SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.8 Severe Weather

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

Hazard Profile

Hazard Description

Hail

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32°F or colder. As the frozen droplet begins to fall, it might thaw as it moves into warmer air toward the bottom of the thunderstorm or the droplet might be picked up again by another updraft and carried back into the cold air to re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail (NSSL 2021).

Thunderstorms and Lightning

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS 2021). A thunderstorm forms from a combination of moisture, rapidly rising warm air, and a force capable of lifting air, such as a warm and cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and lightning. The NWS considers a thunderstorm *severe* only if it produces damaging wind gusts of 58 miles per hour (mph) or higher or large hail one inch (quarter size) in diameter or larger or tornadoes (NWS 2021).

Thunderstorms include heavy rainfall and occasional, gusty winds but often include hail and lightning. Damage from severe thunderstorm winds accounts for half of all severe summer weather reports in the lower 48 states and is more common than damage from tornadoes. Heavy rainfall produced by thunderstorms may result in several types of flooding, including riverine, flash floods, and local drainage floods. Thunderstorms can also range in magnitude and severity (NOAA n.d.).

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm (NOAA n.d.). There are two main types of lighting: intra-cloud and cloud-to-ground.

- Intra-cloud lightning is an electrical discharge between oppositely charged areas within the thunderstorm cloud (National Weather Service 2023).
- Cloud-to-ground lightning is a discharge between opposite charges in the cloud and on the ground. Cloud-to-ground lightning can either occur between negative charges in the cloud and positive charges on the ground (a negative flash) or between positive charges in the cloud and negative charges on the ground (a positive flash) (National Weather Service 2023).

Wind

Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms (NWS 2012). The following are descriptions of types of damaging winds:

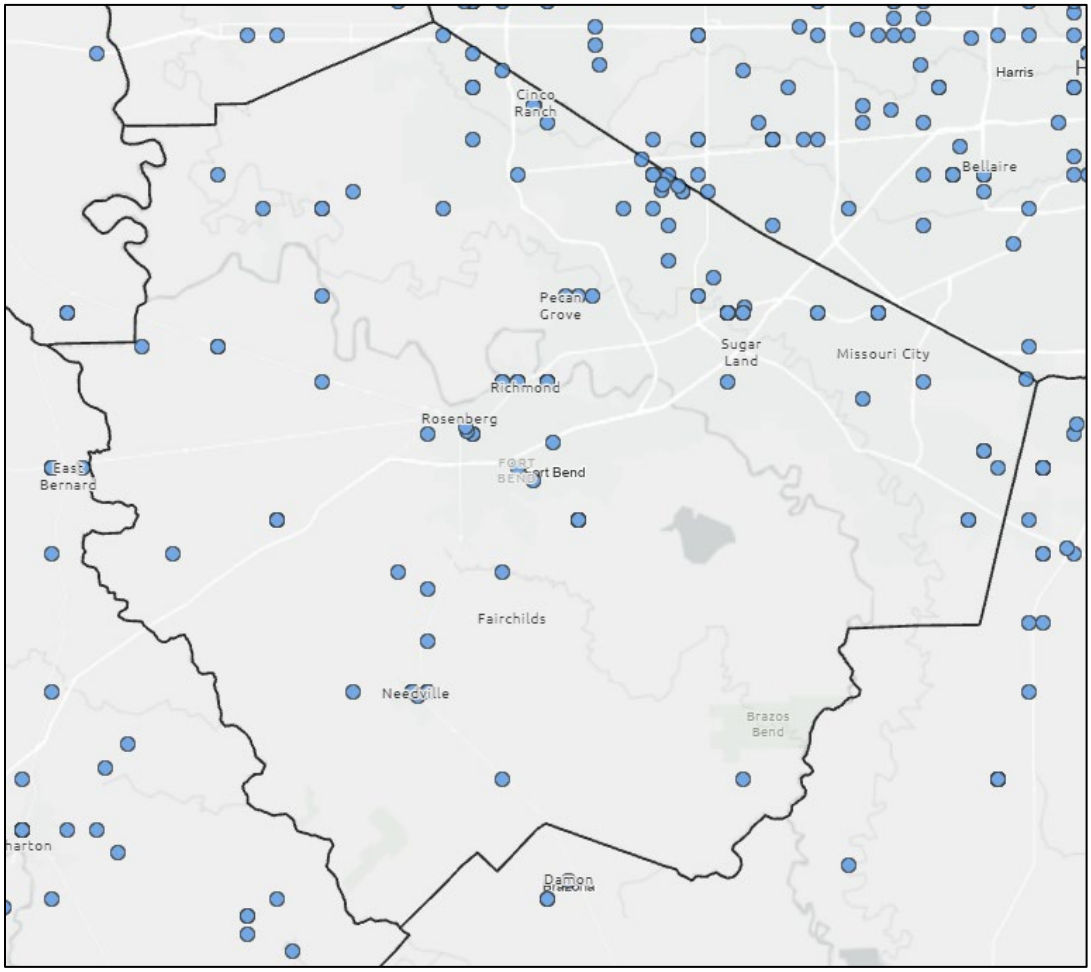
- **Straight-line Wind**: Used to define thunderstorm wind, which is not linked with rotation and is mainly used to differentiate from tornadic winds (NOAA n.d.)
- **Down Draft**: A small-scale column of air that sinks toward the ground (NOAA n.d.)
- **Macroburst**: An outward burst of strong winds that are more than 2.5 miles in diameter (NOAA n.d.)
- **Microburst**: A small, concentrated downburst that produces an outward burst of relatively strong winds near the surface (NOAA n.d.)
- **Downburst:** General term to describe macro and microbursts (NOAA n.d.)
- **Gust Front:** Leading edge of rain-cooled air that clashes with a warm thunderstorm inflow (NOAA n.d.)
- **Derecho:** Long-lived windstorm associated with rapidly moving precipitation or thunderstorms. If wind damage swatch is more than 240 miles and includes gusts of wind that reach 58 mph or greater, then the event can be classified as a derecho (NOAA n.d.)

