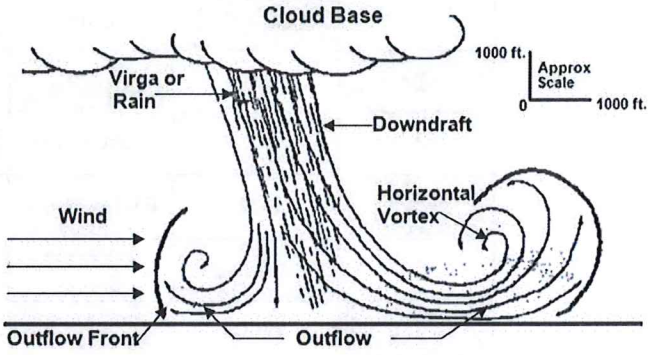
4.3 High Winds

4.3.1 Hazard Profile

Wind is defined as 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. Winds vary from zero at ground level to 200 mph in the upper atmospheric jet stream at 6 to 8 miles above the earth's surface.

The mean annual wind speed in the mainland United States is reported by FEMA to be 8 to 12 mph, with frequent speeds of 50 mph and occasional wind speeds of greater than 70 mph. Tropical cyclone winds along coastal areas from Texas to Maine may exceed 100 mph.

Figure 4–8: Microburst Diagram



A Microburst is a particularly violent type of downburst that can generate winds up to 168 mph

Location

High Winds can occur in any location within the planning area, at anytime. All participating jurisdictions are considered vulnerable to the effects of High Wind events 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.

Winds are always part of severe storms, but do not have to accompany a storm to be dangerous. Down-slope windstorms, straight-line winds, derechos (a widespread and long-lived, violent straight-line windstorm that is associated with a fast-moving band of severe thunderstorms), and microbursts (a very localized column of sinking air, producing damaging straight-line winds that are similar to but distinguishable from tornadoes) can all cause death, injury, and property and crop damage. Winds of 90 mph have been recorded in Mustang, and as high as 150 mph between El Reno and Piedmont.

Measurement

There are several scales that measure wind speeds in addition to the Fujita and Enhanced Fujita Scales. Many believe the most appropriate for the purpose of Oklahoma hazard planning is the Beaufort Scale of Wind Strength.

Canadian County jurisdictions may experience a wind force of 9-12, as measured on the Beaufort Scale shown in Table 4-14.

High winds generated by spring and autumn storms can be devastating to older houses and mobile homes

Extent/Severity

Wind is the fourth-leading cause of property damage in the United States. From 1981 to 1990, the insurance industry spent nearly $23 billion on wind-related damage. Of the primary sources of high wind damage (hurricanes, tropical storms, severe thunderstorms, and winter storms), severe local windstorms accounted for 51.3% of the losses. See Table 4-15 for data related to casualties and damages caused by high wind events.

Table 4–14: Beaufort Scale of Wind Strength

Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.

Source: Huler, Scott (2004). Defining the Wind: The Beaufort Scale

Cladding damage, especially glass damage, is not only costly but threatens pedestrian safety; increases damage to interior contents, and lengthens business downtime.

The extent of a high wind event can be scientifically measured using the Beaufort Scale of Wind Strength. The quality of construction and the enforcement of building codes within the jurisdiction can greatly influence the extent of a high wind event.

Canadian County considers a minor severity wind event to be a 9 or lower on the Beaufort Scale (Strong Gale, below 54 mph), and a major severity storm to be above 9 on the Beaufort Scale (Whole Gale/Storm) with winds 55-mph and higher.

Frequency

Canadian County reported 73 high wind events from 1995 through 2009 (after duplicate reports have been removed) that injured two people and did a total of $6,814,000 in damage. This data indicates that Canadian County can expect around 5 thunderstorm/high wind events each year

that generate winds of between 60 and 80 mph, and some that reach speeds of 150 mph. High wind is one of Canadian County's most frequent natural hazards.

Impact

High Wind can result in damage to homes, businesses and people and cause loss of income to both individuals and communities. As stated above, according to NCDC data, high wind events did $6,814,000 damage in Canadian County between 1995 and 2009. Canadian County can therefore expect close to five high wind events per year that do an average damage of $454,266 per year and $93,342 per event. The most destructive event on record during this period resulted in $5.5 million damage near Union City on June 3, 1995. This wind storm and related damage has probably been exceeded by the 150-mph winds that occurred in El Reno and Piedmont on May 24, 2011. However, the destruction caused by this latter high wind event cannot be untangled from the damage wrought by the tornado that accompanied the same storm.

