



## SECTION 4. RISK ASSESSMENT

### 4.3 Hazard Profiles

#### 4.3.9 Tornado

The following section provides the hazard profile and vulnerability assessment for tornadoes in Fort Bend County.

##### *Hazard Profile*

##### *Hazard Description*

The National Oceanic Atmospheric Association (NOAA) defines a tornado as a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground (NOAA 2011). Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust, and debris. Tornadoes are the most violent of all atmospheric storms and the most hazardous when they occur in populated areas. Tornadoes can topple mobile homes, lift cars, snap trees, and turn objects into destructive missiles. Among the most unpredictable of weather phenomena, tornadoes can occur at any time of day, in any state in the union, and in any season. While the majority of tornadoes cause little or no damage, some are capable of tremendous destruction, reaching wind speeds of 200 mph or more (NOAA 2023).

Damage paths for tornadoes can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds of 30–125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. Most tornadoes are on the ground for less than 15 minutes (NWS n.d.).

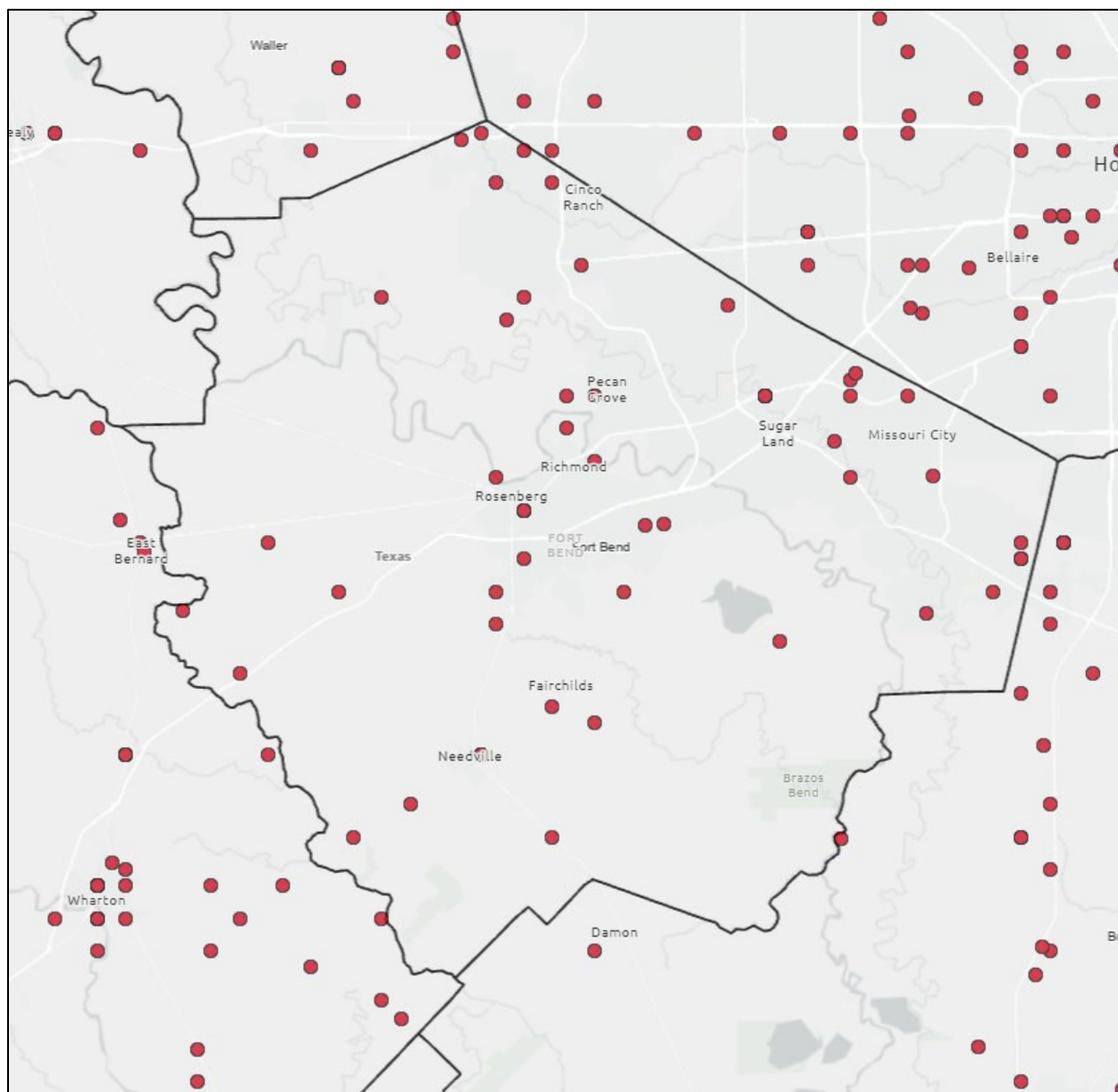
Tornadoes can occur at any time of the year, with peak season for Texas from May into early June (NOAA n.d.). An average of 1,224 tornadoes occur in the United States each year, based on tornadoes recorded between 1991 and 2015. The State of Texas averages 147 tornadoes each year (Livingston 2016).

