

4.7 Extreme Heat

4.7.1 Hazard Profile

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 long periods. A lack of nighttime cooling can exacerbate the conditions when community infrastructure fails to release ambient heat increases gained during the day.

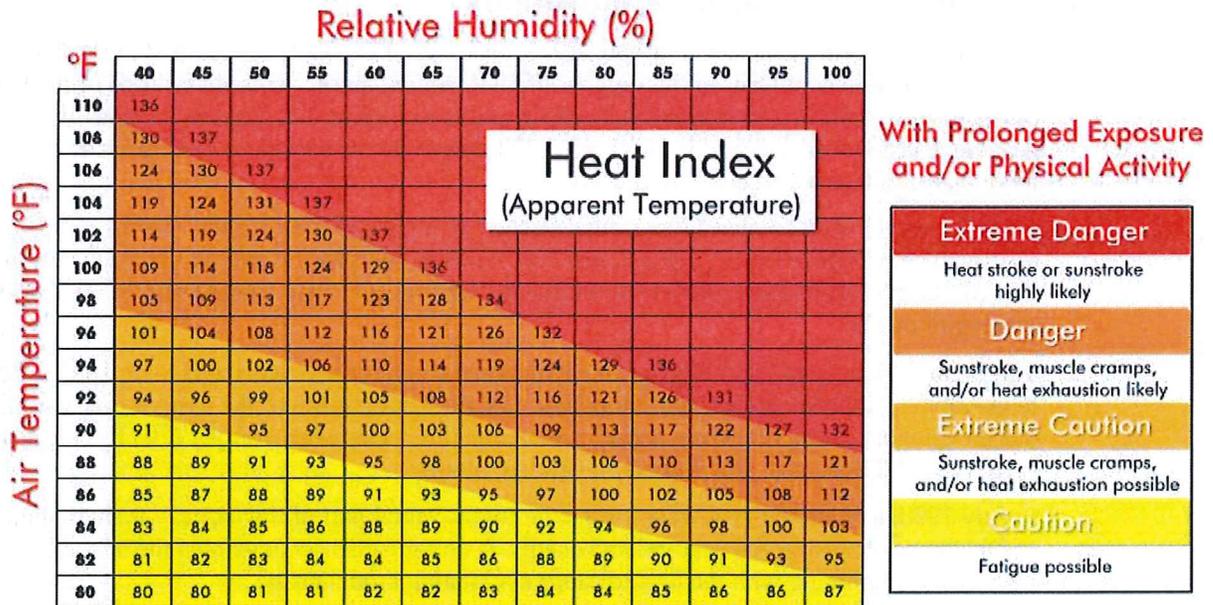
Location

Canadian County's location on the open prairie means the jurisdiction has little protection from the occasional heat waves that settle upon the region. Temperatures can be in the triple digits for weeks, sometimes (as in 2011) for months. Sustained high temperatures impact the entire county, but particularly the aged, the poor, the obese, those with heart problems, and people who work out of doors. See Figures 1-5, and 1-6 for demographic data on locations of elderly and low income in Canadian County.

Measurement

The Heat Index and Heat Disorders table relates index ranges with specific disorders, particularly for people in the higher risk groups. The heat index illustrates how the human body experiences the combined effects of high temperature and humidity. It more accurately reflects what the body experiences than simply measuring the air temperature. For example, when the air temperature is 98° F and the relative humidity is 50%, the human body experiences the discomfort and stress equivalent to 113° F with no humidity.

Figure 4-16: Heat Index Chart



Extent/Severity

The extent of the extreme heat hazard is largely dependent on the weather conditions occurring across the jurisdiction. High heat events typically will not affect property as adversely as vulnerable populations.

Over the past 10 years, the average high temperature for July and August in the Canadian County area has been 94 degrees F with an average humidity of 66%, which puts the area in the “Danger” category on the National Weather Service (NWS) Heat Index scale, without factoring in relative humidity.

