystals collide high up in a thunderstorm cloud. As lightning passes through the atmosphere the air immediately surrounding it is heated, causing the air to expand rapidly. The resulting sound wave produces thunder.

Location

All areas of the county are subject to Lightning Hazard.

Extent

Lightning extent can be difficult to quantify. Below is a descriptive narrative that describes extent in terms of minor and major severity.

According to the NASA Global Hydrology Research Center, cloud-to-ground (CG) lightning is the most damaging and dangerous form of lightning. Most flashes originate near the lower-negative charge center and deliver negative charge to Earth.

However, an appreciable minority of flashes carry positive charge to Earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months.

According to the National Weather Service, positive CG flashes are often observed as far away as 10 miles or more from the main precipitation area of a thunderstorm due to the location of the upper charge region. This poses an extra fire danger, and can catch people who are outdoors off guard. Once in contact with an object on the ground, a CG flash can have multiple return strokes (looks like a flickering flash), a continuous current (looks like a steady flash), or a combination of these two. Continuous current is more destructive and leads to a greater chance of fire. This is because the electricity remains in contact with an object for a longer period of time, allowing for greater heat to build up, (lightning can be as hot as 50,000 degrees Fahrenheit). Positive CG flashes predominantly have continuous currents and are more likely to cause damage than negative CG flashes, due to the likelihood of continuous and high peak currents (NWS, 2019).

Previous Occurrences

Lightning occurs frequently, but often does not cause damage to life or property. Damaging lightning was recorded six times in the NOAA storm records for Oklahoma (Harper Co Storm Events, 2019). Three were listed as lightning events; 3 more were lightning events in conjunction with Drought conditions. Tank batteries are often hit by lightning.

Based on the information above, the following lightning events are considered to be:

Minor severity: Any lightning strike that does not cause injury, death, or property damage.
Major severity: Any lightning strike that causes injury, death, or property damage.

EVENT ID	LOCATION	DATE	TIME	EVENT TYPE	PROP DAM $	CROPS DAM $	SOURCE	EVENT NARRATIVE
5312042	LAVERNE	8/9/2002	1715	Lightning	5000	0	STORM CHASER	Lightning struck a building and a storage tank.
5391487	LAVERNE	4/19/2004	2210	Lightning	15000	0	LAW ENFORCEMENT	Lightning caused a tank battery to catch on fire.
5391489	LAVERNE	4/19/2004	2230	Lightning	15000	0	LAW ENFORCEMENT	A tank battery caught on fire due to a lightning strike.
5523912	HARPER CO.	7/1/2006	0	Drought	50000	750000	OFFICIAL NWS OBS.	At the beginning of the month the drought conditions were mainly in the severe (D2) category with parts of western Oklahoma in the extreme (D3) drought category. By the end of the month the entire area had worsened to an extreme (D3) drought. The dry conditions also increased the fire danger across the area. Several fires were reported with less than a few hundred acres burned per fire. Some of the fires were believed to have been started by lightning
5529086	HARPER CO.	8/1/2006	0	Drought	100000	2000000	OFFICIAL NWS OBS.	The dry conditions maintained an increase in wildfire potential across the region with burn bans issued across part of the area. However, this did not stop some wildfires from occurring. Most fires burned less than 100 acres causing some damage to pasture, etc. Some of these fires were believed to have been started by lightning, while others were caused by humans.
408386	HARPER CO.	8/4/2012	2230	Wildfire	0	0	EMERGENCY MANAGER	A grass fire was ignited by lightning along Highway 34 just south of the Oklahoma Kansas state line. The fire was extinguished by rain. No damage was reported. The exact time the fire ended is unknown.

Probability of Future Events

The storm data records that were evaluated covered 11 years; 2002 through 2012. Six damaging lightning events were recorded during that period. That indicates a 60% probability, or a Medium to High expectation of damage from lightning. It's likely that other fires may have been caused by lightning, but the cause may not have been recorded.

Vulnerability

People and animals outdoors have the greatest vulnerability for bodily injury or loss of life due to lightning strikes. Though protective steps are taken to mitigate the danger, Tank batteries are hit with some regularity. Tank batteries are vulnerable to lightning strike and can release a significant amount of hazardous material. A tank battery is a container used to store crude oil, and is located near a site where the oil is produced from a well. In three of the six recorded incidents a tank battery was hit. In 2016, a tank battery was again hit near Laverne, and according to local reports these incidents are not infrequent.

Outdoor recreation areas such as golf courses at Doby Springs and Laverne, municipal swimming pools (Buffalo and Laverne), school play yards and sports stadiums are among areas where lightning can be a danger. Buildings are vulnerable to structural fires, and utility infrastructure may be damaged, particularly electrical transformers or substations. Electronics inside buildings can also be destroyed by the power surge of a lightning strike passing through the electrical grid, which can disable critical communication systems.

Impact

Life and health can be impacted negatively by these events, from both direct and indirect effects. Direct impacts are those which result from physical proximity to a lightning strike. Indirect impacts are those which occur as a secondary effect of a strike, such as a communication breakdown which disrupts emergency response to a health crisis, crime, or accident.

The risk of fire caused by lightning was evidenced by the data, in that three of the six incidents recorded were lightning-induced fires; one a grass fire, and two fires which were exacerbated by drought conditions. The cost of damages to buildings and infrastructure must be borne by owners or insurance companies. Disruption of the economic purpose of affected structures is a cost which may be difficult to quantify and absorb.

5/13/2016 YouTube
Tank Battery Hit Near Laverne
uploaded by FireAlley

3.4.8 Tornado

Tornados are violently rotating columns of air that reach from the bottom of a cumulonimbus cloud to the ground. Tornados are found in severe thunderstorms, but not all severe thunderstorms produce tornados. While all tornados touch both the ground and the bottom of a cloud, it is possible for only part of the tornado to be visible.

A tornado may be on the ground for only a few seconds, or last for over an hour. They can appear in a variety of shapes and sizes, ranging from thin, rope-like circulations to large, wedge-shapes greater than one mile in width. However, a tornado's size is not necessarily related to its wind speed. The strongest tornados can have wind speeds in excess of 200mph. In Oklahoma, most tornados occur between 3PM and 9PM, during the months of March through May, but may occur anytime the necessary atmospheric conditions of wind shear, lift, instability, and moisture are present.

Location

Harper County has a significant history of tornado activity. Most of Oklahoma lies in an area often referred to as Tornado Alley, characterized by interaction between cold, dry air from Canada, warm to hot, dry air from Mexico and the Southwestern U.S., and warm, moist air from the Gulf of Mexico. Meteorologically, the region is ideally situated for the formation of supercell thunderstorms, often the producers of violent (EF-2 or greater) tornadoes (NOAA 2019)

The interactions among these three contrasting air currents produces severe weather with a frequency virtually unseen anywhere else on our planet. An average 62 tornadoes strike the state per year – one of the highest rates in the world by square mile of land area. (US Tornado Climatology, 2010).

Extent

The scale of intensity for tornados in Harper County should be viewed with the caveat that tornados are usually rated on the Fujita Scale by calculating the amount of damage to structures directly in the path of the tornado; in this rural area, where few structures are present, a severe storm may bypass most homes, barns or buildings. Therefore, some tornados may not be accurately evaluated if they have passed through mostly open sage land. Even in such cases, livestock and infrastructure such as roads, fences, signs, poles and utility structures are all at risk.

See scale, below.

Enhanced F Scale for Tornado Damage

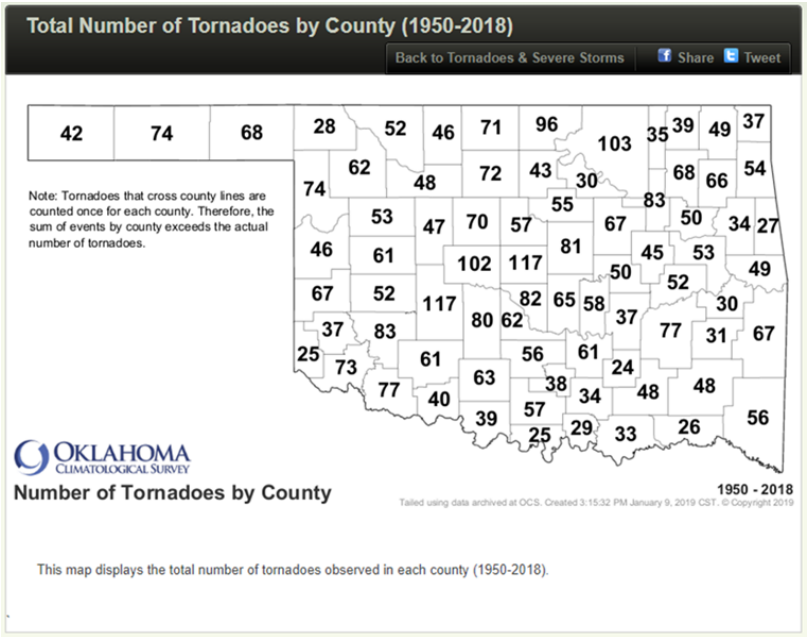
FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**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

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

Previous Occurrences

Between 1950 and 2018, 28 tornados have been recorded in Harper County, with many more occurring nearby, in adjacent counties.

It should be noted that tornados often cross county lines, so are counted as an event in each county.



Tornados 2000-2016								
Date	Time (CST)	Path Length (yards)	Path Width (yards)	F-Scale	Killed	Injured	County	Path
2/24/2000	2013	27	150	F1	0	0	Lipscomb TX/ Ellis/ Harper	10 NE Lipscomb TX - 2 W Catesby - 5 SE Laverne
10/19/2005	1647	13	400	F1	0	0	Harper/ Woodward	10 SSE Selman - 5 WNW Alabaster Caverns S. P.
4/23/2007	1714	0.2	30	EF0	0	0	Harper	8 SSW Buffalo
4/23/2007	1751	0.2	30	EF0	0	0	Harper	4 NE Laverne
5/23/2008	1903	5	1100	EF3	0	0	Harper	10 SSW - 5 SSW Selman
5/23/2008	1958	9	125	EF0	0	0	Harper/ Clark KS	9 NNW - 11.5 N Buffalo OK - 8.5 S Sitka KS
4/14/2012	1459	0.5	30	EF1	0	0	Woodward/ Harper	9 E Fort Supply
11/16/2015	2108	27	400	EF2	0	0	Ellis/ Harper	6 SSE May - 10 E Buffalo
11/16/2015	2209	19	810	EF1	0	0	Harper Comanche KS	17 NW - 19 NW Freedom
5/23/2016	2024	2	50	EFU	0	0	Harper	13 SSE - 11 SSE Selman

Probability of Future Events

Previous occurrences indicate that 28 tornados were recorded over 68 years, giving a typical probability of a .41 chance of a tornado in any given year. Over the most recent 10 years (2008-2018), 6 tornados were recorded, resulting in a probability of .6 chance of a tornado per year. It remains to be seen whether that increase indicates a trend toward increased frequency, or is due to a limited sample set.