Location

Hail

Hailstorms can form anywhere; however, they are more likely to fall in areas that have the most thunderstorms. The longer a hailstone spends in the clouds, the larger it becomes as more droplets continue to freeze. Hail falls when it becomes heavy enough to overcome the strength of the thunderstorm updraft and is pulled to the earth by gravity. Smaller hailstones may be blown away from the updraft by horizontal winds, so larger hail typically falls closer to the updraft than smaller hail (NOAA n.d.). Figure 4.3.8-1 shows recorded hail events in Fort Bend County from 1950 to 2022. As the figure shows, the entire County has recorded hail events, of all magnitudes. Therefore, the entire County is susceptible to hail and its damages.

Figure 4.3.8-1. Recorded Hail Reports in Fort Bend County, 1950 to 2022

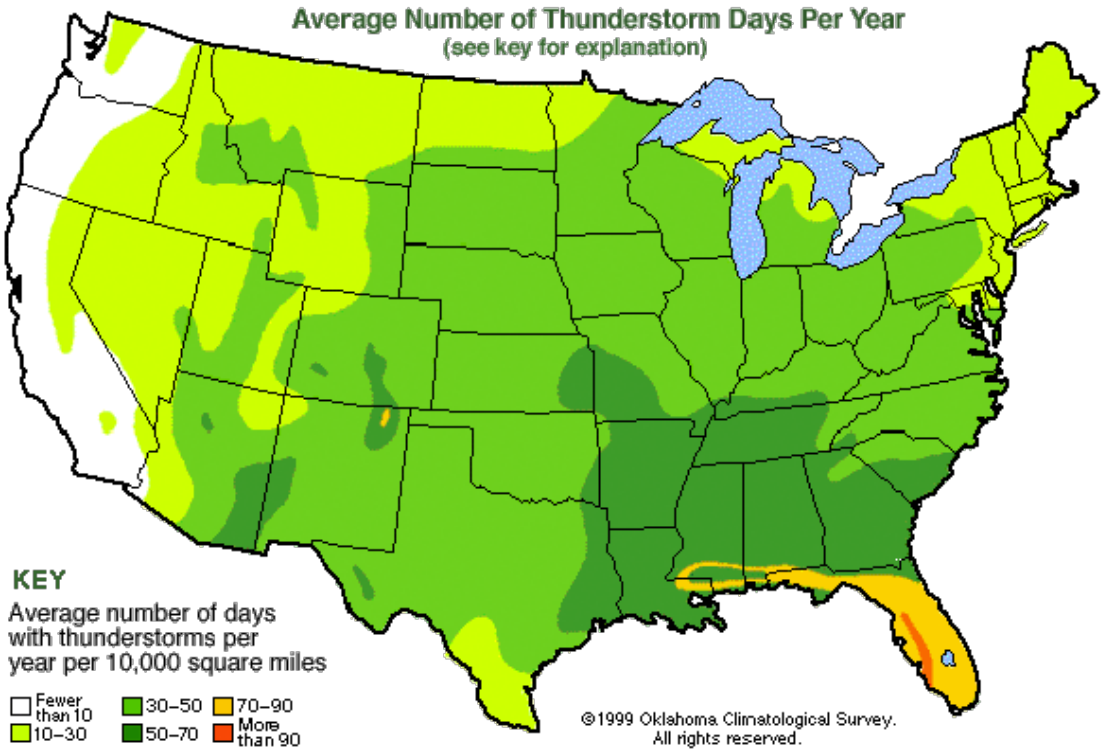


Source: SPC 2024

Thunderstorms and Lightning

Thunderstorms tend to take place during the spring and summer months, and during the warmest times of the day, which tend to be late afternoon and early evening (NOAA n.d.). Figure 4.3.8-2 displays thunderstorm days per year across the United States. The map shows that Fort Bend County is likely to have between 50 and 70 thunderstorms each year (University Corporation for Atmospheric Research 2023).