Sustained high temperatures are a hazard that impacts the entire county, but particularly the elderly, the poor, the obese, those with heart problems, and people who work out of doors. The impact of the extreme heat hazard can be mitigated by notifications and warnings to vulnerable populations, the establishment of cooling rooms, utility cost assistance programs, backup electric generation for critical facilities, Medical Reserve Corps training, and similar measures.

Extreme heat also puts pressure on electrical grids as people crank up air conditioners, often resulting in widespread power outages. Blackouts and brownouts from overloaded grids can further increase the risk of heat-related injuries and deaths among vulnerable populations.

Canadian County considers a minor severity heat event to be a heat index of 95 or less and a major severity to be a heat index greater than 95 for a period of two or more weeks.

Frequency

Canadian County has experienced 4 excessive heat events in the past 15 years, and five in the past 18 years: in 1994, 1999, 2001, 2006 and 2011. Based on this limited data, extended periods of temperatures above 100 degrees Fahrenheit can be expected at least once every 3 years.

Impact

The impact of extreme heat is primarily the danger to people, resulting in muscle cramps, nausea, heat exhaustion, heat stroke, and death, but it can also increase the risk of and impacts from wildfire and drought.

4.7.2 History/Previous Occurrences

In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat. In the summer of 1936, temperatures across two-thirds of the United States rose well above 110 degrees Fahrenheit, and to as high as 121 degrees in some places. The heat wave lasted for 13 days, killing about 5,000 people. In the disastrous heat wave of 1980, more than 1,250 people died.

A 1988 drought and heat wave that settled on the central and eastern United States caused approximately \$40 billion in livestock and crop damage. Another in 1993 in the southeastern United States caused approximately \$1 billion in livestock and crop damage and an undetermined number of deaths.

The Central Plains and Corn Belt States experienced a heat wave from July 11-19, 1995, when temperatures climbed above 120° Fahrenheit. A significant portion of the eastern U.S. was in the danger category during the same period, with temperatures between 105° to 120° F. This heat wave caused 670 deaths, 465 of them in Chicago alone.

In July 1998, a blistering heat wave struck the south-central part of the nation—including much of Oklahoma—causing five heat-related deaths. A drought also accompanied the heat wave in Oklahoma, combining with the heat to cause devastating crop damage.

In Oklahoma, July is generally the hottest month of the year, closely followed by August. The NWS compiled a 106-year record of monthly and annual average temperatures for Oklahoma. The “Dust Bowl” years of 1921, 1931, and 1936 show the highest average temperatures across a 12-month period for the past 100 years. A map showing extreme heat events by county in

Oklahoma for a reporting period of 1989-2009 is included in Figure 4-17. Casualties and damages caused by extreme heat are summarized in Table 4-24.

During 2005-2006, Oklahoma experienced the worst drought in its history—a result of months of high temperatures and low precipitation. One result was a record number of wildfire outbreaks (see Sections 4.8 Drought and 4.11 Wildfire).