Vulnerability

Fortunately, no personal injuries or deaths have been recorded as a result of local tornados in recent decades. The general population is aware of the risk, and people often retreat to shelters or keep an eye on the news to stay informed of storm paths, taking precautions as needed. Every type of farm, business and residential buildings are vulnerable to tornadic damage, as well as utility infrastructure, schools, recreation areas, vehicles, crops, livestock

and trees. Nursing homes and medical facilities are especially vulnerable due to the difficulty of evacuating patients and staff that may be in the path of danger.

Impact

Tornados are very destructive events. One factor that must be borne in mind is that in rural areas, the true magnitude of a tornado may not be measured, since categories are designed to reflect quantifiable damages. For that reason, an event that would be very destructive if it impacted a town might be categorized as only an EF0, if it passed instead through open range. The impacts of tornados will vary according to the strength of the wind speed and the amount and type of debris that is borne aloft by the vortex.

While structural damage is common, secondary impacts of tornado events can be equally serious, particularly the loss of power. Communication equipment can be damaged, making the delivery of emergency services more difficult. Cellphone and radio towers are exposed to wind, rain and flying debris. Post-storm impacts include the loss of damaged buildings or equipment. Power outages can take time to repair, putting health increasingly at risk for individuals dependent on breathing machines, dialysis or other critical health needs. Food storage or even buying a gallon of gas becomes a challenge during loss of electrical power.

3.4.9 Wildfire

Wildfire is an uncontrolled fire in a rural or wilderness area. The majority of wildfires occur when precipitation is low. A wildfire often begins unnoticed and can spread quickly, lighting brush, trees, and structures. There are three different classes of wildfires. A surface fire is common in grasslands, or areas with open vegetation, and can spread quickly. A ground fire is a dense, very hot fire that has a thick fuel source and significantly damages the soil health where it occurs. Crown fires are those that move by jumping along the tops of trees. Wildfires often begin unnoticed, but are usually signaled by dense smoke that fills the area for miles around.

Location

Wildfire is a danger throughout the county, but areas with Red Cedar trees are especially at risk. Dry brush and tumbleweeds collect in fence rows and brushy places, creating a literal tinderbox for sparks. A fire that starts as a rural wildfire can quickly become a threat to a farmstead or town.

Extent

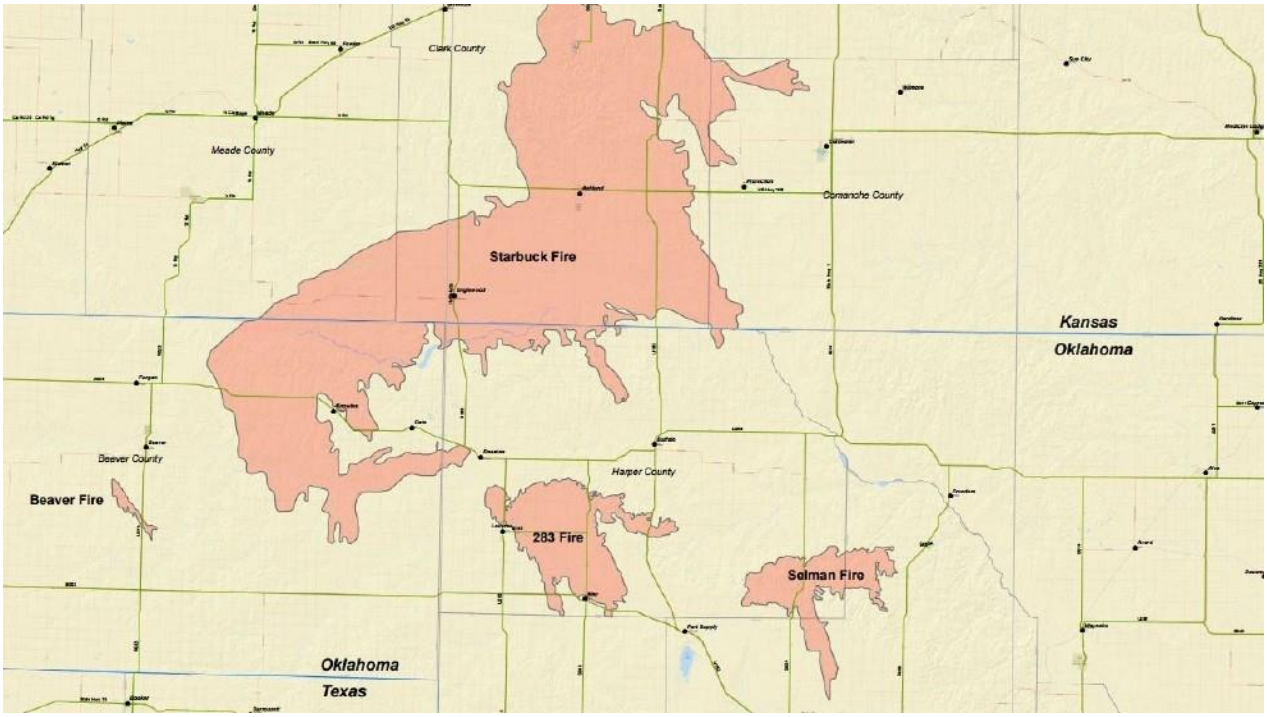
Brush and grass fires are considered to be Wildfires when they grow to more than 3,000 acres in size. Relative humidity has an effect on the potential for wildfire events. During times of high humidity, prescribed fires can be used safely to control vegetation and improve pasture. When humidity is low, the danger from fire increases rapidly.

The Keetch-Byram Drought Index with Fire Danger Rating Data Incorporated	
0 – 200	Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.
200 - 400	Fires more readily burn and will carry across an area with no gaps. Heavier fuels will still not readily ignite and burn. Also, expect smoldering and the resulting smoke to carry into and possibly through the night.
400 - 600	Fire intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
600 - 800	Fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn thorough the night and heavier fuels will actively burn and contribute to fire intensity

Fire Danger Rating System		
Rating	**Basic Description**	**Detailed Description**
CLASS 1: Low Danger (L) COLOR CODE: Green	fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) COLOR CODE: Blue	fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) COLOR CODE: Yellow	fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) COLOR CODE: Orange	fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.

CLASS 5: Extreme (E) **COLOR CODE: Red**	fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.
Source: http://www.wfas.net/content/view/34/51/		

March 6, 2017 NWOK Complex; Starbuck Fire, Beaver, 283 and Selman Fires



Previous Occurrences. Incidents of Fire response are recorded by the Oklahoma Department of Forestry.

WILDFIRES

Get More data

ALL FIRE RUNS

Region	County	FDID#	Fire Dept	How Reported	2008 Total Runs	2009 Total Runs	2010 Total Runs	2011 Total Runs	2012 Total Runs	2013 Total Runs	2014 Total Runs	2015 Total Runs	2016 Total Runs	2017 Total Runs	2018 Total Runs	Year with the most reports
11	Harper	30001	Buffalo Fire Dept	Annual	85	70	57	62	54	7	26	42	87	100	105	2018
11	Harper	30002	Laverne	NFIRS	68	75	77	81	94	61	59	85	119	16	49	2016
11	Harper	30003	Rosston	Annual		19	8	9	15	4	7	16	36	41	33	2017
11	Harper	30005	Selman	Annual	9	14	9	18	12	8	4	11	17	17	15	2011
11	Harper	30006	May Community	Annual			New dpt	5	3	10	9	6	30	53	27	2017

Over an 11 year period, the 1,944 total fire calls from the table above were averaged below to indicate frequency and probability:

Fire Dept	Total # fires reported	Average per year
Buffalo	695	63
Laverne	784	71
Rosston	188	17
Selman	134	12
May	143	13

Probability of Future Events

Vulnerability

All areas of the County are vulnerable to Wildfires, especially during times of less rain. Drought conditions and low humidity together create extremely volatile conditions when a single spark can initiate a very big problem of containment within a few minutes if a small fire reaches an area with Red Cedar. Old shelterbelts, fence lines, abandoned farmsteads and fallow land can become clogged with tumbleweeds and dry brush, ready tinder for any fire.

Any small fire can become a wildfire when response teams are too far away to arrive quickly. Therefore, it is necessary to support the small volunteer Fire Departments throughout the County to mitigate this hazard, improve response capability and reduce the potential for injury and loss of life, for both humans, livestock and wildlife.

Impact

Impacts of wildfires are loss of life, injury, and destruction of property.

3.4.10 Winter Storm

Winter Storm can refer to a combination of winter precipitation, including snow, sleet and freezing rain. A severe winter storm can range from freezing rain or sleet to moderate snow over a few hours, or to blizzard conditions and extremely cold temperatures that last several days.

Blowing snow is wind-driven snow that reduces visibility and causes significant drifting. Blizzards occur when falling and blowing snow combine with winds of 35 mph or greater, reducing visibility to near zero.

Freezing rain is precipitation that falls, as liquid, into a layer of freezing air near the surface. When the precipitation makes contact with the surface, it forms into a coating or glaze of ice and even a small accumulation can cause a significant hazard.

Sleet is frozen precipitation that has melted by falling through a warm layer of the atmosphere and then refreezes into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and can accumulate like snow and become a hazard to motorists.

Ice storms are extended freezing rain events, lasting several hours to sometimes days, when the freezing rain accumulates on surfaces and damages trees, utility lines, and roads. Ice loads on overhead power lines, combined with windy conditions, may cause the lines to "gallop." This forceful motion often causes the lines to break away from the connectors and poles, resulting in widespread power failure.

Wind Chill is used to describe the relative discomfort and danger to people from the combination of cold temperatures and wind. The wind chill chart from the National Weather Service shows the apparent temperature derived from both wind speed and temperature.