4.3.2 History/Previous Occurrences

In Canadian County, wind events are generally associated with the huge convective thunderstorms that move through the region in the spring and fall months generating tornadoes, downbursts and high winds. It is not unheard of for winds produced by these storms to reach speeds of 80-100 mph (as on April 29, 2009), with winds of 50-70 mph being commonplace. Downbursts, like the one that struck Tulsa on June 6, 2006, can topple trees, damage houses and power lines, and break up sidewalks and streets. Table 4-15 compares the number of high wind events in Canadian County with the number of high wind events in Oklahoma for the reporting period 1995-2009. Similarly, Figure 4-9 is a map showing high wind events in Oklahoma by county between the years 1989 to 2009.

Table 4–15: High Winds in Oklahoma and Canadian County for 1995 - 2009
From NOAA National Climatic Data Center

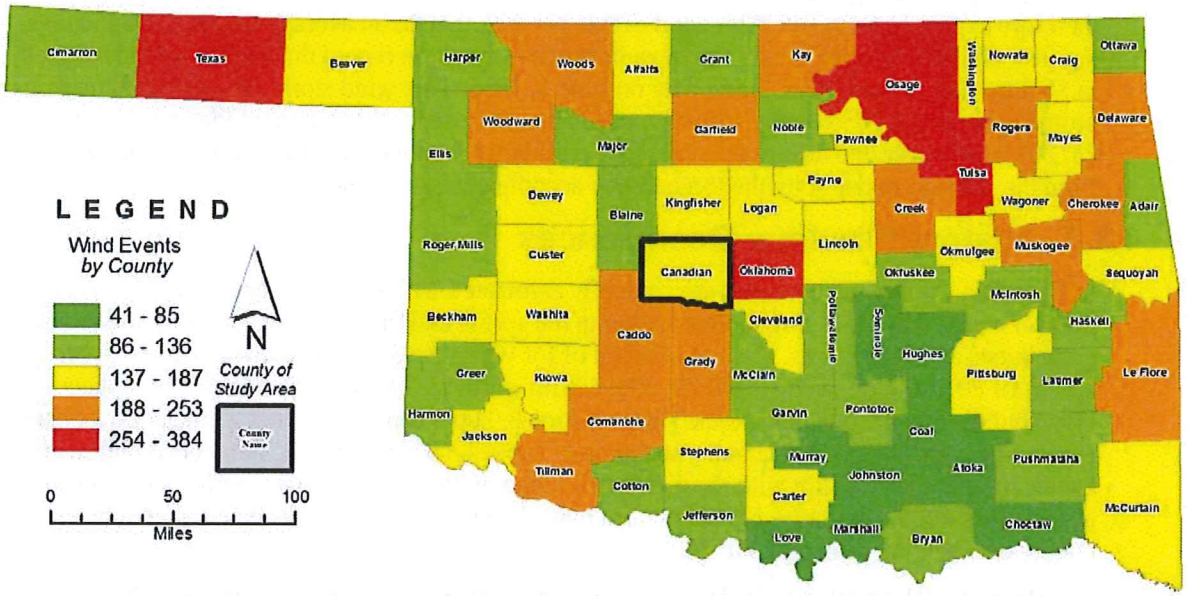
Location	Events	Deaths	Injuries	Damage Events	Property Damage
Canadian County	73	0	2	28	$6,814,000
Oklahoma	9,174	8	196	2,525	$959,603,000

NCDC does not separate community damages from county reports for High Winds, Thunderstorm Winds, and Strong Winds. The Oklahoma numbers are raw.

- **June 3, 1995** – High winds caused $5.5 million damage in northern Union City.
- **July 23, 1995** - Severe thunderstorms winds created $50,000 damage in El Reno and Yukon and another $50,000 in Mustang. Piedmont and Yukon also experienced high winds but no damages were reported.
- **August 2, 1996** – Severe thunderstorm winds in and near Okarche brought major damage to the area. Three mobile homes were split or destroyed, and two RVs and a cattle trailer were overturned. Three barns were demolished, roofs of schools were damaged, and numerous trees split or uprooted by the severe winds. $130,000 in damages was reported.

