# 4.6 Severe Winter Storms

## 4.6.1 Hazard Profile

A severe winter storm is one that drops more than two inches of snow or a quarter inch of ice. An ice storm occurs when freezing rain falls and freezes immediately upon contact.

The National Weather Service (NWS) in Norman issues a Winter Weather Advisory when one to three inches of new snow or icing are expected which could make driving and walking hazardous. A Winter Storm Warning is issued when hazardous conditions are forecast to occur across the area, or when there is difficulty in determining the type of conditions which will predominate.

**Canadian County is vulnerable to ice storms produced by warm, moist Gulf air colliding with arctic air from Canada**

### *Location*

Oklahoma experiences the periodic collision of warm, moist Gulf air and arctic air from the Canadian Shield.

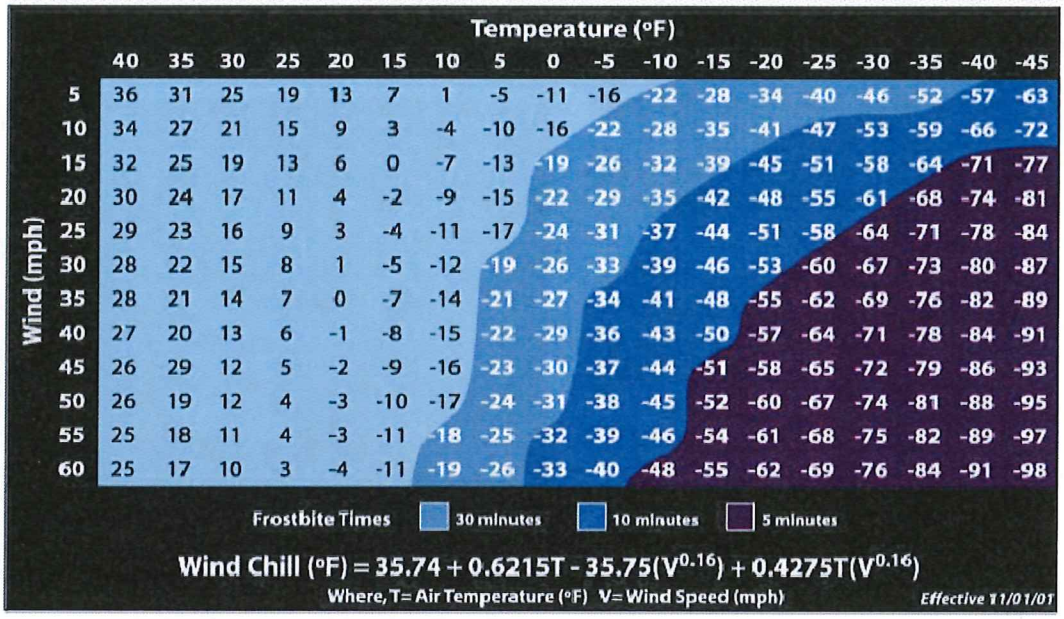
Because of this climatic positioning, Canadian County experiences winter weather ranging from extreme sub-zero temperatures, snow and freezing rain to mild, spring-like days. Therefore the entire planning area is equally at risk of experiencing winter storms, all locations are vulnerable including: Canadian County, the Cities of El Reno, Mustang, and Piedmont; the Towns of Calumet, Okarche, and Union City; and the participating School Districts: Banner Public Schools, Calumet Public Schools, Darlington Public Schools, El Reno Public Schools, Maple Public Schools, Mustang School District, Okarche School District, Piedmont Public Schools, Union City Public schools, Redlands Community College, and Canadian Valley Technology Center, all are considered vulnerable to the effects of a severe winter ice/snow event.

### *Measurement*

The *Wind Chill Index* is a measure of how cold the wind makes real air temperature feel to the human body. Created in 1870, the National Weather Service released a more scientifically accurate equation in 2001. The chart (Figure 4-14) is used to calculate wind chill. (The Chart is not applicable in calm winds or when the temperature is over 50°F.)

Table 4-21 displays Balthrop's Winter Storm Physical Intensities. This measure of the intensities and impacts of winter storms was developed by Charles Balthrop of the Oklahoma Department Emergency Management. From an historical standpoint, this chart is fully applicable to Canadian County and an accurate predictor of future Severe Winter Storms.