Figure 4.3.8-2. Average Number of Thunderstorms in the US

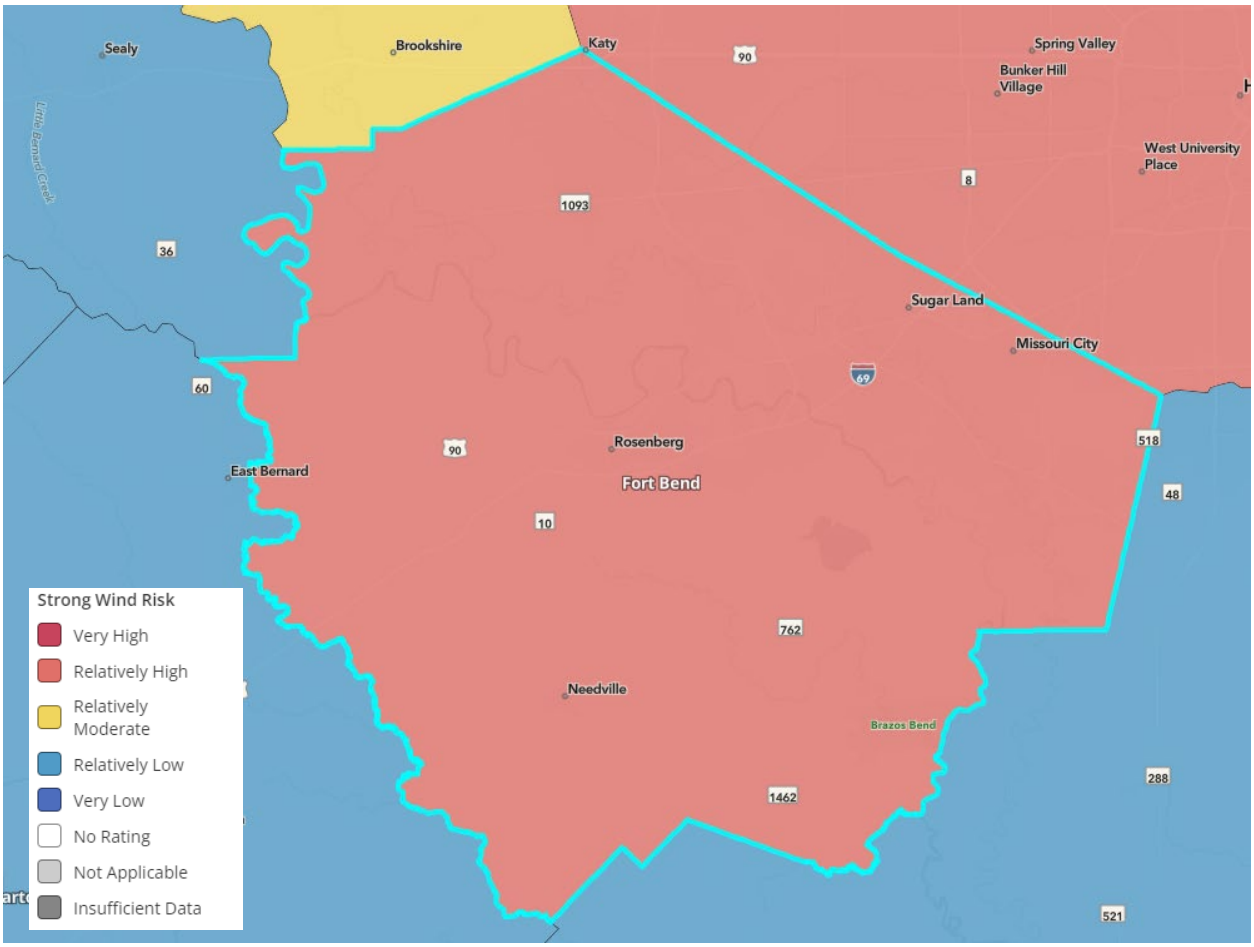


Source: University Corporation for Atmospheric Research 2023

Wind

Severe summer weathers have the power to produce powerful winds; therefore, strong and powerful winds have a higher chance of occurring in locations that are more likely to experience these storms (NOAA n.d.). In addition, high wind events may occur without a thunderstorm, tornado, or hurricane present and can be just as dangerous and destructive as those hazards. Figure 4.3.8-3 displays the strong wind risk index for Fort Bend County. According to the figure, the County has a "relatively high" risk to strong winds.