Location

Winter storms typically occur several times a year in NW Oklahoma. Ice and freezing rain, snowfall and cold temperatures create a hazard to all residents and structures.

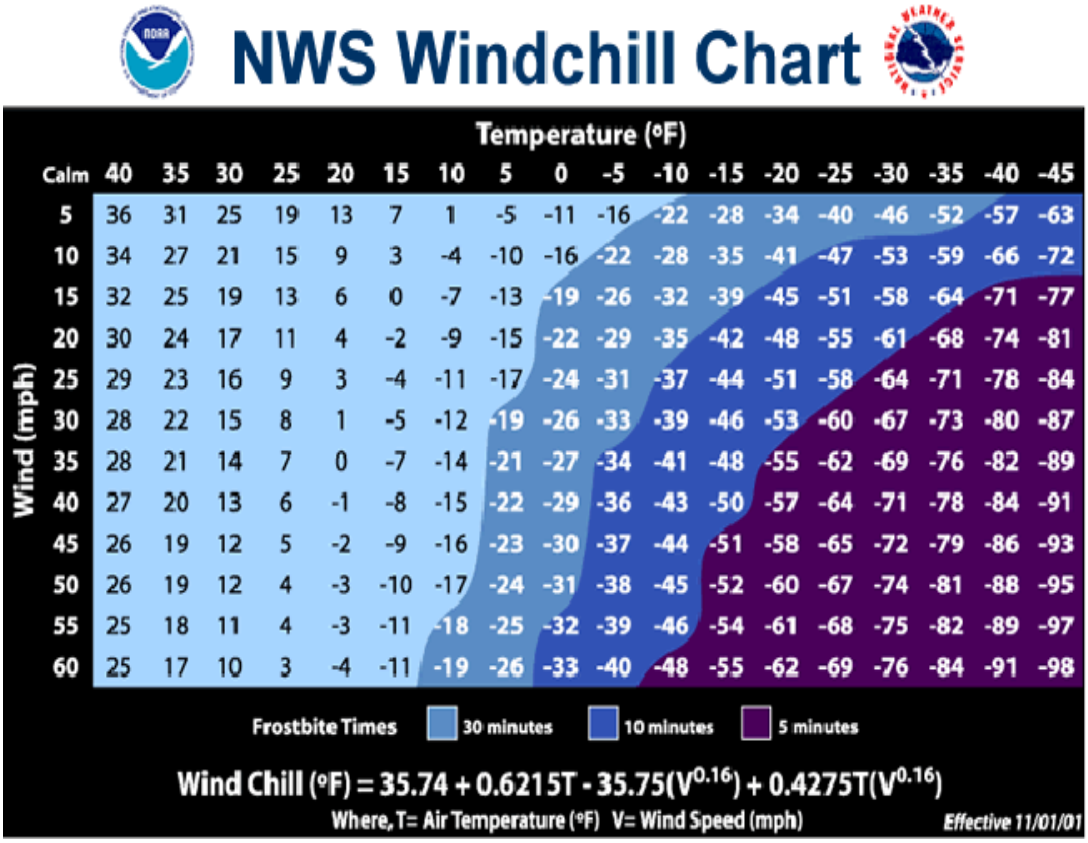
Extent

While serious winter weather events are not unusual, most storms in Harper County are short-lived. It is unusual for snowfall to remain on the ground more than a few days (OKHMP, 2019).

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	DAMAGE AND IMPACT DESCRIPTIONS
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
4	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)



Previous Occurrences

Between the years 2000 and 2018, forty-five winter storms are recorded in the NOAA data. See Table Appendix B.3.

Probability of Future Events

Forty-five severe storms recorded in a 19 year period indicates a probability of 2 or 3 such storms each year; 100% = High probability.

Vulnerability

Humans, crops and livestock are vulnerable to injury or death from extreme temperatures, especially people working outdoors, children and the elderly. Livestock can suffer when graze and hay are covered by snow and water is frozen. During winter storms, road conditions deteriorate, creating dangerous exposure scenarios. Utility infrastructure is vulnerable to ice, wind and snow, leading to secondary effects such as loss of power, loss of communication, and difficult conditions for rescue personnel.

Impact

Winter storm conditions can impact humans, animals and infrastructure throughout the county. Power loss during times of extreme temperatures can create a dangerous situation for those who rely on electricity for medical support equipment. Emergency response vehicles and personnel can be delayed due to roads conditions or communication breakdowns. Winter storms were one of the top three concerns expressed by the public.

CHAPTER FOUR: MITIGATION STRATEGY

4.1 Capabilities Assessment

The ability of a community to respond and recover from disasters is a function of the capabilities and resources available. Some of these capabilities include the skills of staff and employees; others are met by contracting for services on an as-needed basis.

In addition to staff skills, abilities and services, each incorporated municipality has the authority to impose regulations on land development, manage floodplains, and may be a provider of critical utilities or functions such as water, sewer, and electric services and waste collection.

For a good portion of each year, schools are responsible for nearly every child in a community and employ many other local people. Schools therefore, have a special interest in ensuring public safety from hazardous events. Other educational opportunities offered to a community can enhance the efficacy of pre-disaster planning and post-disaster management.

The tables below provides a summary of the administrative and technical capabilities currently in place in each participating jurisdiction. A mark (X) indicates that the jurisdiction was reported to have the authority to implement the specified regulatory tool and that the tool is currently in place.

4.1.1 Existing Institutions, Plans, and Ordinances

EXISTING PLANS AND ORDINANCES

JURISDICTION	BUILDING CODE	ZONING ORD	SUBDIVISION ORD	SPECIAL PURPOSE ORD	GROWTH MGNT ORD	SITE PLAN REVIEW	COMPREHENSIVE PLAN	CAPITAL IMP PLAN	ECON DEV PLAN	EM RESPONSE PLAN	POST DISASTER PLAN
HARPER COUNTY										X	X
TOWN OF BUFFALO								X		X	X
TOWN OF LAVERNE								X		X	X
TOWN OF MAY											X

Notes: Codes: Municipalities have such authority but have not yet exercised it.
Post Disaster Plan: The County plan covers all municipalities.

4.1.2 Administrative and Technical Capability

LOCATION	ENGINEER AVAILABLE (TYPE)	FLOODPLAIN MNGR	SURVEYORS	STAFF WITH EM EXP	STAFF W GIS OR HAZUS	SCIENTISTS (GEO, BIO, AG)	EM MANAGER	GRANT WRITERS
HARPER COUNTY	X	X	X	X	X		X	X
TOWN BUFFALO	X		X					X
TOWN LAVERNE	X		X					X
TOWN MAY	X		X					X
ROSSTON	X		X					X
SELMAN	X		X					X
NOTES:	Hired by project	OEDA	Hired by project		OEDA	as needed (from Alva)		by Contract or OEDA

4.1.3 Financial Capabilities

JURISDICTION	CAPITAL IMP PROJ FUNDING	TAX AUTHORITY	UTILITY SERVICE FEES	DEVELOPMENT FEES	GEN OB FUNDS & BONDS	CDBG/REAP	FEDERAL FUNDS	STATE FUNDING
HARPER COUNTY	X	X			X	X	X	X
TOWN OF BUFFALO	X	X	X		X	X	X	X
TOWN OF LAVERNE	X	X	X		X	X	X	X
TOWN OF MAY	X	X	Trash only		X	X	X	X

4.1.4 Education and Outreach Capabilities

JURISDICTION	LOCAL CITIZEN GROUPS INVOLVED	NON-PROFITS	ONGOING ED & INFO PROGRAMS	NATURAL DISASTER/SAFETY PROGRAMS	STORM-READY CERTIFICATION	FIREWISE COMMUNITY	PUB/PRIVATE PARTNERSHIPS FOR DISASTER ISSUES
HARPER COUNTY	X	X	X	X			X
TOWN OF BUFFALO	X	X	X	X			X
TOWN OF LAVERNE	X	X	X	X			X
TOWN OF MAY	X	X		X			X
NOTES:		AM RED CROSS					

4.1.5 School District Capability Assessment

HARPER COUNTY SCHOOLS

SCHOOL DISTRICT ASSESSMENT	BUFFALO	LAVERNE
1. HAS YOUR SCHOOL DISTRICT HAD POSITIVE RESPONSES TO BOND ISSUES?	YES	YES
2. BASED ON POPULATION IS YOUR SCHOOL DIST GROWING OR DECLINING?	GROW	GROW
3. HAS THE DISTRCT TAKEN MEASURES TO PROTECT STUDENTS FROM HAZARD EVENTS?	YES	YES
4. LIST ANY HAZARD EVENTS THAT DAMAGED YOUR SCHOOLS IN THE LAST 10 YRS:	NONE	NONE

4.1.6 Capability conclusion

Because this is a rural county with low population density, Harper County municipalities do not typically have as many regulatory ordinances that one might find in a city of larger size. Staff is available for most local services, but people with special technical skills such as Grant Writers, Engineers, Surveyors and GIS Technicians are typically hired from the Regional COG or from nearby cities on an individual project basis.

Other critical capabilities. Hospitals, Medical Clinics and Residential Care facilities are located at Buffalo and Laverne. Volunteer Fire Departments are in place in each community. There is another, informal, asset that is evident in this region, and that is a high cultural value placed on being stewards of one's neighbors.

4.2 NFIP Participation

FEMA has not completed a study to determine flood hazard locations in Harper County; therefore, a flood map has not been published at this time. Local knowledge is the primary source of flood data available. Flood insurance from the NFIP is only available to communities participating in the NFIP program, therefore, no flood insurance is currently available to property owners in the county (FAQ NFIP Insurance, 2019). There are no repetitive loss structures due to riparian zone flooding in Harper County.

4.3 Mitigation Goals

Hazard Mitigation planning is intended to enhance the health, safety, and general welfare of the community and is guided by the following four principles.