## Figure 4–14: Wind Chill Index




## Table 4–21: Balthrop's Winter Storm Physical Intensities

| | | |
|---|---|---|
| Level 1 – Nuisance Event<br>No Major Impact | Little snow/ice accumulation. Roads not hazardous | Little to no effect on the Jurisdiction. |
| Level 2 – Minor Event<br>Caution Advised | Dusting to 2 inches of snow. No measurable ice.<br>Winter Weather Advisory | Untreated roadways may become hazardous and slick. Livestock may need additional supplemental feed. |
| Level 3 – Major Event<br>**Isolated Emergency Conditions In the Jurisdiction** | Significant Snow Accumulations 2-8 inches.<br>Ice Accumulations of ¼ to ½ inch.<br>Reduced visibility.<br>Wind causing drifting snow.<br>Winter Storm Warning | Widespread hazardous road conditions. Travel discouraged. Areas isolated because of drifting snow. Isolated power outages because of down power lines from ice accumulation. Tree damage. Livestock loss potential increases, supplemental feed necessary. |
| Level 4 – Extreme Event<br>**The Jurisdiction is Under a Full State of Emergency** | Crippling Event.<br>Snow accumulations over 8 inches. Winds over 35 mph.<br>Drifting snow, little to no visibility.<br>Ice Accumulations of more than ½ inch.<br>Blizzard Warning | Road conditions hazardous to impassable. People and livestock isolated. Widespread power and utility outages. Infrastructure damage. High potential for loss of livestock. Structures threatened from accumulating snow and ice. Communications infrastructure lost from ice accumulation. May be a long lasting event. |

**Source: State of Oklahoma Hazard Mitigation Plan**

### *Extent/Severity*

Winter storms cause great inconvenience, injuries and deaths. Everyone is affected by the loss of mobility. Streets and highways are slick and hazardous. Even walking from house to car can be dangerous. Public transportation is often blocked. Residents, commuters, travelers and livestock may become isolated or stranded without adequate food, water and fuel supplies.

People are often inconvenienced or at risk of physical harm from loss of electric power to their homes. Above-ground electrical and telephone lines and tree limbs are often coated in a heavy accumulation of ice, which break when under the stress of sufficient weight. Falling trees also often bring down power lines. When electrical lines are damaged, other utilities, such as natural gas, can become inoperable.

Physical damage to homes and facilities can occur from wind damage, and the accumulation of snow, ice, and hail from accompanying winds. Even small accumulations of snow can disrupt transportation systems due to a lack of snow clearing equipment and experienced drivers. Canadian County considers a minor severity winter storm to be a Level 2 event or below (ice accumulation of less than ¼ inch—see Table 4-21), and a major severity event to be Level 3 and above (ice accumulation above ¼ inch) resulting in power outages and hazardous travel conditions.

### *Frequency*

Oklahoma averages 24 winter storm events each year. Occurrences of daily low temperatures below freezing range from an average of 140 days per year in the western panhandle to 60 days in the Red River plain in southeastern Oklahoma. Occurrences of daily high temperatures below freezing range from an average of 15 days per year in portions of north central and northwest Oklahoma to three days per year in the southeast. A map of winter storm events (snow and ice) in Oklahoma from 1989-2009 as reported by county is displayed in Figure 4-15 below. During the period 1995 through 2009, Canadian County reported 35 ice and snow events, or an average of 2.3 winter storms per year.