Figure 4-17: Extreme Heat Events in Oklahoma from 1989-2009

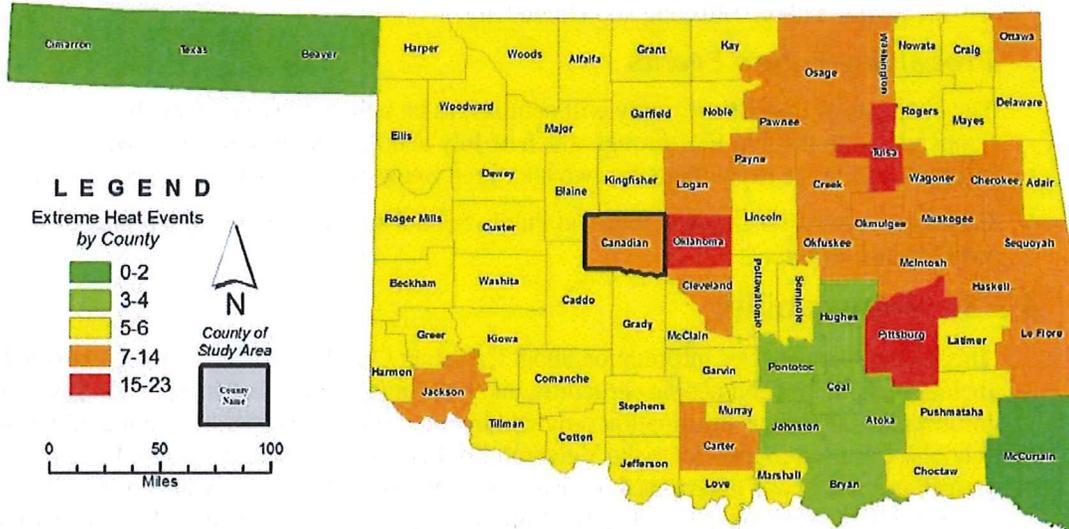


Table 4-24: Casualties and Damages Caused by Extreme Heat

Location	Events	Deaths	Injuries	Damage Events	Property Damages
Canadian County	4	31	100	1	\$10,000
Oklahoma	47	91	157	1	\$10,000

Source: National Climatic Data Center

Canadian County Extreme Heat Events

Canadian County has reported four extreme heat events since 1995, which include:

- **August 17, 1999** – Temperatures rose into the 90s in mid July and remained there through August and early September. A woman in El Reno died in her home in of exposure to excessive heat on August 17, when the thermometer stood at 99° F.
- **July-August, 2001** – An extended period of excessive heat affected all of western and central Oklahoma in July and August. Temperatures reached the triple digits on July 9 and remained in the 90s and low 100s until August 25. A man collapsed at a house in Yukon in June due to the heat, and died later in the hospital. In July eight people died from the heat in central Oklahoma, five in Oklahoma City, one each in Edmond, Stillwater and Lawton.
- **June-August 2006** – Temperatures rose in June and remained in the triple digits for much of July and August. One man died in Yukon on June 20th, followed by 10 more fatalities in central Oklahoma, most of them in the Oklahoma City Metro Area. In August, the heat wave killed 8 more people, all of them outdoors or in houses without air conditioners. The heat was accompanied by one of the worst droughts in Oklahoma history. I-40 buckled in Canadian County, west of Oklahoma City, as did several other streets in the area. Water shortages and stressed power grids forced many communities to ask citizens to restrict the use of water and power during the hottest part of the day.

- June-August 2011** – This was the hottest summer on record in Oklahoma history. In Canadian County, temperatures rose above 100° F on 58 days from mid June through the end of August, reaching 110° on July 9 and again on August 5th and 6th. Indeed, the first 6 days of August saw the thermometer rise to at least 107°. Average high temperatures in July were 102.5° and in August 102.2°, shattering the records set in 1980 and during the 1930s. The extreme heat was accompanied by a drought that nearly emptied Lake Hefner. The Oklahoma City Metro Area requested its water customers to move to rationing, including El Reno, Piedmont, Yukon, Mustang and Union City.

Probability/Future Events

The residents of Canadian County will continue to be vulnerable to extreme heat, with temperatures in the mid-90s through much of July and August. Extreme heat waves, with temperatures in the triple digits for two and three weeks at a time can be expected every 3 years.

Canadian County, its Communities and Public School systems have a high probability of a future extreme heat event.

