Section 10: Tornadoes

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Why Tornadoes Are a Threat

The Guadalupe River Basin is known for frequent severe weather and thunderstorms, many of which can spawn tornadoes.

Tornadoes are one of the most violent storms on the planet. A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. The most violent tornadoes are capable of tremendous destruction with wind speeds of 250 miles per hour or more. In extreme cases, winds may approach 300 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. Tornadoes are classified on the Fujita scale, as shown in Table 10-1.

Texas is the tornado capital of the United States.
- National Academy Press

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Table 10-1. Fujita Tornado Scale

F-Scale Number	Intensity	Wind Speed (mph)	Type of Damage Done
F0	Gale tornado	40-72	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; attached garages may be destroyed.
F2	Significant tornado	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206	Roof and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted.
F4	Devastating tornado	207-260	Well-constructed homes leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible tornado	261-318	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles flying through the air in excess of 100 meters; trees debarked; steel reinforced concrete badly damaged.

Tornadoes occasionally accompany tropical storms and hurricanes that move over land. Tornadoes are the most common to the right and ahead of the path of the storm center as it comes ashore. Tornadoes vary in terms of duration, wind speed and the toll that they take, as shown in Table 10-2.

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Table 10-2. Variations Among Tornadoes

Weak Tornadoes	Strong Tornadoes	Violent Tornadoes
• 69% of all tornadoes	• 29% of all tornadoes	• 2% of all tornadoes
• Less than 5% of tornado deaths	• Nearly 30% of all tornado deaths	• 70% of all tornado deaths
• Lifetime 1-10+ minutes	• May last 20 minutes or longer	• Lifetime can exceed one hour
• Winds less than 110 mph	• Winds 110 – 205 mph	• Winds greater than 205 mph

Source: *Tornadoes…Nature's Most Violent Storms: A Preparedness Guide*, U.S. Department of Commerce, National Weather Service, February 1995.

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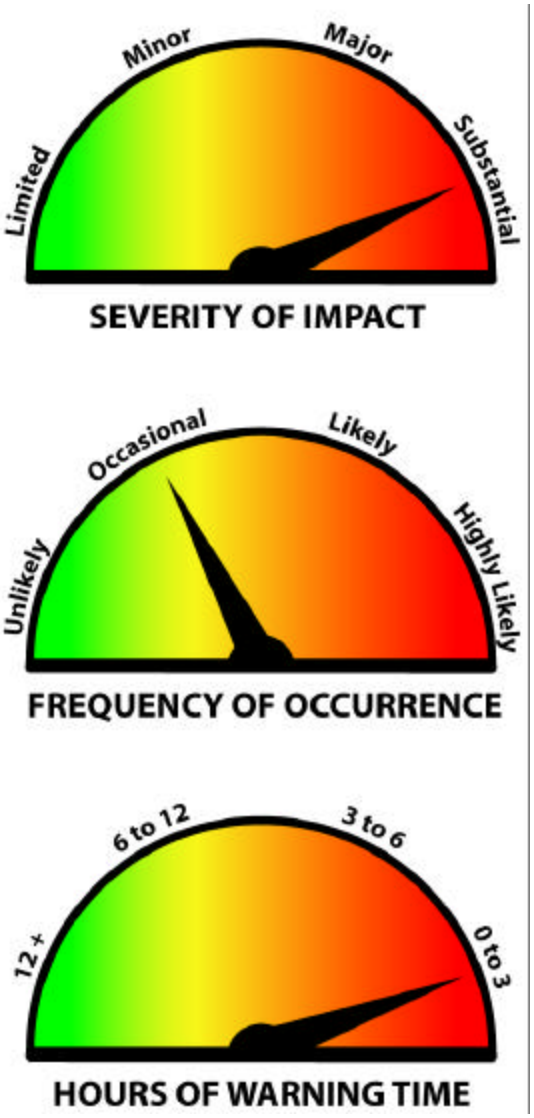
Hazard Profile

The impact of tornadoes can be substantial. They can cause multiple deaths, completely shut down facilities for thirty days or more, and destroy or severely damage more than fifty percent of affected properties.