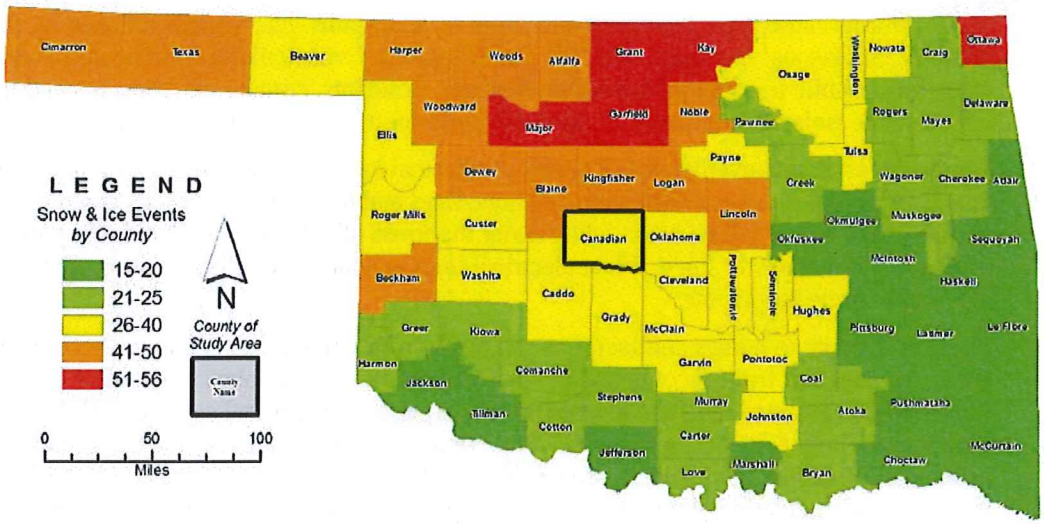
### *Impact*

The impact of a winter storm can affect a region for weeks and even months. Houses, roads, electrical poles and lines, water systems, people and cattle are all vulnerable to severe winter storms. Houses are damaged from the weight of snow or ice, roads buckle and or become slick and hazardous, electrical poles and lines break, and people lose electricity and heat, water lines freeze and burst, and people and livestock have no water. People and livestock are also susceptible to frostbite and death from exposure.

## 4.6.2 History/Previous Occurrences

The National Climatic Data Center reported 447 winter storm events (raw numbers) for Oklahoma during the 15-year period from January 1995 through March 2009. More than $732 million in property damage, two deaths and seven injuries resulted from of these storms.

**Figure 4–15: Winter Storm (Snow & Ice) Events in Oklahoma from 1989-2009**




## *Canadian County Winter Storm Events*

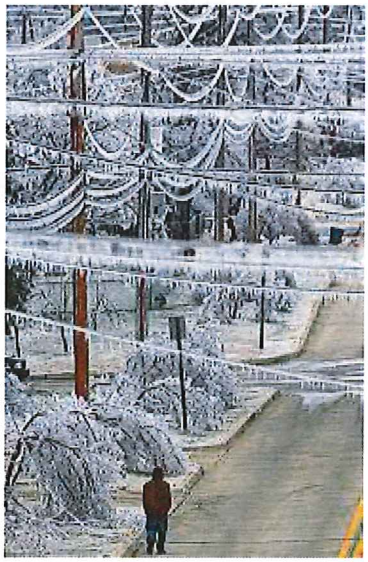
Canadian County reported 35 ice and snow events from 1995 through March 2009 (11 duplicate events subtracted from the 46 in the raw numbers), or an average of 2.3 winter storms per year, which did a total of $524.4 million in property damage in Canadian and neighboring counties. These events are summarized in Table 4-22 and described briefly below.

**Table 4–22: Casualties and Damages Caused by Winter Storms, 1995 - 2009**

| Location | Events | Deaths | Injuries | Damage Events | Property Damages |
|---|---|---|---|---|---|
| Canadian County | 35 | 0 | 1 | 7 | 524,430,000 |
| Oklahoma | 447 | 2 | 7 | 67 | $732,234,000 |

**Source: National Climatic Data Center**

- **December 25-26, 2000** - On Christmas Day, 2000, Oklahoma suffered one of the most costly natural disasters in its history, a record that would last only 13 months. Four to eight inches of snow, sleet and freezing rain fell in a 26-county area, including Canadian County. Where the precipitation fell as freezing rain, ice accumulations were around one inch. Thousands of homes and vehicles were damaged by falling trees and ice, while thousands of trees and utility poles were damaged or destroyed. Statewide, nearly 170,000 residents were without electricity, many for nearly a week. Six indirect fatalities were associated with the storm. As of December 2001, $122 million in disaster aid had been sent to help Oklahomans recover from the storm. Most counties in the State were included in the disaster declaration. Power was out for some locations for up to 11 days.



**The winter storm of January 2007 left thousands in southeastern Oklahoma without power for over a week.**

- **January 30, 2002** - The terrible power of severe winter weather was demonstrated again in January

2002 when an even larger ice storm hit the state. In many areas freezing rain continued for 12 to 24 hours, with ice accumulations of one to two inches common. As the end of the storm neared, freezing rain transitioned to sleet and snow. The worst damage from ice accumulations occurred in a 60-mile wide band from Blackwell south to El Reno, Minco and Oklahoma City. The damage was catastrophic in places, with thousands of trees and utility poles brought down by the weight of ice. Dozens of towns were left without power for days, with some residents without power for up to six weeks. At one point, nearly 250,000 customers were without electricity. Total damage was estimated at $301 million. Forty-four counties were included in the disaster declaration.