1. To protect life
2. To protect property
3. To protect the environment
4. To increase public preparedness for disasters

(OKHMP, 2019)

GOALS	
Goal 1	To increase communication and coordination to improve response times and efficiency when disaster strikes
Goal 2	To educate the general public on the importance of hazard mitigation
Goal 3	To determine and reduce areas that are considered in high risk areas or suffer repetitive losses associated with natural disasters
Goal 4	To develop and educate responders and health care providers about mitigation strategies and measures for varying hazards
Goal 5	To enhance and strengthen existing pre-disaster and prevention activities

4.4 Action Items

The plan must include comprehensive range of hazard mitigation actions which reduce the impacts of hazards identified in the risk assessment. These mitigation actions must also be consistent with each hazard's vulnerabilities. A comprehensive range means there must be at least two different types of mitigation actions, per hazard, and per each jurisdiction affected by that hazard. An overall goal of the mitigation actions should be to reduce risk to existing buildings and infrastructure, as well as limit any risk to new development and redevelopment. The action item must identify 1) the hazard addressed, 2) the mitigation action type, 3) the jurisdictions involved, 4) the action to be accomplished, 5) the position, office, department, or agency responsible for implementing the action, 6) the potential timeline for implementation, 7) the approximate cost of the action, and 8) what funding sources will be used.

There are five Mitigation Action Types:

Local Plans and Regulations: Using authorities, policies, and codes to influence development.

Structure/ Infrastructure Projects: Modifying or removing infrastructure to mitigate hazard.

Natural System Protection: Minimizing damage by preserving natural system functions.

Education and Awareness Programs: Informing citizens on how to mitigate hazards.

5% Projects: Actions not quantifiable by a Benefit Cost Analysis, (i.e., sirens, generators, etc.).

STAPLEE Evaluation

Category	**Evaluation**
Social	Community acceptance, Effect on segments of the population
Technical	Technical feasibility, Long term solution, Secondary impacts
Administrative	Staffing, Funding available, Maintenance & operations
Political	Political support, Local leadership support, Public support
Legal	Jurisdictional authority, potential legal challenge
Economic	Benefits outweigh costs, contributes to economic goals, outside funding required
Environmental	Effect on land, water, species, consistent with sound environmental goals

Specific actions were developed to support mitigation goals.

Action item Tables:

Action Item 1	**Establish a community refuge station**
Hazard(s) Addressed	General Hazards; Extreme Heat, High winds, Winter Storms
Mitigation Action Type	Structure, infrastructure improvements
Jurisdiction	County
Action Description	Establish place of refuge at the County Fairgrounds to include power generators for extended winter power outages or disaster preparedness. Apply for OEM assistance to evaluate structure for hardening
Responsible Party	County, Emergency manager
Potential Implementation Timeline	One year
Estimated Cost	Negligible
Potential Funding Sources	OEM Grants
Mitigation Action Evaluation	Social, educational, economic, environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 2	**Regulate water usage; preserve resources**
Hazard(s) Addressed	Drought
Mitigation Action Type	Local Plans & Regulations
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Adopt ordinances regulating water usage during times of drought to enforce preservation of water resources
Responsible Party	County, Buffalo, Laverne, Rosston, May, Selman
Potential Implementation Timeline	Ongoing
Estimated Cost	Negligible
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, educational, economic, environmental
Will this action protect lives and/or prevent injury?	Water conservation practices will protect people from the threat of water shortages as a result of drought.
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 3	**Become a Firewise Community**
Hazard(s) Addressed	Wildfires, Lightning, Drought
Mitigation Action Type	Natural system protection, Education & awareness
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Take required steps and make application to be a Firewise community
Responsible Party	Emergency manager
Potential Implementation Timeline	Ongoing
Estimated Cost	Negligible
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, educational, economic, environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 4	**Adopt regulations to require defensible space**
Hazard(s) Addressed	Drought, Wildfire
Mitigation Action Type	Local Plans & Regulations
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Adopt ordinances regulating defensible space around structures in the Wild land/Urban Interface area for existing and new buildings.
Responsible Party	All jurisdictions
Potential Implementation Timeline	Ongoing
Estimated Cost	Negligible
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, educational, economic, environmental
Will this action protect lives and/or prevent injury?	Water conservation practices will protect people from the threat of water shortages as a result of drought.
Will the action eliminate or reduce damage to infrastructure?	Rain water harvesting will reduce the demand on municipal water supplies
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 5	**Elimination of Red Cedar**
Hazard(s) Addressed	Wildfire
Mitigation Action Type	Local plans & Regulations, Natural System protection, Education & Awareness
Jurisdiction	County, all municipalities
Action Description	Adopt regulation to require control & elimination of Red Cedar. Provide education to encourage compliance
Responsible Party	County, Buffalo, Laverne, Rosston, May, Selman
Potential Implementation Timeline	Initiate in one year, on-going implementation
Estimated Cost	
Potential Funding Sources	NRCS
Mitigation Action Evaluation	Social, Political, Legal, Economic, Environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 6	**Become a StormReady community**
Hazard(s) Addressed	Tornado, Winter storm
Mitigation Action Type	Local plans & Regulations, Education & Awareness
Jurisdiction	County, all municipalities
Action Description	Take required steps and apply to Stormready community program
Responsible Party	County, Buffalo, Laverne, Rosston, May, Selman
Potential Implementation Timeline	One year
Estimated Cost	Negligible
Potential Funding Sources	Local, State EM
Mitigation Action Evaluation	Social, Technical, Administrative, Political, Legal, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 7	**Additional outdoor warning system sirens installed**
Hazard(s) Addressed	Tornado
Mitigation Action Type	Structure, Infrastructure Projects
Jurisdiction	Buffalo, Laverne, Rosston, Selman, May
Action Description	Apply for grants for sirens, purchase and install
Responsible Party	Local Emergency Managers
Potential Implementation Timeline	1 - 5 years
Estimated Cost	
Potential Funding Sources	FEMA, OEM grants, REAP
Mitigation Action Evaluation	Social, Technical, Political, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 8	**Apply to OEM for assistance with assessment**
Hazard(s) Addressed	Tornado, Winter storms, Power outages
Mitigation Action Type	Local plans & Regs; Structure, Infrastructure project
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Work with OEM to conduct an assessment of community locations appropriate for Hardening agaist storms and other disasters
Responsible Party	County & Local Emergency Managers
Potential Implementation Timeline	1 - 5 years
Estimated Cost	
Potential Funding Sources	Local, State assistance
Mitigation Action Evaluation	Social, Technical, Administrative, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 9	**Design and install safe rooms at local schools**
Hazard(s) Addressed	Tornado
Mitigation Action Type	Social, Technical, Administrative, Economic
Jurisdiction	Buffalo, Laverne Schools
Action Description	Work with OEM to evaluate structures and Apply for grants to install Safe School 101 rooms
Responsible Party	School Districts, Emergency Managers
Potential Implementation Timeline	1 - 5 years
Estimated Cost	
Potential Funding Sources	Local, OEM/FEMA
Mitigation Action Evaluation	Structure, Infrastructure Project
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 10	**Install Community Safe Rooms to reduce the risk of injury, and/or, loss of life.**
Hazard(s) Addressed	Tornado, High winds
Mitigation Action Type	Structure, Infrastructure projects
Jurisdiction	County, all municipalities
Action Description	Work with OEM to evaluate structures and Apply for grants to install Safe rooms
Responsible Party	Emergency managers
Potential Implementation Timeline	5 years
Estimated Cost	
Potential Funding Sources	Local, OEM/FEMA
Mitigation Action Evaluation	Social, Technical, Political, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 11	**Install Residential Safe Rooms to reduce the risk of injury; loss of life.**
Hazard(s) Addressed	Tornado, High winds
Mitigation Action Type	Structure, Infrastructure projects
Jurisdiction	County, all municipalities
Action Description	Work with OEM to evaluate Residential structures and assist citizens with grant applications to install Safe rooms
Responsible Party	Emergency managers
Potential Implementation Timeline	5 years
Estimated Cost	
Potential Funding Sources	Local, OEM/FEMA
Mitigation Action Evaluation	Social, Technical, Political, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 12	**Publish a local map of shelters and places of refuge**
Hazard(s) Addressed	Tornado, Winter storms, General Hazards
Mitigation Action Type	Education & Awareness
Jurisdiction	County, all municipalities
Action Description	Identify shelter locations, publish & distribute a map of places of refuge for each community in the event of tornados and other hazards
Responsible Party	Individual jurisdictions
Potential Implementation Timeline	Initiate within 1 year, then on-going updates
Estimated Cost	
Potential Funding Sources	Local funds, COG support
Mitigation Action Evaluation	Social, Political, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 13	**Bury utility lines for critical facilities**
Hazard(s) Addressed	High Wind, Tornados, Winter storms, Ice, Lightning
Mitigation Action Type	Local Plans & regulatins; Structure, Infrastructure projects
Jurisdiction	Jurisdictions with electrical utilities
Action Description	When making repairs, bury lines when possible
Responsible Party	Utility Administrators
Potential Implementation Timeline	Initiate, then on-going
Estimated Cost	
Potential Funding Sources	
Mitigation Action Evaluation	Technical, Administrative, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 14	**Continue to install rip-rap**
Hazard(s) Addressed	Flood
Mitigation Action Type	Local plans, Infrastructure Projects, Natural System protection
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Continue to install rip-rap to prevent erosion in known erosion and washout areas to protect roads
Responsible Party	County commissioners, Town administration
Potential Implementation Timeline	Ongoing
Estimated Cost	
Potential Funding Sources	Local funds
Mitigation Action Evaluation	Technical, Administrative, Economic, Environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 15	**Post maps of flood zones showing areas vulnerable to flooding.**
Hazard(s) Addressed	Flood
Mitigation Action Type	Natural System protection, Education & Awareness
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Provide to the public maps illustrating NRCS local flood areas
Responsible Party	COG, County, municipalities
Potential Implementation Timeline	6 months
Estimated Cost	
Potential Funding Sources	Local
Mitigation Action Evaluation	Social, Technical, Environmental
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	Yes
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

Action Item 16	**Equip shelters with NOAA weather radios**
Hazard(s) Addressed	Tornado, Winter storms
Mitigation Action Type	5% Projects
Jurisdiction	County, Buffalo, Laverne, Rosston, May, Selman
Action Description	Acquire and distribute NOAAWeather radios to local shelters and spaces of refuge; frequent testing of this equipment
Responsible Party	Emergency managers
Potential Implementation Timeline	Initiate within 6 months, then on-going as needed
Estimated Cost	
Potential Funding Sources	OEM grants
Mitigation Action Evaluation	Social, Technical, Political, Economic
Will this action protect lives and/or prevent injury?	Yes
Will the action eliminate or reduce damage to infrastructure?	No
Is this action technically feasible?	Yes
Does/will the public support this action?	Yes
Does the benefit of action outweigh the costs?	Yes

4.5 Action Item Prioritization

One effective criteria for prioritizing mitigation actions is to analyze each action by the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) Method. This method was applied to the priorities identified by the community. That evaluation is noted within the tables above and labeled "Mitigation Action Evaluation." These criteria assisted the community in prioritizing projects.