Tornadoes are occasional events in the Guadalupe River Basin, their patterns are seasonal, and damages are inevitable as warning time is minimal.

Figure 10-1. Tornado and Windstorm Hazard Profile Summary



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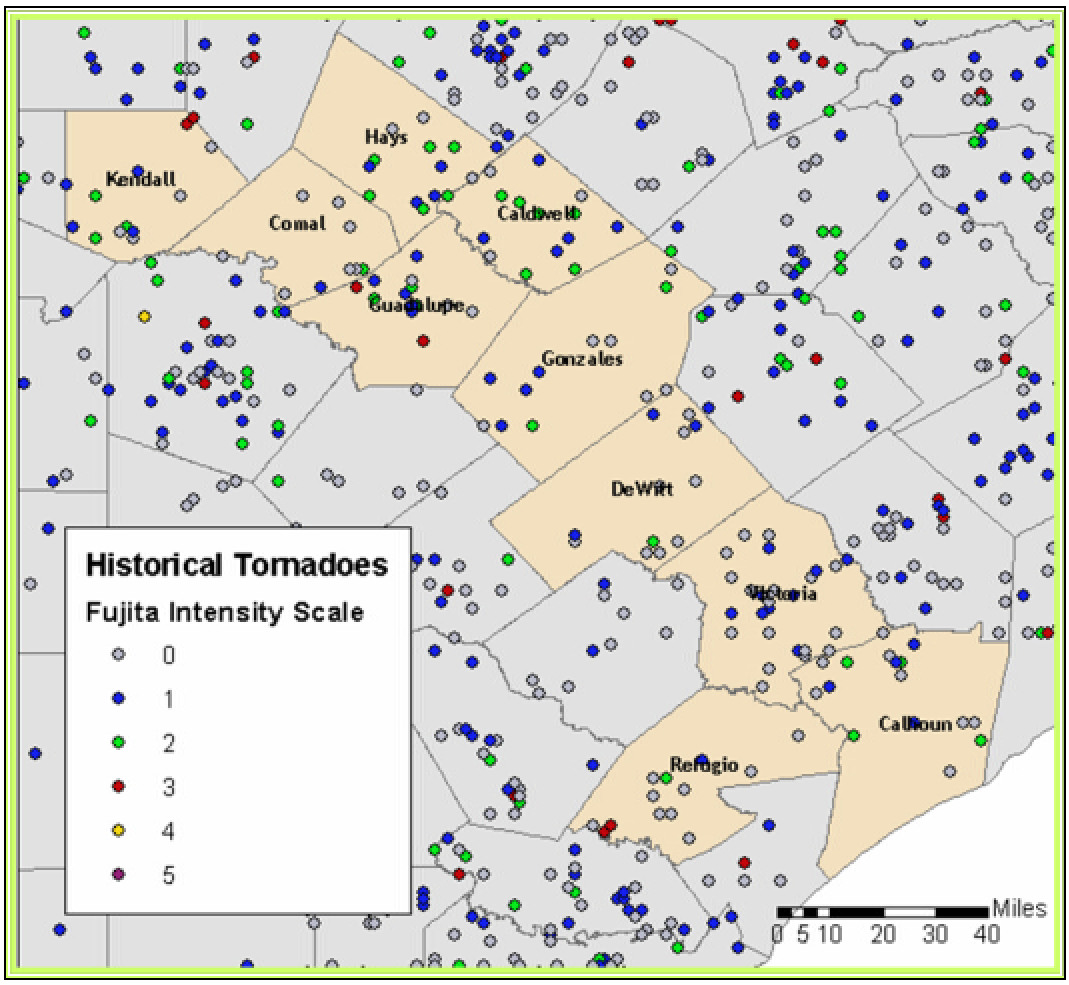
History of Tornadoes and Windstorms

Historical evidence shows that most of the area is vulnerable to tornadoes, which have no defined hazard boundary. Figure 10-2 maps the historical tornadoes that have been reported in the Guadalupe River Basin.