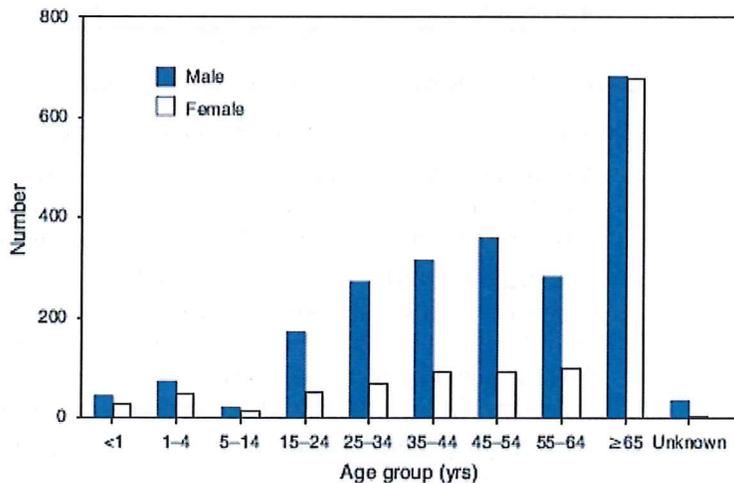
4.7.3 Vulnerability

This section summarizes information about Canadian County’s vulnerability to extreme heat, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the County, incorporated communities and public schools, was used to determine the Vulnerability Criteria identified in Tables 4-2 and 4-3. Canadian County was determined to be at Moderate risk to the extreme heat hazard. (See Table 4-2 Hazard Risk Analysis, and Table 4-3, Summary of Hazard risk Analysis Ranking Criteria for an explanation of how the rankings were derived.) Appendices F and G identify where the incorporated communities and public school systems differ from the County as a whole.

Population

Everyone in Canadian County has the potential of experiencing health related problems during a heat wave. However, several groups are significantly more vulnerable to this hazard. They include the elderly (65 years or older see Figure 4-18), children under one (heat related deaths of children shown in Figure 4-19), those who are economically disadvantaged, those with medical issues such as high blood pressure, cardiac disease and respiratory issues, those with mobility issues which may be due to obesity or economic constraints, outdoor workers, those recreating outside and those who have other limitations that may impair their ability to understand or address this hazard (i.e., mental impairment, substance abuse).

Figure 4-18: Extreme Heat Deaths by Age Group



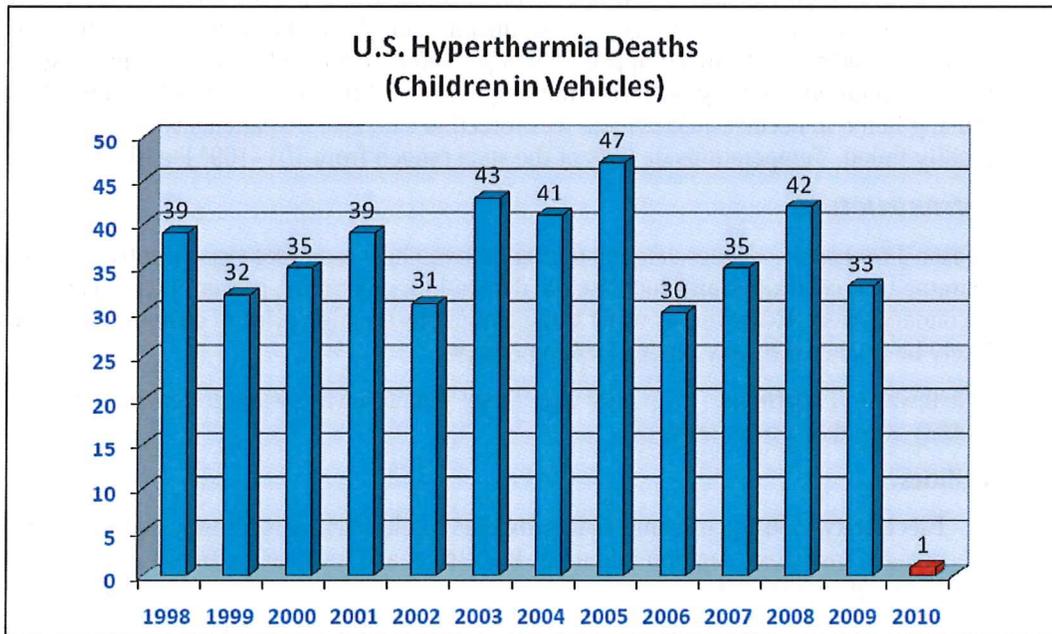
Exposure to extreme heat is reported as the underlying cause of or a contributing factor to death.