Community concerns

Public meetings, surveys and collected comments indicate that the top three concerns for the community were Drought, Wildfires and Winter storms. Tornados were another frequently mentioned concern.

4.6 Integration of Data, Goals, and Action Items

FEMA approved local plans are reviewed within 30 days of approval and stored in the State of Oklahoma Plan Data Base where they are linked and coordinated with the State of Oklahoma Hazard Mitigation Plan. The State Hazard Mitigation Planning Team reviews local plans, risk assessments and mitigation strategies when updates to the State plan are prepared (OKHMP, 2019).

Each jurisdiction in Harper County will receive a copy of this Plan Update so that the data, information, and hazard mitigation goals and actions may be incorporated into other planning mechanisms. Hazard mitigation information and actions identified in this Update may be incorporated into Comprehensive Plans, Capital Improvement Plans, Emergency Management Plans or School District Plans. Regulations may be adopted to facilitate implementation of Hazard Mitigation strategies.

4.7 Eligible Projects

During the development and update of the local hazard mitigation plan, local communities identified those hazards that have the highest risk potential. This hazard analysis identifies benchmark events in those planning areas that have the most serious impact. These events are used to update the local hazard mitigation plan, and to assist OEM in conducting mitigation outreach and project development. Local communities are encouraged to follow the mitigation actions that will best meet their stated goals for their community, with the collective goals of these actions building to a local and state resiliency (OKHMP, 2019).

Identification of Projects. Projects identified in Local Hazard Mitigation Plans will be the initial source for identifying potential projects for Hazard Mitigation funding. All mitigation projects must be identified or support goals and objectives in federally approved local mitigation Plans. Hazard Mitigation Planners will review all FEMA approved Plans to identify mitigation projects. Information acquired during the Preliminary Damage Assessment (PDA) in response to a disaster event is another source for identification of mitigation issues and potential projects. PDA teams will be briefed as to the availability and requirements of the Hazard Mitigation Grant Program so potential projects can be identified for follow-up by the State Hazard Mitigation Staff.

Harper County Commissioners and Mitigation team members prioritized mitigation projects as follows:

HARPER COUNTY HAZARD MITIGATION PROJECT LIST 2020		
1	Establish a community refuge station	Establish place of refuge at the County Fairgrounds to include power generators for extended winter power outages or disaster preparedness apply for OEM assistance to evaluate structure for hardening
2	Regulate water usage and enforce preservation of water resources	Adopt ordinances regulating water usage during times of drought
3	Become a Firewise Community	Take required steps and make application to be a Firewise community
4	Adopt regulations to require defensible space	Adopt ordinances regulating defensible space around structures in the Wild land/Urban Interface area for existing and new buildings.
5	Elimination of Western Red Cedar	Adopt regulation to require control & elimination of Red Cedar. Provide education to encourage compliance
6	Become a StormReady community	Take required steps and apply to Stormready community program
7	Additional outdoor warning system sirens installed	Apply for grants for sirens, purchase and install
8	Apply to OEM for assistance with assessment of structures	Work with OEM to conduct an assessment of community locations appropriate for Hardening against storms and other disasters
9	Design and install Safe rooms at local schools	Work with OEM to evaluate structures and Apply for grants to install Safe School 101 rooms to reduce the risk of injury, and/or, loss of life.
10	Install Community Safe Rooms	Work with OEM to evaluate structures and Apply for grants to install Safe rooms to reduce the risk of injury, and/or, loss of life.
11	Install Residential Safe Rooms	Work with OEM to evaluate Residential structures and assist citizens with grant applications to install Safe rooms
12	Publish a local map of shelters and places of refuge	Identify shelter locations, publish & distribute a map of places of refuge for each community in the event of tornados and other hazards
13	Bury utility lines for critical facilities	When making repairs, bury lines when possible
14	Continue to install rip-rap to prevent erosion	Continue to install rip-rap in known erosion and washout areas to protect roads
15	Post maps of flood zones showing areas vulnerable to flooding.	Provide to the public maps illustrating NRCS local flood areas
16	Equip shelters with NOAA weather radios	Acquire and distribute NOAA Weather radios to local shelters and places of refuge; frequent testing of this equipment

Of special concern for future planning efforts: Drought resilience

Oklahoma Water Resources Board's Financial Assistance Program, which has provided more than $2.7 billion in water/sewer infrastructure projects — have done much to increase the drought resistance of Oklahoma's local water treatment and distribution systems. An analysis conducted for the 2012 Update of the Oklahoma Comprehensive Water Plan (OCWP) estimates that Oklahoma faces an $82 billion need in such financing over the next 50 years (OWRB, Oklahoma Comprehensive Water Plan, 2011).

CHAPTER FIVE: PLAN UPDATE PRIORITIZATION AND REVIEW

This chapter is used when doing a plan updates.

5.1 Changes in Jurisdictional Development

Two modest changes in development have occurred in Harper County since the publication of the previous HMP. Those are: some increase in the number of Tank Batteries which are used as storage for petroleum products, and an increase in the number of wind turbines that have been built. Neither has made a significant change in the potential for, or severity of hazard events in the county; both were addressed in this update as a component of utility infrastructure. No other changes in development have impacted the jurisdiction's overall vulnerability. Housing and industry are both relatively stable.

5.2 Status of Previous Mitigation Action Items

The table below illustrates the status of hazard mitigation actions in the previous plan by identifying those that have been completed and those that have not been completed.

Table KEY:

Green	indicates actions that have been completed
Yellow	indicates the action item has been included as part of the updated action plan
White	the action is no longer relevant or has been incorporated into another action

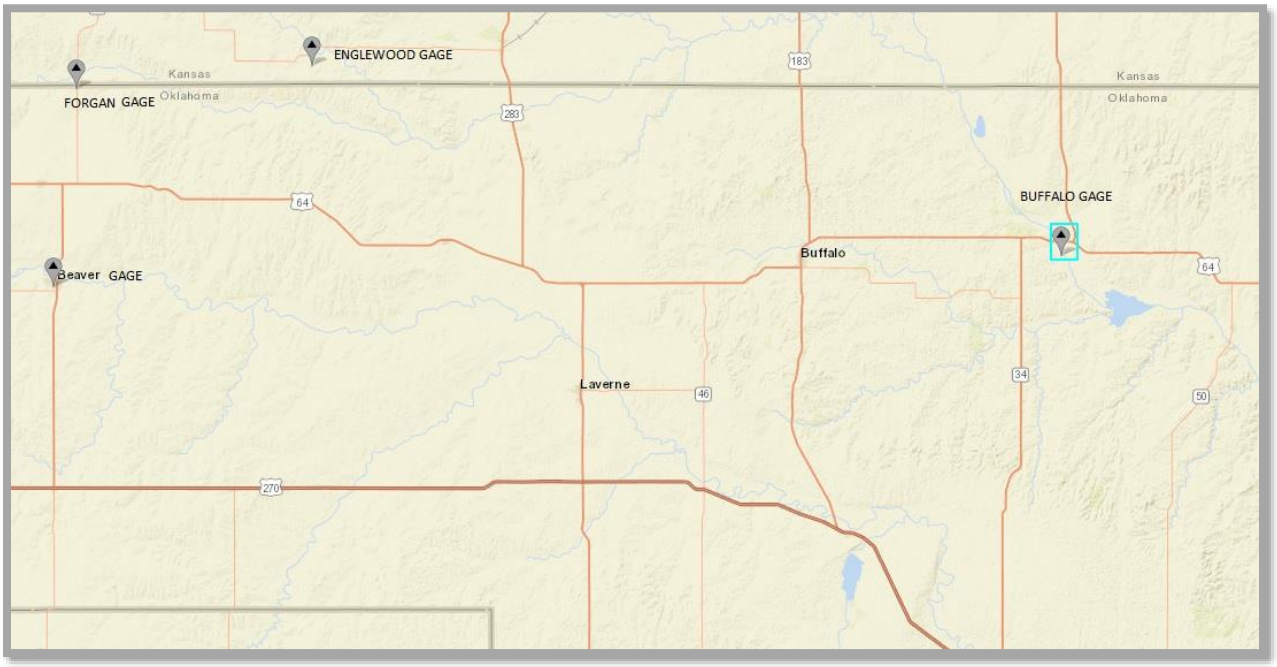
Mitigation items included in previous plan		
Hazard	**Mitigation strategy**	**Progress made**
Drought	Already under the guidance of NRCS and other agencies	NA
Earthquake	Planning, training, mapping and implementation for the County should be coordinated through various State and Federal agencies	State Earthquake maps are now available online
Hail	Additional warning devices be installed and implemented across the County	Some additional sirens were installed; more are needed
High Wind	Improved and consistent building codes	State Building Codes adopted
	Bury utility lines for critical facilities	Ongoing project; some have been buried
	Increased tree trimming near power lines	This has been done, but should be carried forward
Tornados	Test or Improve radio and wire communications with the local media and emergency management personnel	Communications equipment still needs to updated due to Technological advances
	Equip shelters with NOAA weather radios and frequent testing of this equipment	Ongoing project
	Improve sirens or another audible alert and frequent testing of this equipment	Ongoing effort