Figure 10-2. Historical Tornado Events (NOAA Data 1950 - 2002)



The frequency of tornadoes, by County and for selected periods of time is shown in Figure 10-3.

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Figure 10-3. Frequency of Tornadoes (NOAA Data 1950 - 2002)

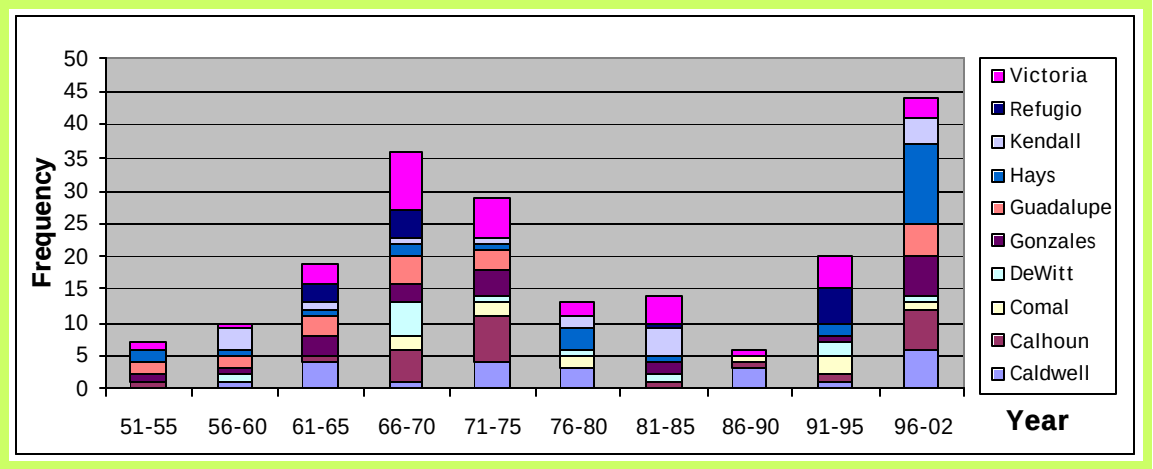

Table 10-3 lists reported tornado events in the Guadalupe River Basin, by County.

Table 10-3. History of Reported Tornadoes in the Guadalupe River Basin, by County

Lower Basin

Event	Year	Date	Fujita	Injuries	Deaths	County/Community
CALHOUN COUNTY						
Tornado	1955	5 Jun	F1	0	0	Calhoun
Tornado	1961	2 Nov	F2	0	0	Calhoun
Tornado	1967	20 Sep	F2	1	0	Calhoun
Tornado	1967	20 Sep	F	1	0	Calhoun
Tornado	1967	27 Sep	F1	0	0	Calhoun
Tornado	1970	3 Aug	F2	0	0	Calhoun
Tornado	1970	2 Sep	F0	0	0	Calhoun
Tornado	1972	7 May	F2	1	0	Calhoun
Tornado	1972	10 Jul	F1	0	0	Calhoun
Tornado	1972	22 Sep	F0	0	0	Calhoun
Tornado	1972	22 Sep	F0	0	0	Calhoun
Tornado	1972	22 Sep	F0	0	0	Calhoun
Tornado	1972	29 Oct	F2	2	0	Calhoun
Tornado	1973	13 Jun	F1	0	0	Calhoun
Tornado	1982	13 May	F1	0	0	Calhoun