More deaths from extreme summer weather occur in urban centers than in rural areas. The masses of stone, brick, concrete, and asphalt that are typical of urban architecture absorb radiant heat energy during the day and radiate that heat during what would be otherwise cooler nights. This phenomenon is referred to as the “Urban Heat Island” (UHI) effect. Tall buildings may effectively decrease wind velocity, thereby decreasing the contribution of moving air to evaporative and convective cooling.

All of Canadian County is vulnerable to extreme heat in summer, including all areas of future development. This is especially true of the 15% of the population aged 65 and above and the 16.5% of the population living in poverty. The average high temperature in Canadian County for July is 94° Fahrenheit, with an average afternoon humidity of 66%. This calculates to a heat index of 105° Fahrenheit, putting the area in the “Danger” category on the National Weather Service (NWS) Heat Index scale. This indicates that with prolonged exposure and/or physical exertion, heat related maladies are likely. During the summer of 2011, when average daytime highs were 102°, Canadian County was in the “Extreme Danger” category for most of July and August.

There has been an increase in the US in the number of heat-related deaths for children under the age of 13 years locked in cars. Between 1990 and 1992, ten such deaths were reported. For 2004 through 2006, 118 deaths involved children left in vehicles, see Figure 4-19.

Figure 4-19: US Hyperthermia Deaths of Children, as of March 8, 2010



Source: San Francisco State University, Department of Geosciences

Possibly the greatest impact of extreme heat on public schools in Canadian County would be the impact on athletes in the county. The Centers for Disease Control and Prevention (CDC), heat illness during athletic practices or competitions is a leading cause of death and disability among U.S. high school athletes and the 3rd most common death among athletes in general. Most fall athletic practices begin August 1st, the beginning of the hottest summer month. High school athletes train sometimes twice a day in triple digit temperatures. Athletes with a Body Mass Index (BMI) categorizing them as obese are at higher risk to extreme heat than a more physically fit individual; though, as previously stated, even the most physically fit can succumb to extreme

heat. Coaches, athletes, trainers, and parents unaware of heat risk factors and protocols are vulnerable to loss of life or injury from this hazard. The purchase of wet bulb meters should be considered by all school districts and athletic programs in the County.

Structures/Buildings

As stated above, during an extreme heat event it is likely to be hotter in cities than in surrounding rural areas, especially at night. Temperature typically begins rising at the outer edges of a city and peaks in the center (the UHI effect).

Strategic planning is therefore required which takes the UHI effect into account, particularly in the context of climate change. At a local scale these include the modification of surface properties, for example, “cool roofs,” “green roofs” and “cool pavements.” Planting trees and vegetation and the creation of green spaces to enhance evaporation and shading are other options, as temperatures in and around green spaces can be several degrees lower than their wider surroundings.

Critical Facilities

Critical Facilities face the same issues from extreme heat as other structures and buildings. In addition, a number of County facilities, such as recreation centers, may be designated as cooling centers for vulnerable neighborhoods. These facilities need to include this ability in their plans.

Of especially high vulnerability would be the medical and long-term care facilities. During an extreme heat event, power outages are not uncommon. While the larger medical treatment facilities in urban areas are equipped with dependable, redundant generator backup systems, a significant number of long-term care/nursing home facilities are not. In July 2006, a Grove area nursing home in northeast Oklahoma was forced to evacuate 84 patients when power to the facility failed. Temperatures in parts of the state ranged from 101–109° F at the time.