A downburst did extensive damage in Midtown Tulsa on June 6, 2006

- **April 30, 2000** - A 90 by 120-foot section of a hospital roof was blown off in El Reno, with debris breaking numerous windows below. Nearly 4 inches of rain covered many rooms, damaging floors, walls, and medical equipment. Damage was estimated at $350,000.
- **August 26, 2006** – 64-mph winds severely damaged one side of a two-story home in Mustang, resulting in rain damage to the inside. Losses were $100,000.



Source: National Climatic Data Center U.S. Storm Events Database
Events include NCDC categories of high winds, thunderstorm winds and storm winds.

Flanagan & Associates, LLC

- **May 24, 2011** - The highest wind gust ever recorded at an Oklahoma Mesonet site was measured near El Reno, as an EF-5 tornado tore a path through Canadian County. The wind speed increased from 61 mph at 4:18 p.m., to 66 mph at 4:19, to 131 mph at 4:20, to 151 at 4:21, and then dropped to 91 mph at 4:22. It was impossible to separate the damage from these winds from that done by the tornado.

Figure 4–9: High Wind Events in Oklahoma from 1989-2009

Probability/Future Events

With 73 high wind events recorded within the Canadian County in a 15-year period (between 1995 and 2009, and 28 of these events producing reported economic losses, it is apparent that damaging high winds will occur about 5 times each year, with about 40% these events producing economic loss. There were 2 reported injuries. Casualties are a very real likelihood in future wind storms.

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

4.3.3 Vulnerability

This section summarizes information about Canadian County's vulnerability to high winds, including the impact on people, structures and buildings, critical facilities, and infrastructure. This information, as well as information provided by the County, cities and towns 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 High risk to the High Wind hazard. Appendices F and G identify where the Incorporated Communities and Public School Systems differ from Canadian County.

The Midwest is especially at risk from high winds because of the powerful thunderstorms that frequent the region.

Population

The people most vulnerable to high wind-related deaths, injuries, and property damage are those residing in mobile homes and deteriorating or poorly constructed houses. (Refer to Figure 1–7: Mobile Home Park Locations). However, all people participating in outdoor activities in high-risk weather conditions are vulnerable to wind-driven debris and falling or collapsing structures. Also at increased risk are those operating motor vehicles, particularly those with high profiles. RV's, school busses, full-sized vans, truck-trailers, etc., can be blown over by high winds, and smaller, lower-profile vehicles can be moved from their designated lane of travel. It should be noted that anyone operating a vehicle at highway speeds during a sudden high wind burst could lose control of their vehicle.

Structures/Buildings

Property damage and loss of life from windstorms are increasing due to a variety of factors. Use of manufactured housing is on an upward trend. This type of structure provides less resistance to wind than conventional construction. Not all states have uniform building codes for wind-resistant construction. Inferior construction practices result in buildings being particularly susceptible to high winds.

The deteriorating condition of older homes and the increased use of aluminum-clad mobile homes will likely cause the impacts of wind hazards to increase. The general design and construction of buildings in many high-wind zones do not fully consider wind resistance and its importance to structural integrity and survival. Near-surface winds and associated effects exert pressure on structure walls, doors, windows, and roofs, causing the structural components to fail.

The relatively high percentage of older homes in Canadian County (28.7% of homes in the County were built prior to 1969) makes the jurisdiction more vulnerable to high wind damage. See Table 1-5 for percentages of homes built prior to 1969, 1959 and 1939. More than half of the residential structures in Calumet and El Reno were built prior to 1969.

Schools buildings in particular are often made up of glass windows, doors, and skylights, all of which are likely to be impacted during a high wind event; shattering glass as a result can injure those nearby. Other structures on school campuses, such as athletic facilities, concession stands, dugouts, etc., can also be severely damaged by straight-line winds. Portable classrooms are probably the most vulnerable, as their construction is similar to that of mobile homes.

Critical Facilities

Critical facilities are defined differently by different organizations and agencies, but are usually classified as those facilities that, if put out of operation by any cause, would have a broadly adverse impact on the community as a whole.

Some of these facilities may include, but not be limited to: structures or facilities that produce, use or store highly volatile, flammable, explosive, toxic and/or water-reactive materials; hospitals, nursing homes, and housing units for vulnerable populations; police stations; fire stations; vehicle and equipment storage facilities and emergency operations centers; and public and private utilities. Since 2001, FEMA has also added banks and other financial institutions to their critical facilities list. Canadian County's critical facilities are listed in Table 1-6.