Figure 4.3.8-3. NRI Strong Wind Risk Index Score

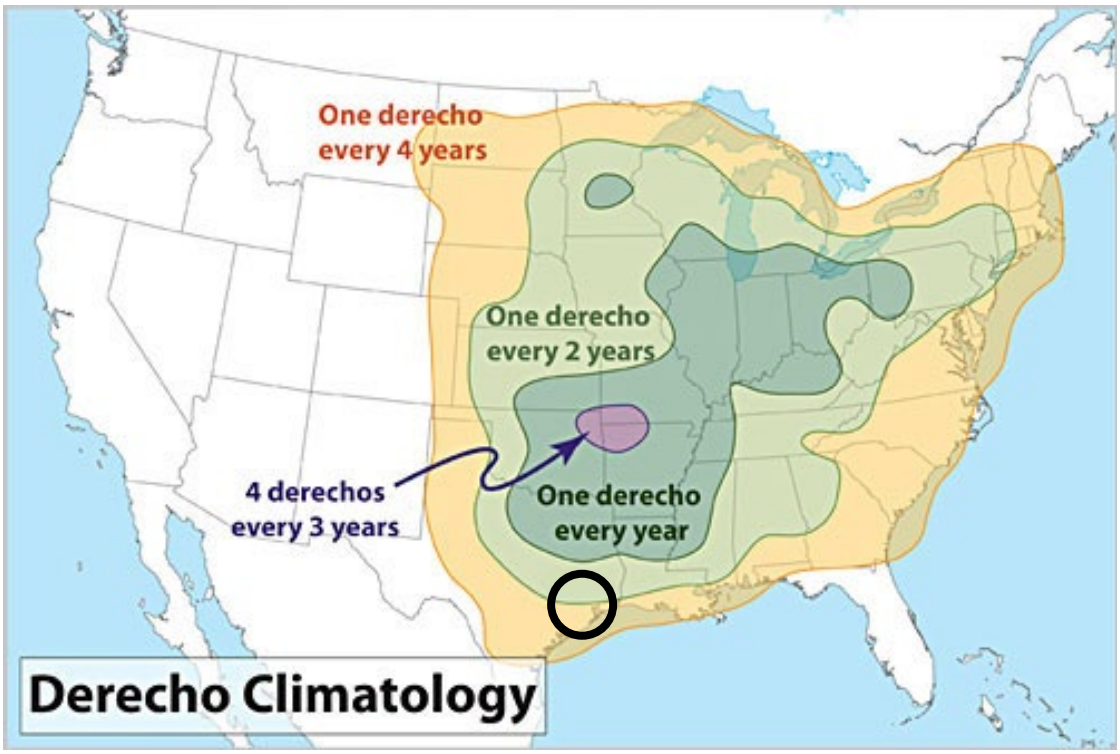


Source: FEMA 2023

Derecho

Derechos in the United States most commonly occur along two axes. One extends along the Corn Belt, from the upper Mississippi Valley southeast into the Ohio Valley, and the other from the southern Plains northeast into the mid-Mississippi Valley, as shown in Figure 4.3.8-4. During the cool season (September through April), derechos are relatively infrequent but are most likely to occur from east Texas into the southeastern states. Although derechos are extremely rare west of the Great Plains, isolated derechos have occurred over interior portions of the western United States, especially during spring and early summer (NOAA 2015). According to Figure 4.3.8-4 below, Fort Bend County can anticipate one derecho every four years.

Figure 4.3.8-4. Frequency of Derechos in the United States



Source: NOAA 2015

Note: The black circle shows the approximate location of Fort Bend County.

Extent

Hail

The severity of hail is measured by duration, hail size, and geographic extent. Hail can exhibit a variety of sizes, though only the very largest hail stones pose serious risk to people, if exposed. It is often estimated by comparing it to a known object (Table 4.3.8-1). Most hailstorms are made up of a mix of different sizes, and only the very largest hail stones pose serious risk to people caught in the open (NSSL 2021). Based on recorded hail events in Fort Bend County, the average size hail is 1.5 inches (H4/severe intensity) and can experience one severe hail event every 12 years and at least one hail event, of any magnitude, each year.

Table 4.3.8-1. Combined NOAA/TORRO Hailstorm Intensity Scales

Size Code	Intensity Category	Typical Hail Diameter (in.)	Approximate Size	Damage Impacts
H0	Hard Hail	Up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33 - 0.60	Marble	Slight damage to plants, crops
H2	Potentially Damaging	0.60 - 0.80	Dime	Significant damage to fruit, crops, vegetation
H3	Severe	0.80 - 1.20	Nickel to Quarter	Severe damage to fruit and crops, damage to glass and plastic structures, plant and wood scored
H4	Severe	1.20 - 1.60	Ping Pong Ball	Widespread glass damage, vehicle bodywork damage
H5	Destructive	1.60 - 2.0	Golf Ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0 - 2.4	Egg	Aircraft bodywork dented, brick walls pitted

Size Code	Intensity Category	Typical Hail Diameter (in.)	Approximate Size	Damage Impacts
H7	Very Destructive	2.4 - 3.0	Tennis Ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0 - 3.5	Baseball	Severe damage to aircraft bodywork
H9	Super Hailstorm	3.5 - 4.0	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorm	4.0+	Softball and up	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Sources: NOAA 2022; State of Texas 2018
Notes: The Hailstorm Intensity Scale allows planners to gauge past damage and mitigate for future expected damage.

Hailstorms can cause extensive property damage affecting both urban and rural landscapes. Fortunately, most hailstorms produce marble-size or smaller hailstones. These can cause damage to crops but they normally do not damage buildings or automobiles. Larger hailstones can destroy crops, livestock, and wildlife and can cause extensive damage to buildings, including roofs, windows, and outside walls. Vehicles can be total losses. When hail breaks windows, water damage from accompanying rains can also be significant. A major hailstorm can easily cause damage running into the millions of dollars (State of Texas 2018).