- **December 9-12, 2007** - A devastating ice storm affected a large swath of Oklahoma beginning on the 9th and continuing through the 12th over parts of the area. The storm left behind a trail of severe damage to trees and power lines, which in turn led to the worst power outage in Oklahoma history (in terms of the number of customers impacted). This was because the brunt of the ice storm affected the urban corridor from near Lawton, to Oklahoma City, to Tulsa, and northeast to Miami and into Missouri. By the time the storm had ended, over one inch of ice had accumulated over a good portion of Oklahoma. The governor declared a State of Emergency for all 77 Oklahoma counties. At least 27 deaths were reported statewide, mainly due to hundreds of automobile accidents, although some were due to prolonged cold air exposure or carbon monoxide poisoning. Tree, power line and power pole damage was widespread statewide. At the peak of the event, more than 641,000 electric customers were without power (the actual number of people was likely much larger). Due to the magnitude of the outage, electrical crews from dozens of states worked 12-hour shifts daily to restore power. Even with this huge relief effort, more than 150,000 residents were still without power one week after the storm. Even city water and sewage plants were without power, making them unable to pump water for a short time. Fallen power lines created another hazard as the broken lines sparked structure fires. Fire departments responded to over 100 structure fires in all. Other fires were caused by portable heating sources inside homes. Schools, churches, and local businesses had to close, some for several days, due to the power outages. The local economy sustained a huge loss, as the ice storm hit during a key weekend for holiday sales. The pecan crop loss alone was estimated at $25 million statewide. Shelters were opened across the State for people who did not have electricity. The storm cleanup was estimated to cost at least $200 million statewide. Cities removed over 750,000 cubic yards of debris.

### *Probability/Future Events*

Based on 35 winter storm events between 1995 to 2009, Canadian County can expect 2.3 winter storms each year. Canadian County, its cities and towns and public school systems have a High probability of a future winter storm event, including all future development areas.

## 4.6.3 Vulnerability

This section summarizes information about Canadian County's vulnerability to winter storms, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the County, its communities and public school systems, was used to determine the Vulnerability Criteria identified in Tables 4-2 and 4-3. Canadian County was determined to be at High risk to the winter storm hazard. Appendices F and G discuss how the cities and towns and public schools differ from Canadian County.

### *Population*

A broad spectrum of Canadian County' population is vulnerable to the effects of winter storms. People who travel in winter storms are at the most risk. Of winter storm-related deaths, 70% occur in cars, more than the number of people caught out in the storm. The elderly are also at risk due to poor health and frequent isolation. Persons over 60 years of age account for half of all exposure-related deaths. According to NOAA, 50% of hypothermia cases occurred in people over the age of 60. In addition, more than 75% of all hypothermia victims were found to be male. Exhaustion and heart attacks caused by overexertion are also likely causes of winter storm-related deaths. The homeless population is also at high-risk to the effects of a severe winter event.

Although it is to be expected that a winter storm event will impact Canadian County public school systems; the students, staff, and faculty are less likely to be directly impacted due to an allocated number of snow days per year.

### *Structures/Buildings*

A direct threat to structures/buildings, including schools, from a severe winter event is excessive snow/ice accumulation on flat/low grade sloped roofs. This is especially true of older structures that were not built to withstand that type of stress. More indirect threats to structures are from power outages causing interruption to heating (loss of supplies, food, sensitive equipment) and frozen water pipes (excessive flooding causing damage to interior and sensitive electronic equipment if pipes break), and fires caused by power lines being torn away from structures, or power surges when power is restored.

School athletic fields and landscaping, too, can be damaged by heavy accumulations of snow for an extended length of time. Trees near buildings may break and damage exterior components or windows. Severe winds and heavy drifts can damage fencing.

### *Critical Facilities*

During a winter event, all critical facilities in Canadian County would be vulnerable to power outages, structural damage, frozen pipes, water damage to equipment, and the interruption of vital services, and road closures or blockages from ice/snow accumulation or downed trees.

Extensive power outages can force hospitals and other emergency services to rely on generators for extended periods, as during the winter storm of December 2007.

### *Infrastructure*

**Water Treatment** – The most significant impact from a winter event to water supplies would be loss of electrical power, delays to chemical deliveries (road inaccessibility), shortage of personnel and staffing issues. Water treatment plants are particularly vulnerable to long-term power loss.