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Event	Year	Date	Fujita	Injuries	Deaths	County/Community
Tornado	1990	22 May	F0	0	0	Calhoun
Tornado	1992	21 Jul	F0	0	0	Calhoun
Tornado	1996	25 Jul	F0	0	0	Fulghums Landing
Tornado	1997	17 Mar	F0	0	0	Indianola
Tornado	1997	17 Mar	F0	0	0	Port O'Connor
Waterspout	1999	3 Sep	N / A	0	0	Port O'Connor
Waterspout	1999	28 Sep	N / A	0	0	Port O'Connor
Tornado	2001	5 May	F0	0	0	Port Lavaca
Total Number of Storms: 23						
REFUGIO COUNTY						
Tornado	1963	8 Nov	F3	1	0	Refugio
Tornado	1963	8 Nov	F0	0	0	Refugio
Tornado	1965	18 May	F2	0	0	Refugio
Tornado	1967	22 Sep	F	0	0	Refugio
Tornado	1967	22 Sep	F	0	0	Refugio
Tornado	1967	22 Sep	F	0	0	Refugio
Tornado	1970	3 Aug	F	0	0	Refugio
Tornado	1981	11 Aug	F0	0	0	Refugio
Tornado	1991	20 Jun	F0	0	0	Refugio
Tornado	1991	20 Jun	F0	0	0	Refugio
Tornado	1992	28 May	F0	0	0	Refugio
Tornado	1992	28 May	F1	0	0	Refugio
Tornado	1995	17 Dec	F0	1	0	Refugio
Total Number of Storms: 13						
VICTORIA COUNTY						
Tornado	1954	22 Oct	F1	1	0	Victoria
Tornado	1960	18 Oct	F1	0	0	Victoria
Tornado	1961	24 May	F0	0	0	Victoria
Tornado	1961	9 Jun	F0	0	0	Victoria
Tornado	1962	27 Apr	F1	0	0	Victoria
Tornado	1967	20 Sep	F	1	0	Victoria
Tornado	1967	20 Sep	F	0	0	Victoria
Tornado	1967	20 Sep	F	0	0	Victoria
Tornado	1967	20 Sep	F	0	0	Victoria
Tornado	1967	20 Sep	F	0	0	Victoria
Tornado	1968	9 May	F0	0	0	Victoria
Tornado	1968	9 May	F0	0	0	Victoria
Tornado	1968	5 Nov	F3	2	0	Victoria
Tornado	1969	11 Apr	F1	0	0	Victoria

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Event	Year	Date	Fujita	Injuries	Deaths	County/Community
Tornado	1972	10 May	F1	0	0	Victoria
Tornado	1975	8 May	F0	0	0	Victoria
Tornado	1975	4 Aug	F0	0	0	Victoria
Tornado	1975	4 Aug	F0	0	0	Victoria
Tornado	1975	4 Sep	F0	0	0	Victoria
Tornado	1975	15 Oct	F0	0	0	Victoria
Tornado	1976	7 May	F1	0	0	Victoria
Tornado	1980	10 Aug	F1	0	0	Victoria
Tornado	1981	18 Oct	F0	0	0	Victoria
Tornado	1982	13 May	F1	0	0	Victoria
Tornado	1983	26 Mar	F0	0	0	Victoria
Tornado	1984	12 Mar	F0	1	0	Victoria
Tornado	1986	17 May	F0	0	0	Victoria
Tornado	1992	3 Jul	F0	0	0	Victoria
Tornado	1993	18 May	F0	0	0	Bloomington
Tornado	1993	18 May	F0	0	0	McFaddin
Funnel cloud	1994	4 Aug	N/A	0	0	Victoria
Tornado	1994	18 Oct	F0	0	0	Placedo
Funnel cloud	1997	20 Jul	N/A	0	0	Victoria
Tornado	1998	17 Oct	F0	0	0	Dacosta
Tornado	2000	22 Oct	F0	0	0	Victoria
Total Number of Storms: 35						

Source: National Climatic Data Center, National Oceanic and Atmospheric Administration.