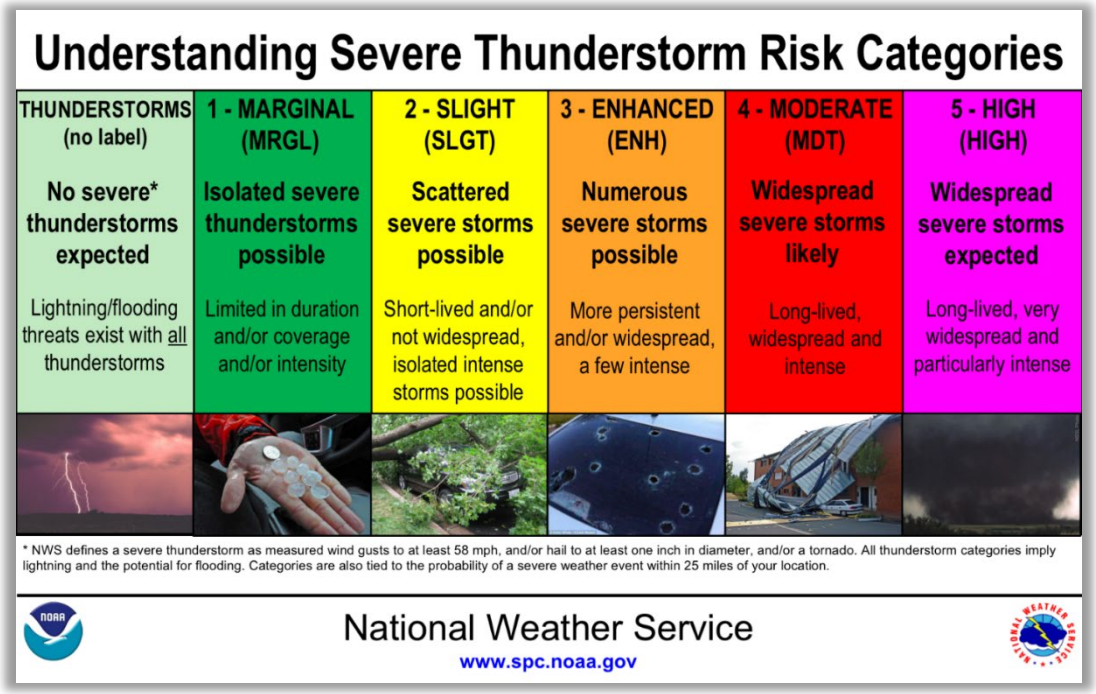
Thunderstorms and Lightning

Severe thunderstorm statements, watches, and warnings are issued by the local NWS office and the Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and notify the public when they are no longer in effect. NWS issues statements, watches, and warnings for thunderstorms:

- **Special Weather Statement:** Issued for strong storms that are below severe levels but may have impacts. Usually reserved for the threat of wind gust of 40–57 mph or hail of 0.5 inches to 0.99 inches in diameter (NWS 2023).
- **Severe Thunderstorm Watches:** A severe thunderstorm watch is issued when severe thunderstorms are possible in and near watch areas (NWS 2023).
- **Severe Thunderstorm Warning:** A severe thunderstorm is imminent or occurring; it is either detected by weather radar or reported by storm spotters. A severe thunderstorm is one that produces winds 58 mph or stronger and/or hail 1 inch in diameter or larger. A warning means to take shelter (NWS 2023).

The NWS has five risk categories for severe weather: marginal, slight, enhanced, moderate, and high. The probabilistic forecast directly expresses the best estimate of a severe weather event occurring within 25 miles of a point (NWS 2022). Figure 4.3.8-5 details the thunderstorm risk categories.

Figure 4.3.8-5. Thunderstorm Risk



Source: NOAA

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. The Lightning Activity Level (LAL) is a scale which describes lightning activity. The scale is part of the National Fire Danger Rating System. The scale is a range of numbers, from one to six, which reflects frequency and character of cloud-to-ground lightning (NWCG n.d.) (NOAA n.d.). Fort Bend County can experience multiple thunderstorms each year, of any severity. Therefore, the entire County can see lightning of any LAL.

Table 4.3.8-2. Lightning Activity Level

Lightning Activity Level (LAL)	Conditions
1	No Thunderstorms
2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a five-minute period.
3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lighting is infrequent, 6 to 10 cloud to ground strikes in a five-minute period.
4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent 11 to 15 cloud to ground strikes in a five-minute period.
5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud strikes in a five-minute period.
6	Dry lightning (same as LAL 3, but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag Warning.

Sources: NWCG n.d.

The National Lightning Detection Network, NLDN, consists of over 100 remote, ground-based sensing stations located across the United States that instantaneously detect the electromagnetic signals given off when lightning strikes the earth's surface. These remote sensors send the raw data via a satellite-based communications network to the Network Control Center operated by Vaisala Inc. in Tucson, Arizona. Within seconds of a lightning strike, the NCC's central analyzers process information on the location, time, polarity, and communicated to users across the country (NASA n.d.).

Wind

Wind is often measured in terms of wind shear. Wind shear is a difference in wind speed and direction over a set distance in the atmosphere. Wind shear is measured both horizontally and vertically. Wind shear is measured in meters per second times kilometers of height. Under normal conditions, the winds move much faster higher in the atmosphere, creating high wind shear in high altitudes.

The amount of force that wind is generating is measured according to the Beaufort scale (Table 4.3.8-1). The scale is named for Sir Francis Beaufort, who established a system for describing wind force in 1805 for the British Royal Navy. The Beaufort scale has 17 levels of wind force. “0” describes conditions that are so calm that smoke rises vertically. “12” describes a hurricane, and “13-17” are reserved only for tropical typhoons, the most powerful and potentially destructive wind systems (Turgeon and Morse 2022). The average recorded wind speeds in the County is 33 knots (near gale winds) that can lead to whole trees moving and feeling wind if outside. The County can experience at least one event with storm-strength winds. The strongest recorded wind event brought 74 knot winds (hurricane winds). The County has a 5-percent chance of hurricane winds occurring in any given year.

Figure 4.3.8-6. Beaufort Wind Scale

#	MPH	Knots	Description	Specifications
0	< 1	< 1	Calm	Smoke rises vertically.
1	1-3	1-3	Light Air	Direction of wind shown by smoke drift but not by wind vanes.
2	4-7	4-6	Light Breeze	Wind felt on face; Leaves rustle; Wind vanes moved by wind
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; Wind extends light flag.
4	13-18	11-16	Moderate	Raises dust, loose paper; Small branches moved.
5	19-24	17-21	Fresh	Small trees begin to sway; Crested wavelets form on inland waters.
6	25-31	22-27	Strong	Large branches in motion; Whistling heard in telephone wires; Umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Whole trees in motion; Inconvenience felt walking against the wind.
8	39-46	34-40	Gale	Twigs break off trees; Wind generally impedes progress; Mobile homes may shake.
9	47-54	41-47	Strong Gale	Slight structural damage occurs; Mobile homes, sheds, roofs, lanais, and RV's suffer minor damage.
10	55-63	48-55	Storm	Small trees uprooted; Moderate damage occurs to mobile homes and RV's; Brick and wood frame houses receive minor structural and roof damage; Some signs blown down.
11	64-73	56-63	Violent Storm	Moderate sized trees uprooted; Large branches snapped off trees; Chimneys and road signs toppled; Significant mobile home damage; Power lines downed.
12	74-95	64-83	Hurricane Category 1	Mobile homes overturned; Large trees and branches downed; Moderate roof damage to wood and brick homes; Minor pier damage.

