Chapter 4: Natural and Man-Made Hazards

44 CFR Requirements met:

Requirement §201.6(c)(2): *[The plan **shall** include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.*

Requirement §201.6(c)(2)(i): *[The risk assessment **shall** include a] description of the type of all natural hazards that can affect the jurisdiction.*

Requirement §201.6(c)(2)(i): *[The risk assessment **shall** include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.*

Requirement §201.6(c)(2)(ii): *[The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.*

Requirement §201.6(c)(2)(ii)(A): *The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.`*

Requirement §201.6(c)(2)(ii)(B): *[The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate.*

Requirement §201.6(c)(2)(iii): *For multi-jurisdictional plans, the risk assessment **must** assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

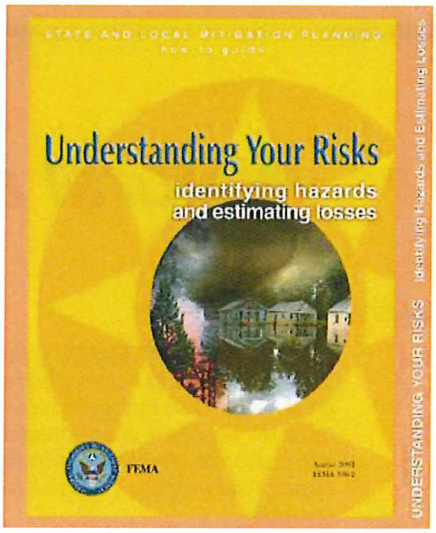
Included in this Chapter:

Introduction
Hazards Summary
Annual Average Damages
Hazards Analysis
Secondary Events
Vulnerability Assessment
4.1 Floods
4.2 Tornadoes
4.3 High Winds
4.4 Lightning
4.5 Hailstorm
4.6 Severe Winter Storms
4.7 Extreme Heat
4.8 Drought
4.9 Expansive Soils
4.10 Urban Fires
4.11 Wildfires
4.12 Earthquakes
4.13 Fixed Site Hazardous Material Events
4.14 Dam Failures
4.15 Transportation Hazards
4.16 Hazard Composite

Introduction

According to the Federal Emergency Management Agency (FEMA), a hazard is defined as an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, or agricultural loss, among other types of loss or harm. Hazards are generally classed into two categories based on their source: natural hazards and man-made hazards. Each hazard has its own defining characteristics, such as time of year and geographic area of probable occurrence, severity, and risk level.

Natural phenomena, such as floods, tornadoes, severe drought, and wildfires, are natural hazards because they have the potential to destructively impact human settlements and activities. When damage from a natural hazard occurs, the event is generally called a natural disaster.



Man-made hazards are broadly defined as hazards that originate from accidental or intentional human activity. They can affect localized or widespread areas and are frequently unpredictable. This category of hazard includes such events as dam breaks and hazardous material events.

While Oklahoma communities can expect disaster-related losses, hazard assessments can be used to create proactive measures against likely events, and thereby significantly decrease or eliminate their impacts. Therefore, this chapter contains a risk identification and assessment for 15 hazards. The hazards addressed are those deemed most likely to impact Canadian County, Canadian County Communities, and Canadian County school districts. The hazards include:

1. **Floods**
2. **Tornadoes**
3. **High Winds**
4. **Lightning**
5. **Hail**
6. **Severe Winter Storms**
7. **Extreme Heat**
8. **Drought**
9. **Expansive Soils**
10. **Urban Fires**
11. **Wildfires**
12. **Earthquakes**
13. **Fixed-Site Hazardous Materials**
14. **Dam Failures**
15. **Transportation of Hazardous Materials**

Each hazard is covered in a separate section, which includes the following information:

- **Hazard Profile** – Causes, effects, normal frequency (how often it is likely to occur at a particular location), and available scales or methods of measuring the severity of the events, if any; the geographical extent and impact of the hazards; and the identification of any topographic or geological conditions that would make a particular area prone to the hazard.
- **History/Previous Occurrences** – Notable past occurrences of the hazard, including national, state, and local examples, if any. Where available, historical losses, in terms of lives and property, are detailed.
- **Vulnerability** – The people, geographic locations, and types of property subject to the particular hazard are identified. For each hazard with a definable geographic location, such as floods and dam breaks, the number, types and value of buildings and contents are identified, along with the vulnerable populations. In addition, the potential effect on infrastructure, such as communications and utilities are reviewed.
- **Scenario** – When appropriate for the hazard, a "worst-case" scenario is presented and analyzed. This information can be used to further prioritize the risks for the community inherent in a particular hazard.
- **Future Trends** – Potential effects of the hazard in terms of future development areas of the community are reviewed in terms of population, structures, infrastructure, and critical facilities. When known, other factors such as emerging technological trends may be included in this analysis.

Information on each of the natural and man-made hazards is presented in summary form beginning on the following page. More detail follows in subsequent chapters and appendices.

Summary of Natural and Man-Made Hazards

Floods	The accumulation of water within a body of water and the overflow of excess water onto adjacent lands. The floodplains are the lands adjoining the channel of a river, stream, ocean, lake, or other watercourse or body of water that is susceptible to flooding. Canadian County, its Communities and Public School systems have a moderate vulnerability to the effects of flooding, and have a moderate probability that a flood event will occur.
Tornadoes	A rapidly rotating vortex or funnel of air extending to the ground from a cumulonimbus cloud. When the lower tip of a vortex touches earth, the tornado becomes a force of destruction. Canadian County, its Communities and Public School systems have a high vulnerability to the tornado hazard and a high probability that a tornado event will occur.
High Winds	Wind is the motion of air relative to the earth's surface. Extreme windstorm events are associated with cyclones, severe thunderstorms, and accompanying phenomena such as tornadoes and downbursts. The people most vulnerable to high wind-related deaths, injuries, and property damage are those residing in mobile homes (see Figure 1-7 for location of mobile home parks) and deteriorating or poorly constructed homes. Canadian County, its Communities and Public School systems have a high vulnerability to high wind events and a high probability that a high wind event will occur.
Lightning	Lightning is generated by the buildup of charged ions in a thundercloud. When that buildup interacts with the best conducting object or surface on the ground, the result is a discharge of a lightning bolt. The air in the channel of a lightning strike reaches temperatures higher than 50,000˚ Fahrenheit. Oklahoma is vulnerable to frequent thunderstorms and convective weather patterns, and therefore its vulnerability to lightning is a constant and widespread threat during thunderstorms. Canadian County its Communities and Public School systems are at high vulnerability for lightning strikes and a high probability that a lightning event will occur.
Hail	A hailstorm is an outgrowth of a severe thunderstorm in which balls or irregularly shaped lumps of ice fall with rain. Extreme temperature differences from the ground upward into the jet stream produce strong updraft winds that cause hail formation. In 2010, the National Weather Service increased its size criteria for hail that defines a severe storm event to 1 inch from ¾ inch. Canadian County its Communities and Public School systems are at high vulnerability to the hail hazard, and have a high probability that a hail event will occur.
Severe Winter Storms	A severe winter storm is one that drops four or more inches of snow during a 12-hour period, or six or more inches during a 24-hour period. An ice storm occurs when freezing rain falls and freezes immediately upon contact with earth, plants, roads, homes and other structures. Canadian County, its Communities and Public School districts, are at high vulnerability to the severe winter storm hazard, and have a high probability that a winter storm event will occur.
Extreme Heat	Extreme summer weather is characterized by a combination of very high temperatures and exceptionally humid conditions. A heat wave occurs when such conditions persist over time. Canadian County, its Communities and Public School districts, are at moderate vulnerability from extreme heat events, and have a high probability that an extreme heat event will occur.
Drought	Drought is a climatic dryness severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems. Drought duration and severity are usually measured by deviation from norms of soil moisture, annual precipitation and stream flows. Canadian County, its Communities and Public School districts, are at moderate vulnerability from drought and have a moderate probability that a drought event will occur.
Expansive Soils	Soils and soft rock that swell and shrink with changes in moisture content are commonly known as expansive soils. Expansive soils develop gradually and are seldom a threat to the population, but can cause severe damage to improvements built upon them. Canadian County, its Communities and Public School districts, are at high vulnerability to expansive soils and have a high probability that an expansive soils event will occur.
Urban Fires	An urban fire affects homes or other improved structure. Fire generates a black, impenetrable smoke that blocks vision and stings the eyes, making it difficult to navigate and evacuate the building on fire. Canadian County, its Communities and Public School systems have a high vulnerability from urban structure fires, and a high probability that an urban fire event will occur.
Wildfires	A wildfire can be a fire that burns along the ground, moving slowly and killing or damaging trees; a fire burning on or below the forest floor in the humus layer down to the mineral soil; or a fire rapidly spread by wind that moves by jumping along the tops of grass, brush and trees. Canadian County, its Communities and Public School systems are at moderate vulnerability to wildfires, and have a high probability that a wildfire event will occur.