Infrastructure

Water Treatment – Water demand during extreme heat increases significantly. Given that extreme heat conditions also increase the demand for electricity, power outages can be a potential secondary effect. However, as water treatment plants are high priority customers, they would not likely be impacted by any planned rolling outages.

Wastewater Treatment – The most significant threat to wastewater treatment plants in Canadian County would be power outages.

Utilities:

Electricity - During extreme heat, providers of electrical service may experience power outages from lines sagging into trees, high loads and insufficient field staff to effectively handle the workload.

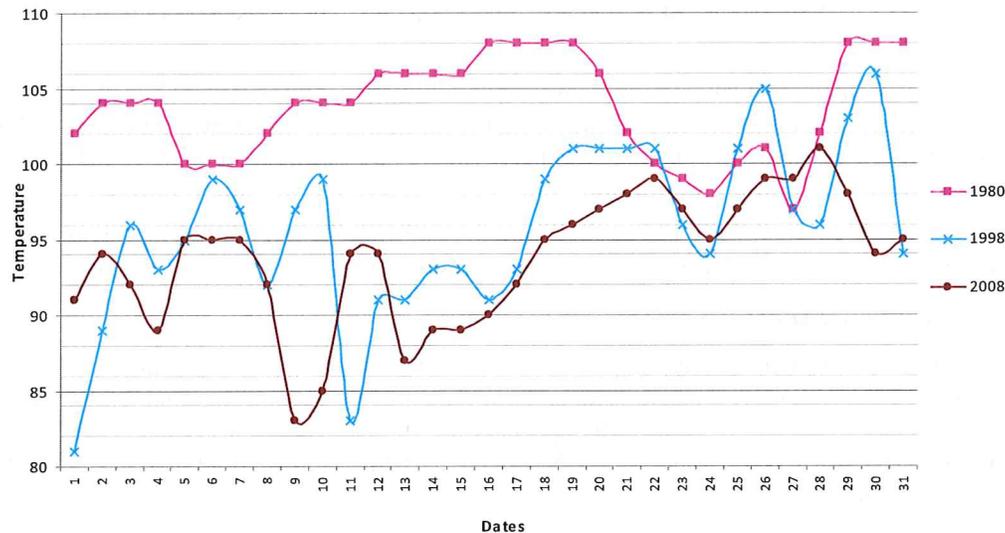
Gas – Most natural gas service in Canadian County is provided by Oklahoma Natural Gas (ONG). No significant vulnerabilities in the delivery of natural gas supply during extreme heat events have been reported.

Transportation Systems (Highways, Public Transportation, Railway, Airports) – No impacts on Canadian transportation systems is expected from high heat, other than buckling roadways and traffic lights not being operational due to electrical outages.

Emergency Services- Fire, Police and Medical Services are all similarly at risk to the effects of extreme heat. Fire and Medical Services typically receive a higher volume of heat-related calls, taxing their response capabilities. Fire and Police services could be considered at risk to secondary effects, due to the added physical stress of working in high temperatures, particularly

during wildfire events. While not an immediate threat to delivery of these services, the demand for additional personnel could potentially increase the cost for these resources.

4.7.4 Heat Scenario



During the summer of 1980, the state of Oklahoma was one of several states heavily impacted by a major heat wave. Across the United States, reported heat-related fatalities exceeded 1,700. In Oklahoma, 37 deaths were reported. In Oklahoma City, this event was remembered as the most prolonged and severe heat wave outside of the dust bowl years. The 50 days of triple-digit temperatures at Oklahoma City stood, until recently, as an all-time record.

There have been other heat waves. The summer of 1998 delivered high temperatures and drought that led to 173 heat-related deaths in the country and 28 in Oklahoma. 1998 is ranked among the top ten hottest summers since 1938. That summer the first 100° day was recorded on July 19, and the last one on September 22—a total 22 days with temperatures at or above 100°. Another hot summer was in 2008. The temperatures from these three Julys are compared in the following graph.