Source: NOAA n.d.

The NWS issues advisories and warnings for winds that are typically site-specific. The NWS issues high wind advisories, watches, and warnings when wind speeds can pose a hazard or are life-threatening. The criterion for each of these varies from state to state. According to the NWS (2020), wind warnings and advisories for the State of Texas are as follows:

- **High Wind Watch/Warnings:** Issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible (NWS 2023).
- **Wind Advisories:** Issued when sustained winds of 30–39 mph are forecast for one hour or longer or wind gusts of 46–57 mph for any duration (NWS 2023).

Worst-Case Scenario

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and erosion occur. A worst-case event would involve prolonged high winds, an intense hail event, and a lightning strike at a critical facility (such as an emergency service station) during a thunderstorm. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, and landslides on steep slopes. Flooding could further obstruct roads and bridges, further isolating residents. Important issues associated with severe weather in the Planning Area include the following:

- Older building stock in the Planning Area is built to low code standards or none. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The potential for isolation after a severe storm event is high.
- There is limited information available for local weather forecasts.
- The lack of proper management of trees may exacerbate damage from high winds.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was included in six disaster (DR) or emergency (EM) declarations for severe weather-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 the County Profile.

Table 4.3.8-1. FEMA Declared Severe Weather Disaster (1954–2022) in Fort Bend County

FEMA Declaration Number	Date(s) of Event	Incident Title
DR-930-TX	December 20, 1991 - January 14, 1992	Texas Severe Storm, Thunderstorms
DR-1041-TX	October 14, 1994 - November 8, 1994	Texas Severe Storm, Thunderstorms, Flooding
DR-1257-TX	October 17, 1998 - November 15, 1998	Texas Severe Storms, Flooding, and Tornadoes
DR-1379-TX	June 5, 2001 - June 20, 2001	Texas Severe Storms and Flooding
DR-1439-TX	October 24, 2002 - November 15, 2002	Texas Severe Storms, Tornadoes, and Flooding

FEMA Declaration Number	Date(s) of Event	Incident Title
DR-4223-TX	May 4, 2015 - June 22, 2015	Texas Severe Storms, Tornadoes, Straight-line Winds, and Flooding

Source: FEMA 2022

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 2012 and 2022, Fort Bend County was not included in five severe weather-related agricultural disaster declarations.

Table 4.3.8-2. USDA Declared Severe Weather Disaster (1954–2022) in Fort Bend County

USDA Declaration Number	Date(s) of Declaration	Incident Title
2012-S3288	July 12, 2012	Wind, High Winds
2013-S3499	March 27, 2013	Wind, High Winds
2013-S3500	April 03, 2013	Wind, High Winds
2013-S3507	April 10, 2013	Wind, High Winds
2014-S3693	May 14, 2014	Wind, High Winds

Source: USDA FSA 2022

Previous Events

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

Table 4.3.8-3. Severe Weather Events in Fort Bend County (2017–2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
January 16, 2017	Thunderstorm Wind	N/A	N/A	Several weak tornadoes formed in an unstable air mass from a thunderstorm. Severe thunderstorm wind damage also occurred, which knocked many fences down.
May 22, 2017-May 23, 2017	Thunderstorm Wind, Hail	N/A	N/A	Morning storms became severe and produced severe wind damage, some flooding, and two tornadoes. Caused $100,000 in property damages. Severe thunderstorms developed and produced damaging winds and large hail. Significant downburst wind damage occurred with an estimated 100 mph wind. Simonton experienced $30,000 in property damages, and Arcola experienced $5,000 in property damages. Severe thunderstorms developed along and ahead of a cold front and produced damaging winds and large hail. Significant downburst wind damage occurred near Sealy with an estimated 100 mph wind.
September 5, 2018	Lightning	N/A	N/A	Lightning started a residential fire near the intersection of Lakebridge Lane and Hollow Lane. Approximately $10,000 in property damages occurred.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
April 6-7, 2019	Thunderstorm Wind	N/A	N/A	A storm system moved across the area during the day and produced large hail, damaging winds and tornadoes. Dewalt experienced $6,000 in property damages and $3,000 in crop damages. Sugar Land experienced $3,000 in crop damages.
April 13, 2019	Hail	N/A	N/A	A storm system moving eastward across the state produced several tornadoes, some wind damage, and large hail.
May 9, 2019	Thunderstorm Wind, Hail	N/A	N/A	Shortwave disturbances traveling across a slow-moving frontal boundary within a moist air mass allowed for the development of high rainfall, producing storms and downed trees from strong winds. Shortwave disturbances traveling across a slow-moving frontal boundary within a moist air mass allowed for the development of high rainfall-producing storms.
June 6, 2019	Thunderstorm Wind	N/A	N/A	Shortwave disturbances traveling across a slow-moving frontal boundary with severe wind produced which knocked down trees and power lines. Orchard experienced $7,000 in property damages, Fulshear experienced $6,000 in property damages, and Crabb experienced $7,100 in property damages.
January 10, 2020	Thunderstorm Wind	N/A	N/A	A strong storm system produced a squall line that moved eastward across the area and produced a lot of wind damage and one tornado. Richmond experienced $18,000 in property damages, and Stafford experienced $11,000 in damages.
May 16, 2020	Thunderstorm Wind	N/A	N/A	A passing squall line produced wind damage that knocked down trees and damaged houses. Hobby experienced $15,000 in property damages.
May 27, 2020	Thunderstorm Wind	N/A	N/A	Severe thunderstorms developed and produced wind damage, hail, and a few tornadoes, which knocked down power lines in the Katy area. Katy experienced $5,200 in property damages.
May 18, 2021	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms moved across the area in the evening through late night hours and produced wind damage, lightning damage, and some flooding. City of Houston reported downed trees.
May 28, 2021	Thunderstorm Wind	N/A	N/A	Strong thunderstorms resulted in wind damage across Greater Houston area and flash flooding. Trees were downed, and roof damage was reported in Katy. Katy experienced $25,000 in property damages.
June 15, 2021	Thunderstorm Wind, Lightning	N/A	N/A	A number of severe thunderstorms developed across the area, resulting in many reports of tree damage, 1-inch hail, and building damage and power outages due to both winds and lightning strikes. Fairchilds experienced $5,000 in property damages. A home in Fort Bend County caught fire after being struck by lightning. Approximately $10,000 in property damages occurred.
August 10, 2022	Thunderstorm Wind	N/A	N/A	Showers and thunderstorms moved southward across the area, producing wind damage and