Middle Basin

Event	Year	Date	Fujita	Injuries	Deaths	County/ Community
CALDWELL COUNTY						
Tornado	1957	26 Apr	F2	0	0	Caldwell
Tornado	1961	4 Aug	F2	3	0	Caldwell
Tornado	1961	12 Nov	F2	0	0	Caldwell
Tornado	1965	15 Apr	F2	0	0	Caldwell
Tornado	1965	28 Aug	F2	0	0	Caldwell
Tornado	1967	8 May	F1	0	0	Caldwell
Tornado	1971	25 Feb	F2	0	0	Caldwell
Tornado	1971	24 Jul	F1	0	0	Caldwell
Tornado	1973	13 Sep	F1	0	0	Caldwell
Tornado	1974	8 Aug	F0	0	0	Caldwell

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Event	Year	Date	Fujita	Injuries	Deaths	County/ Community
Tornado	1976	7 Apr	F0	0	0	Caldwell
Tornado	1980	10 Aug	F1	0	0	Caldwell
Tornado	1980	10 Aug	F2	20	0	Caldwell
Tornado	1987	3 May	F1	0	0	Caldwell
Tornado	1987	3 May	F1	0	0	Caldwell
Tornado	1988	17 Sep	F0	0	0	Caldwell
Funnel clouds	1994	6 Nov	N / A	0	0	Lockhart
Tornado	1998	5 Jun	F0	0	0	Lockhart
Tornado	1998	5 Jun	F1	0	0	Lockhart
Funnel cloud	2000	4 May	N / A	0	0	Mc Mahan
Tornado	2000	22 Oct	F0	0	0	Martindale
Tornado	2000	12 Nov	F0	0	0	Lockhart
Tornado	2002	30 Dec	F0	0	0	Lockhart
Total Number of Storms: 23						
DEWITT COUNTY						
Tornado	1960	25 Jun	F0	0	0	DeWitt
Tornado	1967	20 Sep	F	0	0	DeWitt
Tornado	1967	20 Sep	F	0	0	DeWitt
Tornado	1969	11 Apr	F2	0	0	DeWitt
Tornado	1969	16 May	F1	0	0	DeWitt
Tornado	1970	3 Aug	F0	0	0	DeWitt
Tornado	1972	30 Jul	F0	0	0	DeWitt
Tornado	1978	23 Apr	F1	0	0	DeWitt
Tornado	1983	3 May	F0	0	0	DeWitt
Tornado	1993	18 May	F0	0	0	Cuero
Tornado	1993	18 May	F0	0	0	Meyersville
Tornado	1996	20 Sep	F1	0	0	Cuero
Total Number of Storms: 12						
GONZALES COUNTY						
Tornado	1955	20 Mar	F1	0	0	Gonzales
Tornado	1959	14 Jun	F	0	0	Gonzales
Tornado	1962	3 Jun	F1	2	0	Gonzales
Tornado	1965	18 May	F0	0	0	Gonzales
Tornado	1965	18 May	F2	0	0	Gonzales
Tornado	1967	20 Sep	F	0	0	Gonzales
Tornado	1967	20 Sep	F	0	0	Gonzales
Tornado	1967	20 Sep	F	1	0	Gonzales
Tornado	1972	7 May	F1	0	0	Gonzales

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Event	Year	Date	Fujita	Injuries	Deaths	County/ Community
Tornado	1972	7 May	F1	0	0	Gonzales
Tornado	1973	11 Oct	F2	0	0	Gonzales
Tornado	1975	29 Apr	F0	0	0	Gonzales
Tornado	1982	6 May	F1	0	0	Gonzales
Tornado	1984	6 Jun	F0	1	0	Gonzales
Tornado	1991	19 Feb	F2	0	0	Gonzales
Funnel cloud	1997	27 May	N / A	0	0	Wrightsboro
Tornado	1998	7 Mar	F0	0	0	Smiley
Tornado	1998	14 Jul	F1	0	0	Gonzales
Tornado	1999	1 Jan	F0	0	0	Leesville
Tornado	2000	12 Nov	F0	0	0	Dilworth
Tornado	2000	12 Nov	F0	0	0	Cheapside
Total Number of Storms: 21						

Source: National Climatic Data Center, National Oceanic and Atmospheric Administration