**Wastewater Treatment** – The most significant threat to the operation of Canadian County's wastewater treatment plants during a winter storm would be power outages impacting the plant and lift stations.

**Utilities:** As shown by past winter storms particularly that of December 2007, damage to utility infrastructure can cause staggering losses in the wider economy.

**Electricity** – Exemplified by the December 2007 storm, providers of electrical service can experience challenges in meeting the needs of Canadian County customers due to:

destruction of distribution and transmission poles, broken power lines, staffing shortages, danger to workers from downed power lines, hazardous road conditions and fallen debris.

**Gas** – In a winter storm event gas meters can be damaged from ice accumulation, falling power lines or tree debris. Service personnel can be blocked from reaching meters or endangered by fallen trees and power lines, as well experience delays due to road conditions, extreme temperatures and insufficient staff.

**Transportation Systems (Highways, Public Transportation, Railway, Airports)** – All transportation systems are at risk during a winter event in Canadian County. Road closures due to ice/snow accumulation can result in loss of retail trade, wages and tax revenue. Such closures sometimes cost $10 million/day in a large metropolitan area like Oklahoma City. The inability of public transportation to function after a winter event can also contribute to increased risk to the population if it hampers access to necessary medical care or shelter. Will Rogers Airport in Oklahoma City was closed for several days during the December 2007 storm. In addition to delaying the transportation of goods and materials, passengers were stranded at the airports.

**Emergency Services**- Fire, Police and Medical Services are all vulnerable to the same potential affects of a winter storm event. Emergency workers may not be able to get out of their homes, and once on the job they face dangers from downed power lines, hazardous road conditions and fallen debris from trees, and insufficient field and/or office staff to effectively handle the workload. Additionally, debris, fallen power lines or impassable roads can hamper effective response times for emergency calls and increase the risk of vehicle accidents for responders.

## 4.6.4 Winter Storm Scenario

### *Overview*

As noted above, Oklahoma experienced two major winter storm events in 2007. The first occurred in January, hitting Muskogee and surrounding counties the hardest. The second came in December, wreaking havoc across much of Oklahoma, but having its greatest impact on Lawton, Oklahoma City and Tulsa. Both of these events resulted in an Emergency Declaration by the Governor of Oklahoma for all 77 counties in the State. The major impact from these two storms was widespread and prolonged power outages, which had a profound impact on both residential and business communities.

Although smaller in scope and impacted populations, the response phase of the January 2007 winter event was longer in duration than for the December event, largely because the temperatures were lower both before and after the precipitation, roads were inaccessible longer, people required shelter longer, and smaller, rural communities experienced severe water supply issues due to power outages.

Daytime temperatures during the January (Muskogee) event remained at or near freezing, with nighttime temperatures dropping into the teens and twenties for several days. By contrast, the temperatures during the December (Oklahoma City/Tulsa) event remained well above freezing during the day and fell into the upper twenties and lower thirties at night. The higher daytime temperatures allowed roadways and power lines to be cleared of ice and recovery to begin more quickly.

### *Canadian County Winter Storm Scenario*

The Winter Storm Scenario for Canadian County assumes an 11-day event of the severity of the Muskogee storm of January 2007: A sudden blast of freezing rain, fallen trees and power lines, treacherous road conditions, frozen water pipes, and widespread power outages, followed by a week of sub-freezing temperatures that disrupts daily life and significantly hampers the restoration of services. Canadian County has experienced both freezing rain and prolonged

periods of temperatures below freezing (as in January and November 1996). This scenario assumes an unlucky conjunction of two such storms.

The December 2007 ice storm remains the worst winter storm event in OG&E's 107-year history in terms of customers without power. Of OG&E customers without power, 90% were in the Oklahoma City Metro Area. As bad as this event was, it could have been worse if after the initial period of 32-degree temperatures and freezing rain, the thermometer had continued to fall into the teens, as occurred in the January 2007 event in eastern Oklahoma. These two events are compared in Table 4-23.

Without performing a detailed analysis of comparative temperatures, man-hours and rates of restoration, the table suggests that subfreezing daytime highs followed by nighttime lows in the teens and low 20s complicates and slows restoration of service.