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
				lightning strikes. Roof damage was reported in a community in Fulshear.

Sources: NOAA 2022; USDA FSA 2022; FEMA 2022; Fort Bend County 2018
Notes: Multiple hail-related events occurred in the project area between 2017 and 2022. No declarations were issued by FEMA or the USDA.

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 severe weather events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, and the 2018 Fort Bend County HMP were used to identify the number of severe weather events that occurred between 1950 and 2022. Table 4.3.8-4 presents the probability of future severe weather events for Fort Bend County. Fort Bend County will continue experiencing the direct and indirect impacts of severe weather events each year. Local knowledge indicates many more instances of lightning strikes occurring in the County. Therefore, the calculated probability based on recorded incidents might not represent the actual probability of occurrence.

Table 4.3.8-4. Probability of Future Severe Weather Events, Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hail	120	100%
Thunderstorms and Lightning	23	33.3%
Wind/Derecho	286	100%
Total	**429**	**100%**

Sources: NOAA 2022; State of Texas 2018; Fort Bend County 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 severe weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

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 Team, the probability of occurrence for severe weather events in the County is considered “frequent”.

Climate Change Impacts

The climate of Texas is changing. Most of the state has warmed between .5°F and 1°F in the past century. In the eastern two-thirds of the state, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of hail and lightning (Centers for Climate and Energy Solutions n.d.). Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (UCAR 2017).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the severe weather hazard. The following text evaluates and estimates the potential impact of the severe weather hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

The impact of severe weather on life, health, and safety is dependent upon several factors, including the severity of the event and whether adequate warning time was provided to residents. As a result of severe weather events, residents can be displaced or require temporary to long-term sheltering.

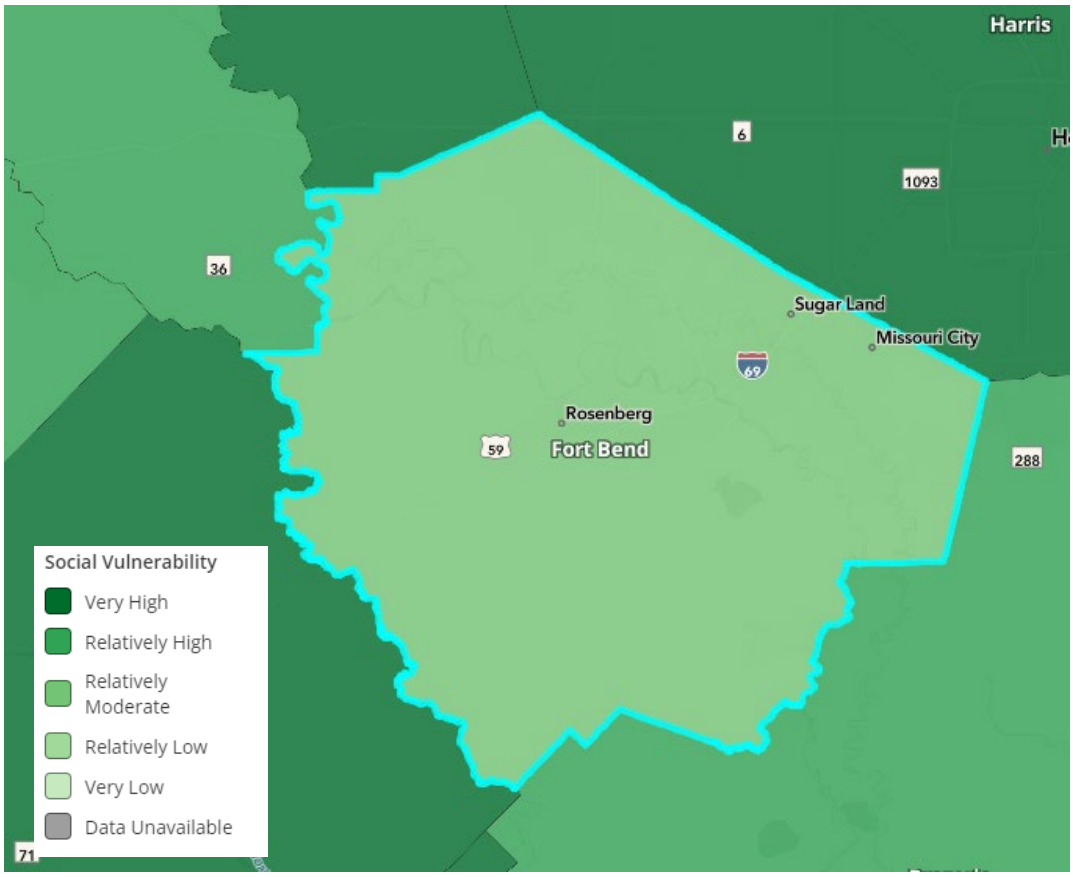
The most common problems associated with severe storms are immobility and loss of utilities. Residents impacted by severe weather may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by winds associated with severe weather can lead to injury or loss of life.