Earthquakes

An earthquake is a sudden, rapid shaking of the ground caused by the fracture and movement of rock beneath the Earth's surface. Earthquakes occur in Oklahoma, most are too small to be felt and cause no visible damage. But, unfelt earthquakes can adversely affect buildings, infrastructure, and lifelines.

Canadian County, its Communities and Public School systems are at a low vulnerability from earthquakes and have a moderate probability that an earthquake event will occur.

Fixed Site Hazardous Material Events

Hazardous materials are chemical substances that, if released can pose a threat to the environment or human health. They can be explosives, flammable and combustible substances, poisons, and radioactive materials. They are stored or used at fixed-sites such as industries. Larger repositories of hazardous chemicals are classified as Tier II Sites and registered/regulated by the Oklahoma Department of Environmental Quality.

Canadian County, its Communities and Public Schools have a moderate vulnerability for fixed-site hazardous materials events, and a moderate probability that a fixed-site hazardous materials event will occur.

Dam Failures

FEMA defines a dam as "a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water." A dam failure is a collapse, breach, or other failure resulting in downstream flooding.

Canadian County, its Communities and Public School systems have a low vulnerability to a dam failure event, and a low probability that a dam failure event will occur.

Transportation Hazardous Materials Events

Transportation is the physical movement of objects and materials through components of a system and its subsystems. Transportation includes the use of aviation, highway, railroad, pipeline, and marine systems for the movement of objects and people. This plan considers the potential of transportation related hazardous materials events and exposure to potential mass casualty transportation accidents.

Canadian County, its Communities and Public School systems are considered to have a moderate vulnerability for a transportation event, and a moderate probability that a transportation event will occur.

Annual Average Damages

Although available data is limited, information on total damage to property, injuries and loss of lives for the 15-year period from 1995 through 2009 has been summarized in Table 4-1. Sources for information include the National Climatic Data Center, the National Response Center, the Oklahoma Geologic Survey, and the Oklahoma Fire Marshal's Office, in addition to information obtained from local sources.