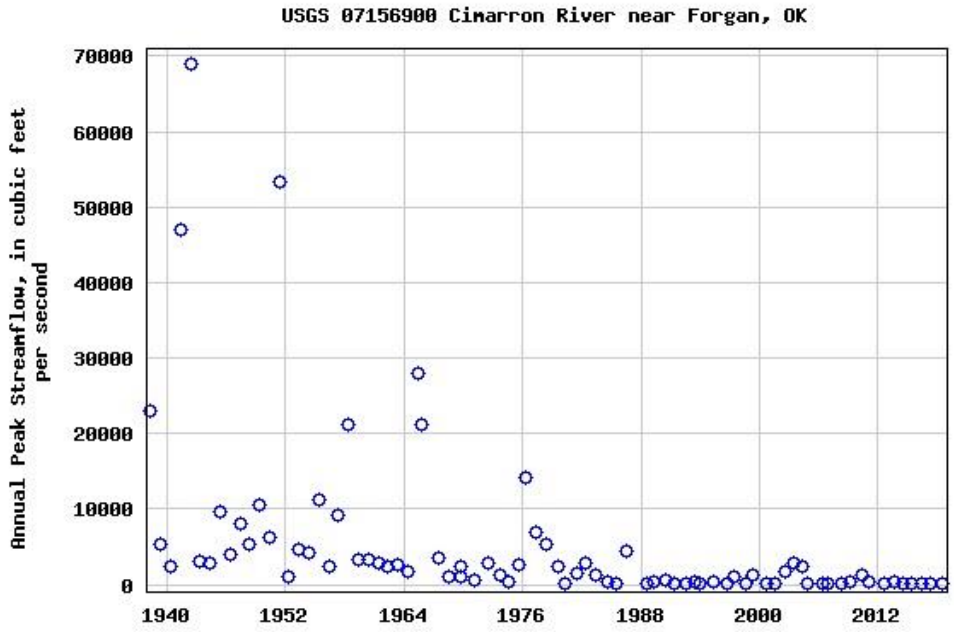
	Response and preparedness plans should be evaluated and tested prior to events	Ongoing effort
	Continue to improve education about disaster preparedness and safety in the local schools	Ongoing effort
	Develop and implement special notification measures for residents who live in high risk structures	Incorporated into other communication strategies
	Inform the public about available storm shelters and safe rooms	Ongoing need
	Evaluate existing shelters and plan for improvement or additional facilities; monitor grant opportunities and tax credits for shelters	Carry this forward
Flood	Continue to install rip-rap in known washout and erosion areas	Ongoing need
Wildfires	Increased use of fire retardant materials and fire supression systems in new construction	Building codes were improved
	Employ a strategy of prescribed burns with proper personnel during appropriate weather conditions	Ongoing project
	Elimination of Red Cedar	Ongoing effort
Lightning	Implement a Thor-guard system for local golf courses or outdoor sports tournaments or events	Incorporated into General emergency communication improvements
	Educate the public about lightning safety	Ongoing effort
Temperature Extremes	Compile a database of individuals with special needs or those without adequate HVAC and organize a "telephone tree" among neighbors to check on susceptible individuals during times of extreme temperatures	This is done on a volunteer basis. Improved education, communication and more places of refuge are needed
Sheltering	Development of printed information to be used by local officials and volunteers in educational programs would alert the citizens of the County in the appropriate sheltering procedures	Emergency Management Plan, School District plans
	Develop and provide to citizens a map of local shelters available during hazard events	Objective not met
	New construction or retrofitting of shelters in the area	Progress made; ongoing effort

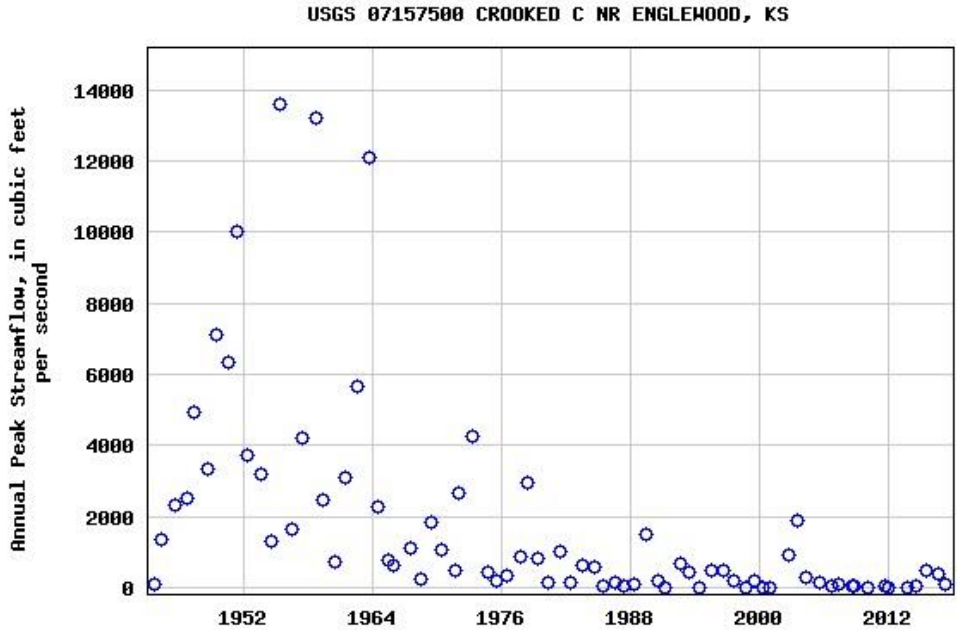
5.3 Changes in Jurisdictional Priorities

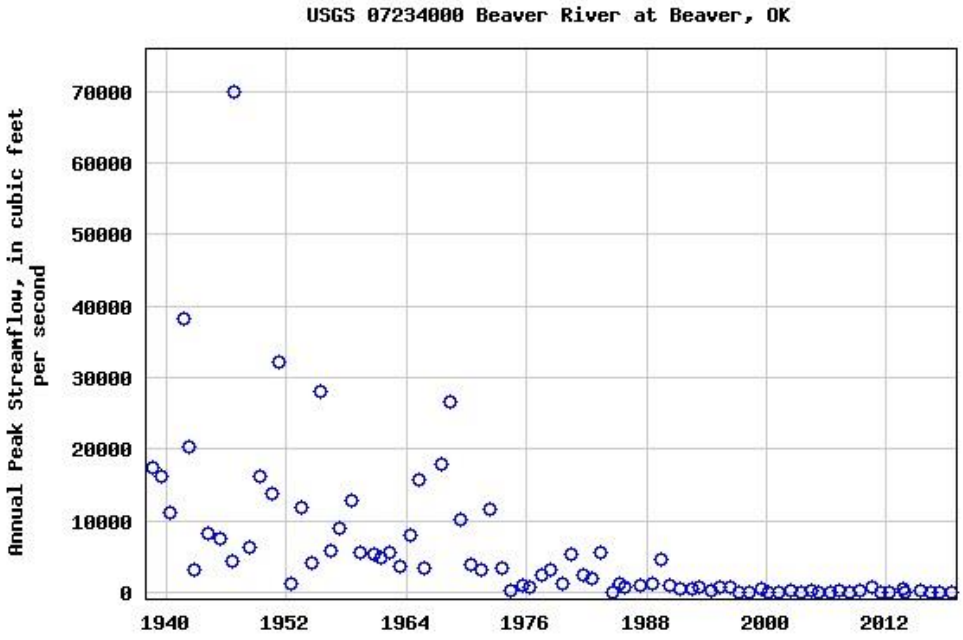
Drought has become a hazard of increased concern to local officials and residents of Harper County. Drought not only affects the availability of fresh water for the health and welfare of humans and animals throughout the county, it can severely damage the agricultural economy. Team members chose to identify additional mitigation measures for drought, but also took special note that the problem of aquifer depletion may become severe at some time in the next two decades. The map below illustrates the location of four stream gages. Four graphs show the trend towards depletion of available surface water at those stream gages upstream from and in Harper County.

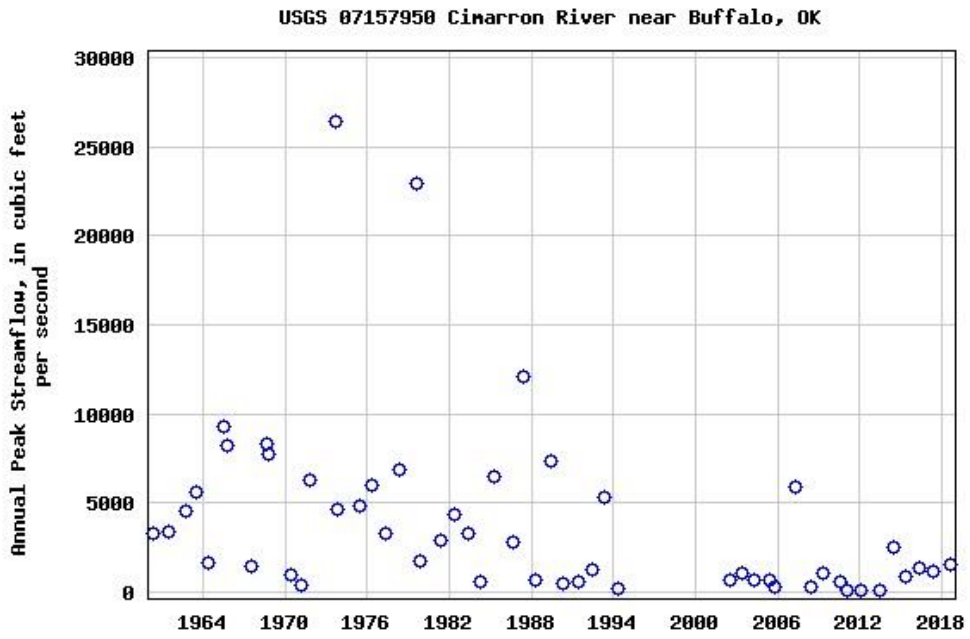
LOCATION OF STREAM GAGES NEAR FORGAN OK, ENGLEWOOD KS, BEAVER OK AND BUFFALO OK






USGS 07157500 CROOKED C NR ENGLEWOOD, KS
Annual Peak Streamflow, in cubic feet per second
14000
12000
10000
8000
6000
4000
2000
0
1952
1964
1976
1988
2000
2012


USGS 07234000 Beaver River at Beaver, OK
Annual Peak Streamflow, in cubic feet per second
70000
60000
50000
40000
30000
20000
10000
0
1940
1952
1964
1976
1988
2000
2012



Wildfires. The danger of Wildfire is a related hazard that may represent an increasing threat if drought becomes more frequent or severe.

5.4 Conclusion

The Goals and Action Items detailed in this Update are intended to assist officials and residents of Harper County as they continue to make progress towards becoming a safer community. As new information and new technology become available, this plan will be updated accordingly.