##### *Location*

Tornadoes can occur at any time of the year, with peak season for Texas from May into early June (NOAA n.d.). An average of 1,141 tornadoes occurs in the United States each year, based on tornadoes recorded between 1985 and 2014. The State of Texas averages 140 tornadoes each year. In Fort Bend, between 1950 and 2022, 58 tornado touchdowns were recorded (**Error! Reference source not found.**). Since tornadoes can strike anywhere, the entire County is vulnerable to tornadoes and its impacts.



Figure 4.3.9-1. Recorded Tornado Touchdowns in Fort Bend County (1950 to 2022)



Source: SPC 2024

### Extent

Damage from tornadoes can vary from minor damage that breaks tree limbs to massive damage that demolishes homes in its path. The type of damage depends on the intensity, size, and duration of the tornado. The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 4.3.9-2 illustrates the relationship between EF ratings, wind speed, and expected tornado damage. Since 1950, 58 tornadoes touched down in Fort Bend County, with an average rating of EF-0. Based on history of occurrence and severity, the County can expect minor damage from tornadoes, with a 45-percent probability of experiencing minor damage (EF-0), 24-percent probability of experiencing moderate



damage (EF-1), 6-percent probability of experiencing considerable damage (EF-2), and 2-percent probability of experiencing severe damage (EF-3) in any given year.

Figure 4.3.9-2. EF Scale

EF Rating	Wind Speeds	Expected Damage
<b>EF-0</b>	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled. 
<b>EF-1</b>	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged. 
<b>EF-2</b>	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed. 
<b>EF-3</b>	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark. 
<b>EF-4</b>	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse. 
<b>EF-5</b>	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped. 

Source: Beddoes 2022

The National Weather Service (NWS) issues tornado watches and warnings. They are issued when conditions are favorable for the development of tornadoes in and close to the watch area. Their size can vary depending on the weather situation. Watches are typically issued for a duration of four to eight hours. A tornado warning is issued by the local NWS office and will include where the tornado was located and what municipalities will be in its path. It is issued when a tornado is indicated by a radar or spotters. Warnings are issued for a duration of 30 minutes (NWS 2020). The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly that little, if any, advance warning is possible (NOAA 2011).

*Worst-Case Scenario*

A worst-case scenario would be an EF-3 tornado crossing through Fort Bend County with 3-second wind gusts ranging from 136 to 165 mph, causing severe damage. A tornado of this magnitude would tear off roofs and tear down walls, uproot trees, and lift vehicles off the ground. This could lead to downed utility poles, street signals, and debris on roadways, disrupting normal operations and impacting emergency response times.



Critical and essential facilities could also be impacts, resulting in periods of service disruption to residents due to facility damages or lack of back-up power.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with tornado events in Fort Bend County. According to NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by 46 tornado events.

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in two disaster (DR) or emergency (EM) declarations for tornado-related events. Generally, these disasters cover a wide region of the state; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

USDA Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Fort Bend County was not included in any tornado-related agricultural disaster declarations.

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known tornado events that impacted Fort Bend County between 2017 and 2022 are discussed below.

Table 4.3.9-1. Tornado Events in the Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend Included in Declaration	Description
February 14, 2017	Tornado	N/A	N/A	Several morning tornadoes developed as a storm system moved eastward across the state. Crabb experienced an EF-2 tornado with peak winds reaching 115 mph, destroying houses and farm infrastructure, totaling approximately \$1,000,000 in property damages. Crabb also experienced an EF-0 tornado, which led to spotty roof damage and a wind peak of 80 mph, totaling approximately \$500,000 in property damages. Stafford experienced an EF-0 tornado, which damaged storage buildings and greenhouses with peak winds hitting 80 mph, totaling approximately \$200,000 in damages. Smada experienced an EF-0 tornado with peak winds up to 80 mph, which damaged houses and produced approximately \$150,000 in property damages.
August 25, 2017- August 26, 2017	Tornado	DR-4332-TX	Yes	Hurricane Harvey made landfall as a Category 4 hurricane near Rockport, Texas, during the evening of August 25th into the 26th. The storm then weakened to a tropical storm and slowed, looping back and tracking over SE Texas. Over the 5-day period, 23





Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend Included in Declaration	Description
				tornadoes were spawned. Juliff experienced both an EF-0 and EF-1 tornado, which damaged homes and roads, with property damages totaling approximately \$1,000,000. Sugarland experienced an EF-1 tornado, which damaged roofs with property damages totaling \$500,000. Clodine experienced an EF-0 tornado, which produced roof damages totaling \$30,000 in property damages. Katy experienced an EF-1 tornado, which damaged business infrastructure with property damages totaling approximately \$800,000. Hobby experienced an EF-1 tornado, which damaged over 25 homes, with property damages totaling approximately \$2,000,000.
May 23, 2018	Funnel Cloud	N/A	N/A	Severe thunderstorms made their way over the region, and several funnel clouds were sighted.
March 22, 2022	Tornado	N/A	N/A	Discrete supercell thunderstorms developed ahead of an advancing cold front, producing strong wind gusts, hail, and tornadoes. Later, a squall line formed along the front itself as it moved through SE TX, resulting in additional straight-line wind and tornado damage across the area. Kindleton experienced an EF-0 tornado with 4 documented injuries due to a flipped RV and approximately \$100,000 in property damages due to tree uprooting and home injuries.

Sources: NOAA 2022; FEMA 2022; Fort Bend County 2018

### Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of tornado events for the County. Information from NOAA-NCEI Storm Events Database, the 2019 State of Texas HMP, the 2018 Fort Bend County HMP, and FEMA Disaster Declaration database were used to identify the number of tornado events that occurred between 1950 and 2022. Table 4.3.9-2 presents the probability of future events for tornadoes in Fort Bend County.

**Table 4.3.9-2. Probability of Future Tornado Events**

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Tornado	46	63%
Funnel Cloud	15	20.5%
<b>Total</b>	<b>61</b>	<b>83.6%</b>

Sources: NOAA-NCEI 2022, State of Texas 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all Tornado events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated. Information regarding Tornadoic and Funnel Cloud occurrences was also gathered from the HMP Steering Committee.

In Section 4.4, the identified hazards of concern for Fort Bend County were ranked (Table 4.4-2). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for tornadoes in the County is considered “frequent”.



### *Vulnerability Assessment*

To understand risk, a community must evaluate what assets are exposed or vulnerable in the hazard area identified. The entire County has been identified as exposed for the tornado hazard. Therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 3), are exposed and potentially vulnerable.

### *Impact on Life, Health, and Safety*

Impacts of a tornado on life, health, and safety depend on several factors, including severity of the event and whether adequate warning time was provided to residents. All residents in Fort Bend County are exposed to tornadoes.

Residents impacted by tornadoes may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by winds associated with tornadoes can lead to injury or loss of life. Like other natural hazards, socially vulnerable populations are most susceptible based on several factors, including their physical and financial ability to react or respond during a hazard and locations and construction quality of their housing.

### *Socially Vulnerable Populations*

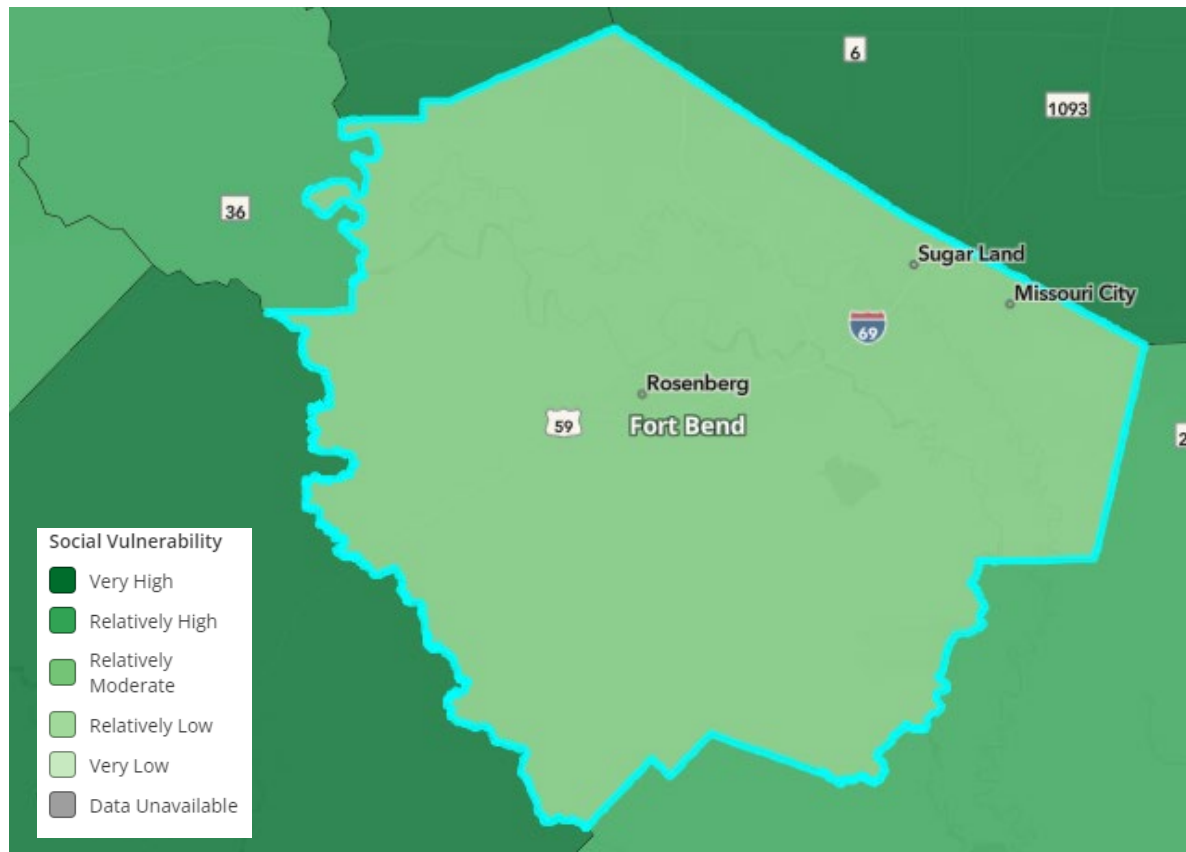
Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