Table 4–1: Summary of Damages

Hazard	Events	Total Property Dmg	Property Dmg/Event	Property Damage/Yr	Injuries	Injuries/ Event	Injuries/ Year	Deaths	Deaths/ Event	Deaths/ Year
Floods	30	$3,042,000	$101,400	$202,800	3	0.10	0.20	0	0	0
Tornadoes	34	$7,141,000	$210,029	$476,067	5	0.15	0.33	0	0	0
High Winds	73	$6,814,000	$93,342	$454,266	0	0	0	0	0	0
Lightning	9	$181,000	$20,111	$12,067	0	0	0	0	0	0
Hail	105	$501,000	$2,277	$33,400	0	0	0	0	0	0
Winter Storms	35	$524,430,000	$13,800,789	$34,962,000	1	0.03	0.07	0	0	0
Extreme Heat	4	$10,000	$2,000	$667	100	20	6.67	31	6.20	2.07
Drought	4	$32,495,000	$2,030,938	$2,166,333	4	0.25	0.26	0	0	0
Expansive Soils	Information not available									
Urban Fires[1]	1,059	$19,310,015	$18,234	$1,755,456	85	0.08	7.73	15	0.01	1.36
Wildfires[1]	2,141	$1,442,100	$674	$131,100	Information not available					
Earthquakes	28	Information not available			0	0	0	0	0	0
HazMat Events	21	Information not available								
Dam Failures	0	0	0	0	0	0	0	0	0	0
Transportation[2]	58	Information not available								

1. Fire data is based on the eleven-year period from 1999 through 2009, based on best available data from the Oklahoma State Fire Marshal's office.
2. Transportation data based on 13 year reporting period 1996-2009. Source: National Response Center

Hazards Vulnerability: Ranking Probability and Impact

A hazards vulnerability ranking provides a quantitative process for use in assessing and evaluating each hazard and using a common base to define criteria and establish a rating and scoring system.

Table 4-2 shows the results of the hazard vulnerability ranking for Canadian County, which includes a quantification of the history, probability, impact, and maximum threat for each event, along with mitigating conditions such as extent of existing mitigation activities and capabilities of local and area response agencies. Table 4-3 provides a summary of the ranking criteria and the scoring method.

Table 4–2: Canadian County Hazard Vulnerability Ranking

Type of Hazard	Occurrence		Impact				Mitigation Activities	Resources		Total Score
	Historical	Probability	Human	Property	Infrastructure	Business		Internal	External	
Winter Storm/Ice Storm	5	5	2.6	3.6	4	4	2	2.5	2	5.8
Tornadoes	4	4	3.25	4	3	3	2	2.5	3	4.8
High Wind Events	5	5	1	3	3	2	1	3	4	4.4
Lightning	5	5	2	3	3	2	2	4	4	4.4
Hail	4.5	4.5	1	4	2	3	1	3	3	4.4
Urban (Structure) Fires	5	5	1	4	1	4	3.5	4	4	4.3
Expansive Soils	5	5	1	3	1	1	1	2	2	4.1
Heat, Extreme	5	5	2	1	1	1	1	3	4	3.6
Wildfires	4.5	4.5	1	2	2	2	2	3.5	4	3.5
Transportation Hazardous Materials Incidents	3	3	3	2	1	3	1	3	4	3.1
Drought	3	3	1.5	2	2	3	2	2	3	3.1
Fixed Site Hazardous Material Incidents	2	3	2.5	2	1	2	1	3	4	2.6
Flooding	3	3	1	2	3	2	3	4	4	2.6
Dam / Levee Failure	0	1	2	3	3	3	1	2	2	2.3
Earthquake	2	2	1	1	1	1	1	3	4	1.3