APPENDIX A References

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APPENDIX B Additional information

B.1 Earthquakes 2011-2018

HARPER COUNTY OK EARTHQUAKES 2011-2018

FID	date	time	mag	Depth(km)	latitude	longitude
818	2011-04-08	12:44:08	2.1	3.143	36.86379	-99.66458
16697	2016-04-12	23:09:41	2.4	3.854	36.70131	-99.67667
17486	2016-06-20	01:13:31	2.3	2.626	36.70022	-99.67976
17739	2016-07-09	03:52:26	2.7	2.231	36.83833	-99.71979
17821	2016-07-15	14:53:56	2.3	3.12	36.81083	-99.71047
17994	2016-08-04	19:04:07	2.4	5	36.60319	-99.33762
17995	2016-08-04	19:11:32	2.4	2.734	36.59793	-99.32558
19278	2016-11-30	03:38:37	2.4	3.195	36.64837	-99.82817
20588	2017-06-21	07:06:56	2.1	3.702	36.84842	-99.7201
20597	2017-06-24	20:32:20	3	5.054	36.88242	-99.72743
20643	2017-07-02	17:55:33	2.4	2.278	36.91211	-99.86172
20731	2017-07-14	02:22:22	2.2	3.389	36.66357	-99.35962
21228	2017-09-18	14:42:23	2.5	5.132	36.85998	-99.71248
21362	2017-10-13	12:52:43	3	0.932	36.84303	-99.71922
21369	2017-10-15	00:44:47	2.4	2.121	36.73346	-99.61784
21789	2017-12-16	00:24:49	2.2	4.41	36.70412	-99.38223
21791	2017-12-16	04:04:32	2.2	4.065	36.70675	-99.38693
21794	2017-12-16	17:34:44	2.7	5.781	36.70851	-99.39175
21795	2017-12-17	01:26:51	2.6	4.585	36.70651	-99.39249
21802	2017-12-18	06:57:39	2.3	2.059	36.71859	-99.37122
21817	2017-12-19	20:17:07	2.2	5.19	36.70525	-99.39066
21853	2017-12-27	14:29:31	2.4	1.513	36.71556	-99.37944
21872	2017-12-29	22:13:24	3.2	6.216	36.72028	-99.39089
21875	2017-12-30	02:47:13	2.2	4.204	36.711	-99.37855
21895	2018-01-01	12:53:21	2.2	2.477	36.71447	-99.35453
21905	2018-01-02	19:48:54	2.2	5	36.71126	-99.37695
21976	2018-01-17	03:41:58	2	5	36.7378	-99.61844
22311	2018-03-12	18:20:11	2.1	4.926	36.71147	-99.37717
22319	2018-03-16	05:59:42	3	3.189	36.71313	-99.38599
22326	2018-03-17	15:13:25	2.8	0.997	36.71791	-99.38766
22329	2018-03-18	18:36:35	2.3	6.36	36.83041	-99.72688
22331	2018-03-19	06:54:37	2.1	5.319	36.85168	-99.6972
22353	2018-03-23	10:26:02	2.2	2.568	36.60905	-99.3281
22414	2018-04-02	17:34:09	2.4	3.04	36.72417	-99.36444
22481	2018-04-09	16:26:41	2.8	3.138	36.72215	-99.3774
22505	2018-04-14	05:22:26	2.1	2.276	36.72101	-99.37092
22677	2018-05-18	10:35:32	2.4	3.052	36.69846	-99.34933
22678	2018-05-18	10:35:32	2.2	4.906	36.69743	-99.34192

B.2 High Wind

EVENT ID	BEGIN LOCATION	BEGIN DATE	BEGIN TIME	EVENT TYPE	MAGN (MPH)	DAM PROP	SOURCE
5230890	HARPER CO.	3/15/2001	940	High Wind	50	0	Gen Public
5236303	HARPER CO.	4/6/2001	1800	High Wind	39	0	AWOS
5235919	HARPER CO.	4/11/2001	1030	High Wind	39	40000	AWOS
5270883	HARPER CO.	10/15/2001	1000	High Wind	39	0	AWOS
5280797	HARPER CO.	3/8/2002	1900	High Wind	45	0	AWOS
5289517	HARPER CO.	4/2/2002	800	High Wind		0	AWOS
5351514	HARPER CO.	4/16/2003	845	High Wind	56	0	AWOS
5297	HARPER CO.	11/15/2006	155	High Wind	52	0	Mesonet
17983	HARPER CO.	2/24/2007	1540	High Wind	54	10000	Mesonet
147537	HARPER CO.	12/13/2008	530	High Wind	36	0	Mesonet
309041	HARPER CO.	4/15/2011	730	High Wind	58	0	Mesonet
504357	HARPER CO.	2/20/2014	635	High Wind	51	0	Mesonet
812992	HARPER CO.	3/13/2019	1330	High Wind	61	2000	Em Manager
812990	HARPER CO.	3/13/2019	1342	High Wind	61	8000	Em Manager

From 2000 through 2018, one hundred (100) other instances of high wind associated with thunderstorms were recorded, 32 of which included property damage.

B.3 Winter storms 2000-2018

HARPER COUNTY WINTER STORMS								
EVENT ID	**BEGIN DATE**	**TIME**	**EVENT TYPE**	**PROP DAM**	**FRZ RAIN**	**MAG SNOW (INCH)**	**WIND GUST (mph)**	**SOURCE**
5128755	1/27/2000	600	Heavy Snow	0	Y	4-8		UNKNOWN
5135771	3/16/2000	600	Winter Storm	0	Y	2-4		EMERGENCY MANAGER
5176950	12/26/2000	300	Winter Storm	50000	Y	4-12		EMERGENCY MANAGER
5228837	1/28/2001	1000	Winter Storm	0		4-7		LAW ENFORCEMENT
5277083	1/30/2002	100	Ice Storm		ICE			EM MANAGER
5280668	3/1/2002	2100	Winter Storm	0	Y	2-4	30-40	GENERAL PUBLIC
5321978	12/3/2002	1400	Winter Storm	0	Y	4-9		OFFICIAL NWS OBS.
5322069	12/23/2002	1200	Heavy Snow	0		4-8		GENERAL PUBLIC
5341590	2/6/2003	930	Heavy Snow	0		4-6		OFFICIAL NWS OBS.
5341607	2/23/2003	1100	Winter Storm	0		4	20-30	OFFICIAL NWS OBS.
5328807	12/9/2003	700	Winter Storm	0		4	25-40	GENERAL PUBLIC
5328795	12/12/2003	500	Winter Storm	0		1-3		GENERAL PUBLIC
5384251	1/25/2004	2200	Winter Storm	0		1-3	40+	NEWSPAPER
5384235	2/1/2004	600	Winter Storm	0	Y	5-6		NEWSPAPER
5384364	2/4/2004	500	Winter Storm	0		1-3		NEWSPAPER
5433809	1/4/2005	930	Winter Storm	100000	2" ICE			EM MANAGER
5433922	1/28/2005	600	Heavy Snow	0		3-8		EM MANAGER
5408	11/30/2006	300	Winter Storm	0	ICE	3-12	35+	COOP Observer
12056	1/13/2007	400	Winter Storm	5000	Y			EM MANAGER
12865	1/20/2007	300	Heavy Snow	0	Y	3-8		EM MANAGER
67050	11/23/2007	2000	Winter Storm	0		2		NEWSPAPER
72953	12/22/2007	1000	Winter Storm	10000		4	25+	COOP Observer
78308	1/31/2008	100	Winter Storm	0		1		COOP Observer
147486	12/9/2008	330	Winter Storm	0		2		DEPT OF HWYS
152769	1/26/2009	800	Winter Storm	0	Y			LAW ENFORCEM
161798	3/27/2009	100	Blizzard	0		25	40+	EM MANAGER
161799	3/27/2009	100	Blizzard	400000		23	40+	COOP Observer
213559	1/28/2010	900	Winter Storm	0		3-5		EM MANAGER
216252	3/19/2010	2000	Winter Storm	0		3-4		Trained Spotter
274200	1/9/2011	1500	Winter Storm	0		3		LAW ENFORCEM
269581	1/19/2011	2100	Winter Storm	0		2		LAW ENFORCEM
269582	1/19/2011	2100	Winter Storm	0				COOP Observer
280946	1/31/2011	2300	Winter Storm	0		1-2	40	EM MANAGER
277215	2/1/2011	0	Winter Storm	0		2	40+	COOP Observer
278285	2/8/2011	1200	Winter Storm	0		6.4	30-40	COOP Observer
428792	2/12/2013	600	Heavy Snow	0		5		PUBLIC

EVENT ID	BEGIN DATE	TIME	EVENT TYPE	PROP DAM	FRZ RAIN	MAG SNOW (INCH)	WIND GUST (mph)	SOURCE
429140	2/25/2013	700	Blizzard	0	Y	13		CO OFFICIAL
492248	12/21/2013	1200	Heavy Snow	0		5		COOP Observer
492249	12/21/2013	1200	Heavy Snow	0		6		CoCoRaHS
497325	1/4/2014	2100	Winter Storm	0		2		LAW ENFORCEM
504340	2/4/2014	400	Heavy Snow	0		7		LAW ENFORCEM
506936	3/2/2014	900	Heavy Snow	0		5		COOP Observer
548773	11/16/2014	300	Heavy Snow	0		4.5		PUBLIC
548769	11/16/2014	300	Winter Storm	0		3		PUBLIC
562711	2/27/2015	800	Winter Weather	0		2		PUBLIC
668722	1/14/2017	1000	Ice Storm		.5 ICE			STORM CHASER
793643	11/12/2018	0	Heavy Snow	0		5.5		COOP Observer

Appendix C Hazards not addressed for Mitigation

C.1. Dam Failure:

A dam is an artificial barrier usually constructed across a stream channel to impound water. Timber, rock, concrete, earth, steel, or a combination of these materials may be used to build the dam. A dam that impounds water in the upstream area is referred to as a reservoir. The amount of water impounded is measured in acre-feet. An acre-foot is the volume of water that covers an acre of land to a depth of one foot. As a function of upstream topography, even a very small dam may impound or detain acre-feet of water. Two factors influence the potential severity of a full or partial dam failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream.

Location. A single water control dam creating a reservoir is located in southwest Harper County about 1½ miles west and 1½ miles south of Laverne. It is classified as a low-risk dam because of the rural location, and because the watershed features indicate that dam failure would result in no probable loss of life and low economic loss.