Upper Basin

Event	Year	Date	Fujita	Injuries	Deaths	County/ Community
GUADALUPE COUNTY						
Tornado	1953	1 Dec	F3	10	0	Guadalupe
Tornado	1955	15 May	F	0	0	Guadalupe
Tornado	1956	20 Oct	F2	1	0	Guadalupe
Tornado	1960	20 Aug	F1	0	0	Guadalupe
Tornado	1961	4 Sep	F2	0	0	Guadalupe
Tornado	1962	28 Oct	F1	0	0	Guadalupe
Tornado	1962	2 Dec	F1	0	0	Guadalupe
Tornado	1967	1 May	F2	0	0	Guadalupe
Tornado	1967	20 Sep	F1	0	0	Guadalupe
Tornado	1967	20 Sep	F	0	0	Guadalupe
Tornado	1969	22 May	F2	0	0	Guadalupe
Tornado	1972	16 May	F1	0	0	Guadalupe
Tornado	1973	20 Jan	F1	0	0	Guadalupe
Tornado	1975	23 May	F0	0	0	Guadalupe
Funnel cloud	1997	10 Jun	N / A	0	0	Zorn
Tornado	1998	10 Feb	F0	0	0	Seguin
Tornado	1999	1 Jan	F0	0	0	Seguin
Tornado	2000	26 Mar	F0	0	0	Seguin

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Event	Year	Date	Fujita	Injuries	Deaths	County/ Community
Tornado	2001	15 Nov	F0	0	0	New Braunfels
Total Number of Storms: 19						
HAYS COUNTY						
Tornado	1953	28 Apr	F3	5	1	Hays
Tornado	1954	30 Apr	F1	0	0	Hays
Tornado	1958	2 May	F1	0	0	Hays
Tornado	1961	12 Nov	F2	0	0	Hays
Tornado	1967	20 Sep	F	0	0	Hays
Tornado	1967	20 Sep	F	0	0	Hays
Tornado	1975	10 May	F1	0	0	Hays
Tornado	1976	30 Mar	F2	0	0	Hays
Tornado	1976	30 Mar	F2	1	0	Hays
Tornado	1980	10 Aug	F2	0	0	Hays
Tornado	1985	22 Apr	F2	0	0	Hays
Tornado	1991	22 Aug	F1	0	0	Hays
Tornado	1994	13 May	F0	0	0	Countywide
Funnel cloud	1996	20 Sep	N / A	0	0	Kyle
Tornado	1997	27 May	F1	0	0	Kyle
Funnel cloud	1997	10 Jun	N / A	0	0	San Marcos
Tornado	1998	8 Apr	F0	0	0	Wimberley
Tornado	1998	8 Apr	F0	0	0	Wimberley
Funnel cloud	2000	22 Oct	N / A	0	0	San Marcos Muni Arpt
Tornado	2001	15 Nov	F1	3	0	Kyle
Tornado	2001	15 Nov	F1	3	0	Kyle
Tornado	2001	15 Nov	F0	1	0	Henly
Tornado	2001	15 Nov	F0	0	0	Wimberley
Tornado	2002	8 Oct	F0	0	0	Driftwood
Tornado	2002	30 Dec	F0	0	0	San Marcos
Total Number of Storms: 25						
KENDALL COUNTY						
Tornado	1950	15 May	F2	0	0	Kendall
Tornado	1957	20 Mar	F1	0	0	Kendall
Tornado	1957	31 Mar	F2	0	0	Kendall
Tornado	1959	1 May	F1	0	0	Kendall
Tornado	1963	28 Apr	F0	0	0	Kendall
Tornado	1969	6 May	F3	0	0	Kendall
Tornado	1975	19 May	F0	0	0	Kendall
Tornado	1976	30 Mar	F2	0	0	Kendall

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Event	Year	Date	Fujita	Injuries	Deaths	County/ Community
Tornado	1979	2 Mar	F1	0	0	Kendall
Tornado	1983	4 Mar	F1	0	0	Kendall
Tornado	1983	4 Mar	F2	1	0	Kendall
Tornado	1983	4 Mar	F0	0	0	Kendall
Tornado	1984	7 Apr	F0	0	0	Kendall
Tornado	1997	27 May	F0	0	0	Sisterdale
Tornado	2001	8 Mar	F0	0	0	Kendalia
Tornado	2001	15 Nov	F0	0	0	Boerne
Tornado	2001	15 Nov	F0	2	0	Boerne
Total Number of Storms: 17						

Source: National Climatic Data Center, National Oceanic and Atmospheric Administration.