Table 4–3: Summary of Hazard Vulnerability Ranking Criteria

Summary:	This tool looks at an organization's or a community's vulnerability to the effects of various hazards. Using a scale of 0 to 5, the probability of occurrence and the impact potential are measured against mitigation activities and the resources available to respond to the hazard. The total is based on a formula that weighs risk heavily but provides credit for mitigation and response and recovery resources. The highest score possible is 7.8. The lower the total score, the lower the overall risk from the Hazard.
Instructions:	*Score each hazard based on a scale of 0 to 5 with 5 being the highest.* Ratings values: 1 = Low : 2-3 = Moderate : 4-5 = High
Historical Occurrence:	This is based on the number of occurrence in the last 20 years. Maximum is 5; if a new hazard, use 0.
Probability:	Score 0 if non-existent, 1 if less than 1%, 2 if less than 5%, 3 if less than 10%, 4 if less than 20%, and 5 if greater than 20%. Percents are based on the likelihood of an event occurring within a 15 year period of time. Probability is the likelihood an event will occur. History and probability are similar, but hazards that are newly developing, hazards where likelihood has increased or decreased based upon new developments or activities, or hazards with no historical information may need to be considered individually.
Impact:	Based on "worst-case scenario" - greatest possible impact should worst-case event occur. Maximum threat is the worst-case scenario of a hazard. Its impact is expressed in terms of human casualties, property loss, and business interruption/loss revenue issues. Secondary events need to be factored in where necessary. Assume maximum population when appropriate (for example, industrial park during peak work hours).
Internal/ External Resources:	Based on the resources available to the community internally, or to Mutual Aid agreements or other understandings with neighboring jurisdictions. May also include private resources available, such as corporate firefighting/hazmat teams or medical resources.
Analysis Results:	**Extreme Vulnerability: Greater than 6.0** / **Moderate Vulnerability : 2.5 to 4.0** **High Vulnerability : 4.0 to 6.0** / **Low Vulnerability : Less than 2.5**

Secondary Events

Although hazards may be individually identified and categorized, many are interrelated, and a disaster may involve multiple hazards. Severe thunderstorms, for example, may spawn high winds, lightning, hailstorms, tornadoes, and flooding. It is generally more useful to consider all secondary events as a part of the overall situation created by the primary event. These "Cascade Events" are presented in Table 4-4 related to each of the hazards studied in this report.

Table 4–4: Secondary (Cascade) Hazard Events

Primary Event	Dam Failure	Drought	Expansive Soil	Flood	Fixed-Site HazMat Event	Power Failure	Urban Fire	Transportation HazMat	Water Supply Failure	Wildfire
Flood	X				X	X	X	X	X	
Tornado					X	X	X	X		
High Wind					X	X	X	X	X	X
Lightning					X	X	X	X		X
Hail						X				
Winter Storm						X	X	X		
Extreme Heat		X	X			X				
Drought			X						X	X
Expansive Soil									X	
Urban Fire					X	X				X
Wildfire					X	X	X	X		
Earthquake	X				X	X	X	X	X	
Fixed-Site HazMat							X			X
Dam Failure				X	X	X		X	X	

Primary Event	Dam Failure	Drought	Expansive Soil	Flood	Fixed-Site HazMat Event	Power Failure	Urban Fire	Transportation HazMat	Water Supply Failure	Wildfire
Transportation HazMat					X	X	X			X

Vulnerability Assessment

The assessment based on the following analyses, shown in Table 4-5, indicates that Canadian County, its Communities and Public School systems are vulnerable at some level to all hazards studied in this document.

Table 4–5: Hazard Vulnerability for Canadian County Communities and Public Schools

Jurisdiction	Floods	Tornadoes	High Winds	Lightning	Hail	Winter Storms	Extreme Heat	Drought	Expansive Soils	Urban Fires	Wildfires	Earthquakes	Hazardous. Material Sites	Dam Failures	Transportation Hazards
Unincorporated Canadian County	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Town of Calumet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
City of El Reno	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
City of Mustang	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Town of Okarche	X	X	X	X	X	X	X	X	X	X	X	X	X		X
City of Piedmont	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Town of Union City	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Banner Public Schools		X	X	X	X	X	X	X	X	X	X	X			X
Calumet Public Schools	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Darlington Public School		X	X	X	X	X	X	X	X	X	X	X		X	X
El Reno Public Schools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Maple Public Schools		X	X	X	X	X	X	X	X	X	X	X			X
Mustang Public Schools	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Okarche Public Schools		X	X	X	X	X	X	X	X	X	X	X	X		X
Piedmont Public Schools	X	X	X	X	X	X	X	X	X	X	X	X			X
Union City Public Schools	X	X	X	X	X	X	X	X	X	X		X	X		X
Redlands Community College	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Canadian Valley Technology Center	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Critical Facilities

Table 4-6 provides a grid that represents the assessment of the susceptibility of structures, institutions, emergency response capabilities that Canadian County has determined are its critical facilities. They, too, are vulnerable at some level to all hazards presented in this Plan.