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.

Although the entire population is exposed to severe weather, some populations are more vulnerable. Vulnerable populations include people who are elderly, people with low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for life support. In general, populations who lack adequate shelter during a severe weather event, those who are reliant on sustained sources of power in order to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable. Refer to Figure 4.3.8-7 for the social vulnerability index for natural hazards.

Figure 4.3.8-7. FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

The County's building stock is exposed to the severe weather hazard. Damage to buildings depends on several factors, including wind speed, storm duration, and path of the storm track. Building construction also plays a major role in the extent of damage resulting from a storm. Due to differences in construction, residential structures are generally more susceptible to storm damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems.

Manufactured housing (i.e., mobile homes) is particularly vulnerable to high winds. The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (U. S. Census 2020)." They can include multi-wide and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their lightweight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Hailstorms can crack, break, and dent building materials, so building construction plays a major role in the extent of damage resulting from hails. Due to differences in construction, residential structures are generally

more susceptible to hail than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings.

Impact on Critical Facilities and Community Lifelines

Overall, all critical facilities in Fort Bend County are vulnerable to being affected by severe weather. Utility infrastructure could suffer damage from lightning, hail, and high winds, 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. 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

Impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Business interruption losses include losses associated with the inability to operate a business because of the damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event. Impacts to 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 suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the populations.

The wind's power to erode the land can be detrimental to agriculture. Loess, a sediment that can develop into one of the richest soils for farming, is easily swept up by wind. Even when farmers take precautions to protect it, the wind can erode up to 2.5 kilograms of loess per square meter. (1.6 pound per square foot) every year (Turgeon and Morse 2022).

Wind is a renewable resource that does not directly cause pollution. Wind energy is harnessed through powerful turbines. Wind turbines have a tall tubular tower with two or three propeller-like blades rotating at the top. When the wind turns the blades, the blades turn a generator and create electricity. The economic drawback to wind farms, however, is the wind itself. If it is not blowing, there's no electricity generated. (Turgeon and Morse 2022).

According to National Oceanic and Atmospheric Administration (NOAA) Technical Paper on *Lightning Fatalities, Injuries, and Damage Reports in the United States from 1959–1994*, monetary losses for lightning events range from less than $50 to greater than $5 million (larger losses associated with forest fires with homes destroyed and crop loss) (NOAA 1997).

Hail-producing severe storms impact the economy; impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Additionally, vehicles parked outdoors are vulnerable to hail damage and could increase the economic impacts of a storm.

Impact on Environment

The impact of severe weather 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 Survey (USGS) and NOAA have been studying and monitoring the impacts of extreme weather phenomena as it impacts long-term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2020). For example, severe weather that creates longer periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Severe wind events can tear apart habitats, causing fragmentation across ecosystems. Researchers also believe that a greater number of diseases will spread across ecosystems because of impacts that severe weather and climate change will have on water supplies (NOAA 2019). 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

Understanding future changes that affect vulnerability in Fort Bend County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County 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

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Areas targeted for potential future growth and development could be potentially impacted by hailstorms since the entire County is exposed. However, due to increased standards and codes, new development can be less vulnerable to extreme temperatures in comparison with the aging building stock currently in Fort Bend.

Projected Changes in Population

The County experienced an increase in population between the 2010 Census (585,375) and the estimated 2016–2020 American Community Survey estimated population of 790,892. The population of the County is expected to increase over the next few years. The increase in population will expose more people to the severe weather hazard.

Climate Change

Scientists must attempt to predict how climate change might affect the individual weather “ingredients” that produce storms that produce strong wind events. 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 (Geographic n.d.).

The entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Climate change may lead to an increase in the number of lightning strikes and lightning-producing storms. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). The changing climate may also increase the frequency of lightning flashes, which could rise by an estimated 50 percent across the continental United States over the next century. A warmer atmosphere can hold more moisture, and moisture is one of the key ingredients for triggering a lightning strike (Sanders 2014).

Change in Vulnerability Since 2018 HMP

As the population grows in Fort Bend County, the number of people who could be impacted by wind events increases. Climate change is creating stronger storms, making the occurrence of severe weather more probable than in the previous plan. As existing development and infrastructure continue to age, they can be at increased risk to failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.