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People and Property at Risk

Because it cannot be predicted where a tornado will touch down, all population, buildings, critical facilities, infrastructure, hazardous materials facilities, and lifelines are considered to be exposed to the tornado hazard and could potentially be affected.

Table 10-4. Exposure of Structures and Lifelines to Tornadoes, by County, in the Guadalupe River Basin

Jurisdiction	Population (2000)	Residential Buildings		Commercial Buildings		Critical Facilities
		Number	Value ($)	Number	Value ($)	Number
Caldwell	32,194	11,374	2,387,436,000	60	285,885,000	33
Calhoun	20,647	9,835	2,171,890,000	78	281,066,000	75
Comal	78,021	42,027	10,237,572,000	214	927,348,000	70
DeWitt	20,013	6,983	1,530,674,000	50	249,433,000	33
Gonzales	18,628	6,510	1,315,844,000	45	208,323,000	26
Guadalupe	89,023	39,668	8,760,265,000	232	950,030,000	77
Hays	97,589	45,837	12,655,070,000	333	1,433,860,000	64
Kendall	23,743	12,844	3,164,217,000	85	391,066,000	23
Refugio	7,828	2,953	640,396,000	11	54,484,000	22
Victoria	84,088	36,206	9,418,849,000	348	1,548,383,000	69
TOTAL	**471,774**	**214,237**	**52,282,213,000**	**1,456**	**6,329,878,000**	**492**

Jurisdiction	Infrastructure and Lifelines				Hazardous Materials Facilities	
	Oil Pipe (km)	Gas Pipe (km)	Highway (km)	Railroad (km)	Number of Sites	Number of Materials
Caldwell	211	83	142	65	1	3
Calhoun	62	151	170	56	6	107
Comal	-	46	153	87	7	16
DeWitt	89	223	213	52		
Gonzales	138	1	329	65	3	8
Guadalupe	170	92	224	69	6	14
Hays	38	21	227	67	6	6
Kendall	-	46	139	-		
Refugio	380	838	147	65		
Victoria	302	680	223	157	5	43
TOTAL	**1,391**	**2,181**	**1,967**	**684**		

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Potential Damages and Losses

The Guadalupe River Basin incurs about $269,685 in annual losses from tornadoes.[1] Table 10-5 shows total exposure, potential annualized property losses, and annualized loss ratios for each county in the Basin. The data indicate that Gonzales County has the highest risk relative to replacement value.

Table 10-5. Exposure, Potential Annualized Property Losses, and Annualized Loss Ratio, by County, from Tornadoes in the GBRA Area

Jurisdiction	Total Exposure	Annualized Expected Property Losses ($)	Annualized Loss Ratio
Caldwell	$2,806,776,000	$11,413	0.0004%
Calhoun	2,681,601,000	10,870	0.0004%
Comal	11,640,775,000	10,870	0.0001%
DeWitt	2,021,890,000	435	0.0000%
Gonzales	1,637,234,000	109,130	0.0067%
Guadalupe	10,376,784,000	652	0.0000%
Hays	14,756,866,000	95,826	0.0006%
Kendall	3,728,076,000	11,957	0.0003%
Refugio	740,701,000	3,636	0.0005%
Victoria	11,424,428,000	14,896	0.0001%
Totals	**$61,815,131,000**	**$269,685**	

GBRA facilities (described on pages 4-18 and 4-19) are also at risk from this hazard. However, no estimate is currently available of potential damages and losses to those facilities.

[1] PBS&J Risk Assessment for the Guadalupe River Basin.

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