**Table 4–23: Comparison of January and December 2007 Events**

| Muskogee Winter Storm Event | | | | | Oklahoma City Metro Area Winter Storm Event | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Daily High | Daily Low | % Customers without Power | Customers without Power | Date | Daily High | Daily Low | % Metro without Power | Customers without Power |
| 13-Jan | 41 | 25 | 71 | 11,095 | 9-Dec | 32 | 25 | 1.6 | 4,568 |
| 14-Jan | 30 | 25 | 65 | 10,062 | 10-Dec | 34 | 25 | 72.5 | 217,500 |
| 15-Jan | 31 | 24 | 55 | 8,587 | 11-Dec | 38 | 32 | 86.7 | 260,174 |
| 16-Jan | 26 | 16 | 59 | 9,156 | 12-Dec | 34 | 29 | 69.6 | 180,970 |
| 17-Jan | 21 | 16 | 60 | 9,277 | 13-Dec | 34 | 28 | 54.9 | 142,795 |
| 18-Jan | 30 | 20 | 58 | 9,039 | 14-Dec | 38 | 30 | 55.0 | 143,049 |
| 19-Jan | 33 | 22 | 47 | 7,267 | 15-Dec | 37 | 26 | 35.4 | 92,000 |
| 20-Jan | 40 | 23 | 42 | 6,497 | 16-Dec | 49 | 18 | 26.7 | 89,483 |
| 21-Jan | 38 | 32 | 23 | 3,564 | 17-Dec | 55 | 27 | 13.2 | 69,373 |
| 22-Jan | 37 | 31 | 2 | 322 | 18-Dec | 55 | 34 | 9.8 | 34,440 |
| 23-Jan | 35 | 19 | 0.6 | 92 | 19-Dec | 63 | 26 | 2.1 | 25,483 |

## 4.6.5 Future Trends

For information on future development areas in Canadian County, see Section 1.2.8.

### *Population*

Increasing energy costs, combined with higher prices for basic necessities, will continue to put a strain on those in the jurisdiction already struggling to meet basic needs. A steadily increasing population living on fixed incomes could translate into a growing number of people unable to provide heat for their homes in times of severe winter weather.

Additionally, more and more elderly are choosing to remain in their homes rather than move into assisted/progressive living situations. Those with special needs may be especially stressed during severe winter storms. Special needs populations will require additional planning considerations.

### *Structures/Buildings*

All residential, commercial and industrial buildings constructed in Canadian County should ensure that the placement of trees and large shrubs will reduce the risk of power line interference. Burying of electrical power lines is the most favorable solution to this vulnerability. Commercial

and industrial projects should include adequate backup power systems to protect critical equipment and data storage.

### *Critical Facilities*

All considerations for Structures/Buildings above apply to critical facilities. Several mitigation measures included in this plan address the issue of power outages at fueling stations and water/wastewater plants. In addition, due to the widespread power outages in 2000, 2002 and 2007 (which appear to be increasing in severity, rising from 170,000 without power in 2000, 250,000 in 2002 and 600,000 in 2007), this plan includes a mitigation measure addressing the development of a Comprehensive Emergency Back-up Generator Hazard Mitigation Plan Annex (EBGHMP) which reviews the capabilities of all County facilities, their necessity in the response and recovery process, their current capabilities to remain up and running during an extended power outage, and the costs of retrofitting them to a workable level.

### *Infrastructure*

Since many new residential and commercial subdivisions are including buried power lines as part of their planning, it is hopeful that this mitigation measure will have a measurable impact on reducing Canadian County's vulnerability to future winter storms.

## 4.6.6 Conclusion

A broad spectrum of a Canadian County's population is vulnerable to the effects of winter storms. The leading cause of death during winter storms is automobile or other transportation accidents, which is not confined to any one demographic group or area. A community's elderly and indigent populations are extremely vulnerable to hypothermia. Exhaustion and heart attacks caused by overexertion are also likely causes of winter storm-related deaths.

Secondary effects of winter storms include house fires and carbon monoxide poisoning from increased and improper use of alternate heating sources. Though not much of a problem, but certainly a possibility in Oklahoma, frozen water lines have been known to impede firefighting efforts.

Canadian County area is highly vulnerable to winter storms. Canadian County, its cities and towns, public schools, critical facilities and citizens are at High risk, including all that may be located in areas of future development.

### *Update Changes*

Identified significant changes made from previous Multi-Hazard Mitigation Plans from Canadian County, Calumet, El Reno, Mustang, Piedmont, and Union City are outlined in Appendix E. Changes are based on criteria outlined for Plan Updates in the Local Multi-Hazard Mitigation Planning Guidance document of July 1, 2008.

## 4.6.7 Sources

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