According to FEMA's National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of tornadoes, when compared to the rest of the United States (FEMA n.d.).

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact on their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available due to isolation during a storm event. Section 3 (County Profile) presents the statistical information regarding these populations in the County. Refer to Figure 4.3.9-3 for the social vulnerability index for tornadoes.



Figure 4.3.9-3. FEMA Social Vulnerability Index for Tornado



Source: FEMA NRI

### Impact on General Building Stock

The entire County’s building stock is exposed to tornadoes. Damage to buildings depends on several factors, including wind speed, storm duration, path of the storm track and tornado, and distance from the tornado funnel. Manufactured housing (i.e., mobiles homes) can be particularly vulnerable to high winds and tornadoes. Due to their lightweight and often unanchored design, they are extremely vulnerable to high winds and will generally sustain the most damage out of all building stock.

### Impact on Critical Facilities and Community Lifelines

Utility infrastructure could suffer damage from tornadoes associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored and could suffer from dehydration. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community’s ability to effectively respond to an event and maintain the safety of its citizens.



### Impact on Economy

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Tornadoes also impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation and reconstruction costs, and wage and rental loss due to repair/replacement of buildings. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could sustain damage, and impacts could result in loss of power, which can affect business operations and provision of heating or cooling to the population.

### Impact on Environment

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The impact of tornado events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as United States Geological Service (USGS) and NOAA have been studying and monitoring the effects of extreme weather phenomena as they impact long-term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2020). Tornadoes can tear apart habitats, causing fragmentation across ecosystems. Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Fort Bend County.

### Future Changes That May Impact Vulnerability

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Understanding future changes that affect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

#### *Projected Development*

Any areas of growth could be potentially impacted by the tornado hazard because the entire County is exposed and vulnerable. Residential development, specifically manufactured homes, may be considered more vulnerable to tornadoes. In general, any development that has weak building and/or construction materials that could be impacted by high winds would be highly impacted by tornadoes.

#### *Projected Changes in Population*

Fort Bend County experienced an increase in population between the 2010 Census (585,375) and the 2020 Census (822,779). The population of the County is expected to increase over the next few years. The increase in population will expose more people to tornadoes (US Census Bureau 2022).

#### *Climate Change*

For all their destructive fury, tornadoes are relatively small and are also very short-lived, lasting from a few seconds to a few hours as opposed to days or weeks at a time. This makes them very difficult to model in the climate simulations that scientists use to project the effects of climate change.





Instead, scientists must attempt to predict how climate change might affect the individual weather “ingredients” that support the development of supercell thunderstorms (the type that produce tornadoes). These weather ingredients are (Geographic n.d.):

- Warm, moist air
- An unstable atmosphere
- Wind at different levels moving in different directions at different speeds, a phenomenon known as wind shear

As global temperatures rise, the hotter atmosphere can hold more moisture. This increases atmospheric instability, a vital supercell ingredient. On the other hand, as the planet warms, wind shear (another vital ingredient) is likely to decrease. These two forces work against each other, and it is difficult to anticipate which might have a greater impact on tornado formation.

There have been changes in tornado patterns in recent years, as it has been recorded that there are fewer days with at least 1 tornado but more days with over 30. The total number of tornadoes per year has remained relatively stable but are becoming more clustered (Geographic n.d.).

#### Change in Vulnerability Since 2018 HMP

There has been an increase in population within the County. Climate change is producing stronger storms, making tornadoes more probable in 2023 than in 2018 when the previous plan developed.