Figure 4-20: July Daily High Temperature in 1980, 1998, and 2008

Because of predictions of global warming, with longer, hotter, drier summers, proposing a worst-case Extreme Heat scenario for Canadian County is problematic. The summer of 2011 is now firmly established as the hottest on record. A more severe event would be one where the 100° days begin earlier in June and remain into September, made worse by a prolonged drought, water emergencies, electrical grid outages, and wildfires.

4.7.5 Future Trends

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

According to NOAA, future extreme heat events are likely to be even worse—more frequent, longer lasting, and more intense.

Population

With the rising cost of fuel and related travel expenses, more people are opting for vacations and/or recreational entertainment at local venues such as public parks. As the number of people

making use of local outdoor venues increases, vulnerability to heat-related illness will also increase.

Also at risk is the homeless population. With the recent home mortgage crisis and other economic stressors on those struggling to meet financial obligations, the number of homeless may well increase. Facilities designated as shelters (either daytime only or residential) will likely be further stretched to meet that need.

It is also probable that an increasing number of people in the more vulnerable population (elderly, fixed income, compromised health situations) will be less able to afford the cost of cooling their homes—due to economic conditions and the relative increase in the number of elderly in the population.

Care should be exercised to ensure that the vulnerable populations in the county, including outdoor workers, are informed about available resources and how to avoid extreme heat illnesses.

Structures/Buildings

While structures and buildings are only vulnerable to extreme heat in a limited way, such as in damage from expansive soils, development in Canadian County's Communities should take into account the potential adverse health impacts of the "urban heat island," where large quantities of dense materials, such as stone, concrete, asphalt, and other construction materials, absorb and store heat rather than reflect it.

Critical Facilities

Any future development or renovation of existing critical facilities should include plans for dependable backup systems for electric power in the event of grid collapses or rolling blackouts.

Infrastructure

As utility infrastructure in the county ages, the water line systems will continue to deteriorate, increasing the likelihood of line ruptures from a combination of drought and peak usage during extreme heat events. Any development in areas with aging infrastructure should be closely monitored to ensure that water lines are capable of handling the additional load – and replaced as necessary.

Sporadic power outages are commonplace during prolonged periods of high temperatures in any community. As Canadian County develops, burden on power delivery systems will continue to grow. Developers should work with OG&E and other utility providers to ensure that electrical grids do not become overloaded.

4.7.6 Conclusion

Canadian County, its communities and public school systems can expect to be hit by extreme heat every summer. The severity of the hazard is dependent on a combination of temperature, humidity, and access to air conditioning. With the average high temperature in July being 94° F, and daily maximum humidity in July and August at around 90%, the heat index can rise to 136° Fahrenheit.

Now that the torrid summer of 2011 has taken its place as the hottest summer on record, with average high temperatures of 102° in July and August, preparing for the even hotter, longer summers indicated by global climate change will require Canadian County and its communities to continue, if not increase, the mitigation measures they have taken to lessen its impact. Much has already been accomplished. Since the summer of 1980, improvements have been made in air conditioning systems, there are many more shopping malls where people can take refuge from the heat, air conditioning has become a standard feature on most cars sold in the Southwest, and more

communities have adopted protocols for opening cooling stations, establishing air conditioner loan programs, and working with utilities to offer discount electricity rates to those in poverty or with special needs. Nevertheless, extreme heat remains a significant hazard, and could become even worse if the dire predictions of Oklahoma's climatologists turn out to be correct.

The most effective proven way to mitigate casualties from extreme heat is through public information and education, although other community programs, such as cooling stations and air conditioner loan programs can also produce an impact.

Data Limitations

The state Medical Examiner's office and the state Health Department have no standardized protocols for defining a "heat-related" death, relying on the judgment of the individual physician attending. This could result in substantially lower mortality/ morbidity figures. In addition, death by other causes such as cardiac arrest, with heat as a "contributing factor," can further confound the final statistics for heat-related deaths and injuries.

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.

4.7.7 Sources

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