All critical facilities within Canadian County should be considered vulnerable to the effects of a high wind event. Structural integrity may be compromised if the facility is in the direct path of the storm, in addition to any secondary issues, such as power disruption, water damage from accompanying rain, injury to workers/residents, etc.

Infrastructure

Water Treatment – Most significant effects from a high wind event would be damaged facilities and loss of electrical power.

Wastewater Treatment – The most significant threat to the operation of Canadian County's wastewater treatment plants during a high wind event would be power outages.

Utilities –The service stations and substations for utility providers would be vulnerable to damage from a high wind event.

> **Electricity:** During a high wind event the utility provider could experience challenges in meeting the needs of Canadian County's jurisdictions, including: destruction of distribution and transmission poles, downed broken power lines, danger to workers derived from downed power lines, and fallen debris from trees or insufficient field and/or office staff to effectively handle the workload.
>
> **Gas:** During a high wind event, the utility provider could experience challenges in meeting the needs of Canadian County's jurisdictions, including: falling power lines or tree debris, inaccessibility to underground gas meters due to fallen debris, downed power lines, extreme temperatures, and insufficient field and/or office staff to effectively handle workload generated by such an event.

Transportation Systems (Highways, Public Transportation, Railway, Airports) –Fallen trees, limbs and power lines can block streets, highways and railroads. High wind can also result in damage to Canadian County airport facilities and aircraft, as well as interrupt normal operations.

Emergency Services- Fire, Police and Medical services are all at similar risk to the secondary effects of a high wind event, such as downed power lines or trees blocking streets and highways, limiting access to affected areas.

4.3.4 Future Trends

All potential development areas for Canadian County are equally at risk from high-wind events, with the following considerations.

Population

As fuel costs continue to rise, more people may turn to lighter-weight vehicles for transportation both in the city and on the highways. Studies have yet to correlate the increase in risk associated with driving these more fuel-efficient, lighter vehicles in dangerous weather conditions, but that possibility merits close monitoring.

With rise in fuel costs, there may well be an increase in people participating in activities in local parks and playgrounds. An increase in such outdoor activities would expose more people to the dangers of high wind events—as, for example, the Indiana State Fair stage collapse that occurred on August 13, 2011, and killing four people.

Structures/Buildings

Construction materials and debris can easily become flying objects during a high-wind event. Construction companies and crews should be cautioned to exercise care in securing apparatus and supplies that could become wind-borne during thunderstorms. Following Hurricane Alicia, a

group of glass distributors determined that more than 80% of glass breakage was caused by wind-borne debris. Sources of debris include roof gravel, construction debris, broken glass and insufficiently secured rooftop appurtenances.

According to a report on "Performance of building cladding in urban environments under extreme winds", large areas of pits, nicks, and scratches indicative of wind-borne debris impacts have been found after high wind events. Although some abraded windows remain completely intact, they are usually replaced because their decreased glass strength could lead to poor performance in future storms.

Critical Facilities

As the threat from the effects of high wind events themselves cannot be eliminated, any critical facilities undergoing expansion, renovation or rebuilding should consider following updated techniques for such projects. The addition of reinforced exterior materials such as windows, doors, siding, etc., can do much to improve the safety of these facilities. Additionally, all efforts to guard against potential secondary effects should also be implemented. These secondary effects may include, but not be limited to, compromise of structural integrity, broken windows/doors from wind-strewn debris, water damage from accompanying rains, power interruptions/surges and communication interruption from lightning or wind damage.

Infrastructure

To minimize the impact of a high wind event on utility service, consideration should be given to providing underground conduits for utility lines, keeping vegetation well trimmed (to limit falling debris), and ensuring that there are multiple access routes to all areas for emergency services vehicles.

4.3.5 Conclusion

Due to Canadian County's location and climate, severe thunderstorms and the high winds they produce will remain a threat to its jurisdictions. Future thunderstorm winds and downbursts are certain. Canadian County, its communities and public school systems are considered to have a High vulnerability to the High Wind hazard. Improved building technologies, advances in public communication capabilities, putting utility feeds underground, and opportunities for collaboration among community agencies and the private sector, especially engineers and developers, should remain prominent in community planning and response endeavors.

Data Limitations

In many cases, tornadoes and high winds occur during the same storm event and their impacts are difficult to distinguish. In some cases, unless there is direct observation, it may never be known whether damage was produced by a tornado or a downburst. This Section should be read and analyzed in conjunction with the Tornado section.

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.

4.3.6 Sources

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