Table 4–6: Vulnerable Critical Facilities in Canadian County

Map ID	Name	Floods	Tornadoes	High Winds	Lightning	Hail	Winter Storms	Extreme Heat	Drought	Expansive Soils	Urban Fires	Wildfires	Earthquakes	Hazardous. Material Sites	Dam Failures	Transportation Hazards
C01	Banner Public Schools		X	X	X	X	X	X	X	X	X	X	X			X
C02	Canadian Co Rural Water District		X	X	X	X	X	X	X		X	X	X			

Map ID	Name	Floods	Tornadoes	High Winds	Lightning	Hail	Winter Storms	Extreme Heat	Drought	Expansive Soils	Urban Fires	Wildfires	Earthquakes	Hazardous Material Sites	Dam Failures	Transportation Hazards
C03	Canadian County Rural Water District #4 Water Tower #1		X	X	X	X	X	X	X		X	X	X			
C04	Canadian County Rural Water District #4 Water Tower #2		X	X	X	X	X	X	X		X	X	X			
C05	Canadian County Rural Water District #1 Water Tower and Booster Station		X	X	X	X	X	X	X		X	X	X			X
C06	Cedar Lake Volunteer Fire Dept #1		X	X	X	X	X	X	X		X	X	X			X
C07	Cedar Lake Volunteer Fire Dept #2		X	X	X	X	X	X	X		X	X	X			
C08	Cedar Lake Volunteer Fire Dept #3		X	X	X	X	X	X	X		X	X	X			X
C09	County Shop District No 3		X	X	X	X	X	X	X		X	X	X			X
C10	Darlington Public School		X	X	X	X	X	X	X	X	X	X	X			X
C11	Federal Correctional Institution		X	X	X	X	X	X	X		X	X	X			X
C12	Maple Public Schools		X	X	X	X	X	X	X		X	X	X			X
C13	Methodist Camp		X	X	X	X	X	X	X		X	X	X			
C14	Mustang Creek Elementary		X	X	X	X	X	X	X		X	X	X			X
C15	Mustang North Middle School		X	X	X	X	X	X	X		X	X	X			
C16	Mustang Trails Elementary		X	X	X	X	X	X	X		X		X	X		
C17	Mustang Valley Elementary		X	X	X	X	X	X	X		X	X	X	X		
C18	Northwood Elementary		X	X	X	X	X	X	X		X	X	X			X
C19	Okarche Water Supply Tank		X	X	X	X	X	X	X		X	X	X			
C20	Richland Fire Department		X	X	X	X	X	X	X		X	X	X			
C21	Stone Ridge Elementary		X	X	X	X	X	X	X		X	X	X			
C22	Canadian County Courthouse		X	X	X	X	X	X	X		X		X	X	X	X
C23	Canadian County Sheriff		X	X	X	X	X	X	X		X		X	X	X	X
C24	Canadian County Assessor		X	X	X	X	X	X	X		X		X	X	X	X
C25	Gary Miller Children's Justice Center	X	X	X	X	X	X	X	X		X	X	X			X
C26	County Shop District No 1	X	X	X	X	X	X	X	X		X	X	X		X	
C27	County Shop District No 2		X	X	X	X	X	X	X		X	X	X	X		X
C28	Canadian County Fairgrounds		X	X	X	X	X	X	X		X		X		X	
C29	Canadian County DHS		X	X	X	X	X	X	X		X		X	X	X	X
C30	Canadian County Judicial Building/ County Clerk		X	X	X	X	X	X	X		X		X	X	X	X
C31	Canadian County Election Board		X	X	X	X	X	X	X		X		X	X		X
C32	Canadian County Health Department		X	X	X	X	X	X	X		X		X		X	X
C33	Canadian Valley Technology Center - Cowan Campus		X	X	X	X	X	X	X		X	X	X		X	