Watershed name	Dams in Watershed	Dams in Harper County	*Monetary Benefits	Farms/ranches benefited	Bridges benefited	Wetlands enhanced/created (acres)	Reduced Sedimentation (tons of soil
Paint Creek	1	1	$188,247	13	5	33	7,478
* Monetary benefits include reduction in flood damage to crops, roads, bridges, fences, and may include other benefits such as irrigation, municipal and industrial water supply and recreation.							

Paint Creek Dam

Extent. Dam Failure in this location would pose low or no risk of loss of human life and low economic loss. Flow would be confined to an area that is crop land and open range.

Oklahoma Dam Classification Chart

Low	Failure would result in no probable loss of human life and low economic loss.
Significant	Failure would result in no probable loss of human life, but can cause economic loss or disruption of lifeline facilities.
High	Failure will probably cause loss of human life.

(OWRB, 2014)

Previous Occurrences. There has been no failure of this dam recorded.

Probability of Future Events. There is a low probability of dam failure.

Vulnerability. Crops on land to the north side of the dam could be damaged. If humans or livestock were present, they may be vulnerable to water rushing in this area in the event of a dam failure.

Impact is restricted to the immediate area. See map.

C.2. Expansive Soils

Expansive Soils. Expansive or swelling soils are soils that swell when subjected to moisture. These swelling soils typically contain clay materials that attract and absorb water. Another category of expansive soil known as swelling bedrock contains a special type of mineral called clay stone.

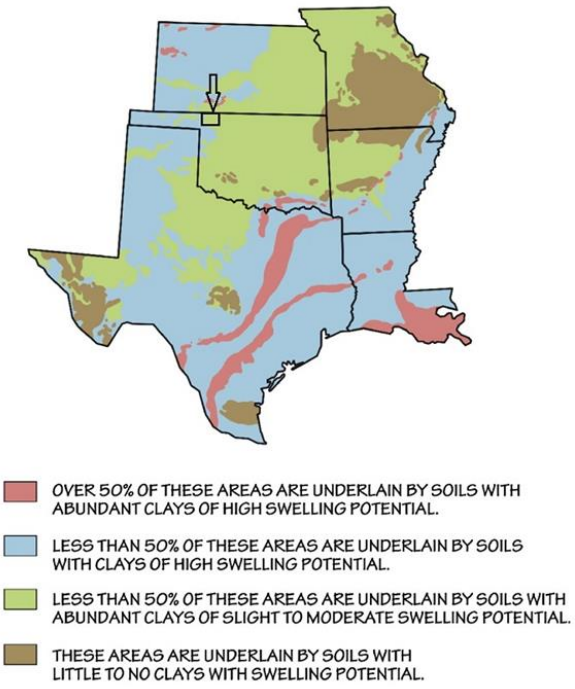
When water is added to these expansive clays, the water molecules are pulled into gaps between the clay plates. As more water is absorbed, the plates are forced further apart, leading to an increase in soil pressure or an expansion of the soil's volume. Soils containing expansive clay become very sticky when wet and are usually characterized by surface cracks or a "popcorn" texture when dry. Therefore, the presence of surface cracks is usually an indication of an expansive soil.

Changes in soil volume present a hazard primarily to structures built on top of expansive soils. The most extensive damage occurs to highways and streets. The effect of expansive soil is most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall. Expansive soils can be recognized by visual inspection in the field or by conducting laboratory analysis of the soil.

According to Dr. Amy B. Cerato, (2014, University of Oklahoma), the primary risk with the presence of expansive soils is damage to infrastructure such as roads and building foundations.

Location and Extent

Determining the extent and location of risk is challenging. "Expansive unsaturated soils cover one-fourth of the United States and undergo large amounts of heaving and shrinking due to seasonal moisture changes. These movements lead to cracking and buckling of the infrastructure built on expansive soils and result in billions of dollars of damage annually (e.g., Wray & Meyer 2004). Although not life-threatening or cataclysmic as compared to other natural events, expansive soils are certainly a natural hazard.



Even though expansive soils have been studied for several decades, all of the idealized models presented to date to predict shrink-swell potential of expansive soils have failed to predict actual soil movement under real conditions. . ." (Hillel 1998).

The location of expansive soils in Harper County is roughly illustrated in the map (left). Most of the County is described as having less than 50% of those areas

underlain by clays with a slight to moderate swelling potential (green). On the western edge of the county, the classification indicates that less than 50% of those areas is underlain by clays with a high degree of swelling potential (blue).

Therefore, while the risk of hazard from expansive soils is relatively low in most of Harper County, it may be wise to consult with NRCS regarding detailed soil maps prior to construction of buildings – especially those planned with a basement. Illustration: (Ellen Lyons, 2015)

Previous Occurrences

Oklahoma does not have disaster information on Expansive Soils because a catastrophic event has not been declared. This hazard develops gradually and is difficult to attribute dollar amounts to this hazard. No history is available because there are no reported losses which identify the presence of expansive soils as the direct cause.

Probability of Future Events

According to the 2019 State of Oklahoma Hazard Mitigation Plan, the potential for serious Expansive Soil events in Oklahoma is unlikely but could occur under the right soil and weather conditions. See the Oklahoma State Plan for more details.

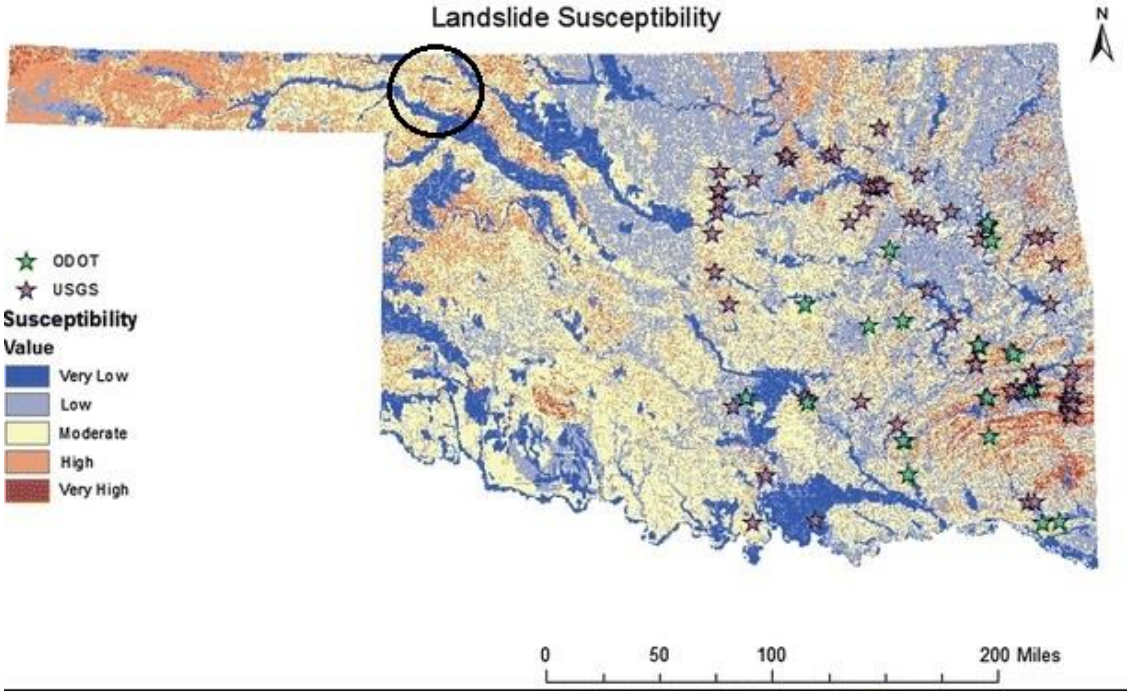
Vulnerability; Impact

Structures most vulnerable to damage from expansive soils include roads and building foundations. Data has not yet been collected and recorded for this potential hazard.

C.3 Landslide

Landslides are defined as the movement of a mass of rock, debris, or earth down a slope. According to the U.S. Geological Survey, almost every landslide has multiple causes. Slope movement occurs when forces acting down-slope exceed the strength of the earth material that compose the slope. Landslides can initiate in slopes already on the verge of movement by rainfall, snowmelt, changes in water level, stream erosion, changes in ground water, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors.

Location. The landslide susceptibility map of Oklahoma was developed using the combined soil texture layer and other rating values (OKSHMP 2019).



Extent. The extent of a potential landslide is Harper County is limited by the nature of the soils and the relatively low elevation of geological features. Oklahoma does not have disaster information on specific landslide occurrences because a disaster event has not been declared. There have been minor cases of rockslides and landslides that have occurred in Oklahoma. Currently, there is no damage history to structures is available because there are no reported losses which identify landslides as the direct cause. There have been limited impacts to transportation corridors as identified by ODOT (OKHMP, 2019), none of which are in Harper County

Previous Occurrences. No previous occurrences of landslides in the county have been reported.

Probability of Future Events. The probability of injury, loss of life or property damage due to landslide is Low.

Vulnerability. Landslide hazards in the State of Oklahoma have been located in specific areas, and are dependent on geological formations and influenced by weather related factors such as periodicity of precipitation. These locations primarily occur in eastern Oklahoma, which has the many of the requisite factors such as precipitation, slope instability and geological formations that are factors in a landslide event (OKHMP, 2019).

Impact. The impact of a landslide in Harper County would primarily be limited to open range. Therefore no landslide mitigation activities were developed for this Update.

C.4 Subsidence

Subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. The principal causes are aquifer-system compaction, drainage of organic soils, underground mining, hydro-compaction, natural compaction, sinkholes, and thawing permafrost.

Subsidence due to abandoned mining operations is the primary concern in portions of Oklahoma. According to the Oklahoma Geological Survey, there are two primary categories of subsidence associated with underground mining. The first is called “chimney” or “plug” subsidence, which is characterized by shearing, steep-sided depressions and large-differential displacements. The second category of subsidence is termed “trough subsidence,” which is characterized by broad, shallow, trough-shaped depressions that form above a mine opening when the overlying strata sag into the mine void.

Location; Impact. Land Subsidence is primarily confined to historic mining sites in Eastern Oklahoma, therefore there is little known risk in the NW part of the state, and no mitigation activities were identified for Harper County.