



## SECTION 4. RISK ASSESSMENT

### 4.3 Hazard Profiles

#### 4.3.6 Hurricane/Tropical Storm

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

##### Hazard Profile

##### Hazard Description

Hurricanes, tropical storms, and tropical depressions that impact Texas form over warm tropical waters of the Gulf of Mexico or the Atlantic Ocean. The warm, moist air over the ocean rises upward from near the surface, creating an area of lower air pressure. These areas of relative low pressure draw in new air from the surrounding high-pressure areas. Quickly cyclonic (counterclockwise) circulation begins, and rain bands spin out from a wall of wind that surrounds a central area of low barometric pressure (the “eye”). Such storms can grow to a thousand miles in diameter and sustain winds near the eye that approach 200 miles an hour (TDEM 2018). According to National Oceanic and Atmospheric Administration (NOAA), tropical cyclones are classified into three main categories (per intensity): tropical depressions, tropical storms, and hurricanes.

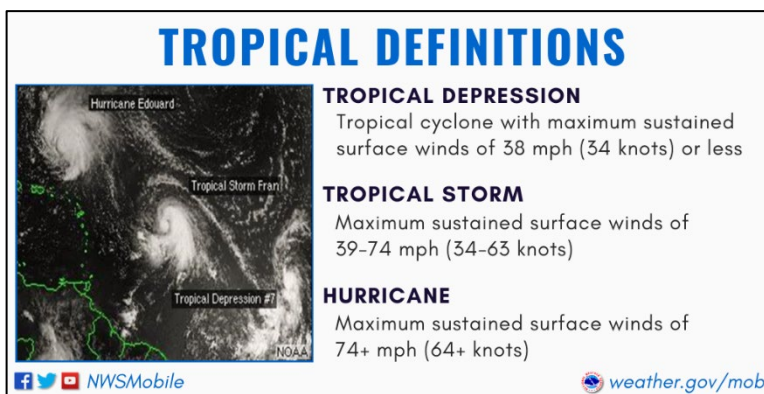
Tropical depressions have maximum sustained winds of 38 mph. Though not as strong as its successors, tropical depressions can bring heavy downpours and sustained winds strong enough to generate rough surf and life-threatening rip currents. When a tropical depression approaches, the National Weather Service may issue a tropical storm watch or warning for the area.

A tropical storm is a tropical cyclone in which the maximum sustained surface wind speeds range from 39 to 73 mph.

At this time, the tropical cyclone is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane.

Hurricanes are areas of disturbed weather in the tropics with closed isobars and strong and very pronounced rotary circulation. An area of clear weather called an “eye” is present in the center of the circulation. To qualify as a hurricane, the wind speed is 74 miles per hour (mph) or more. Hurricanes are classified into categories based on wind speed.

Figure 4.3.6-1. Tropical Cyclone Definitions



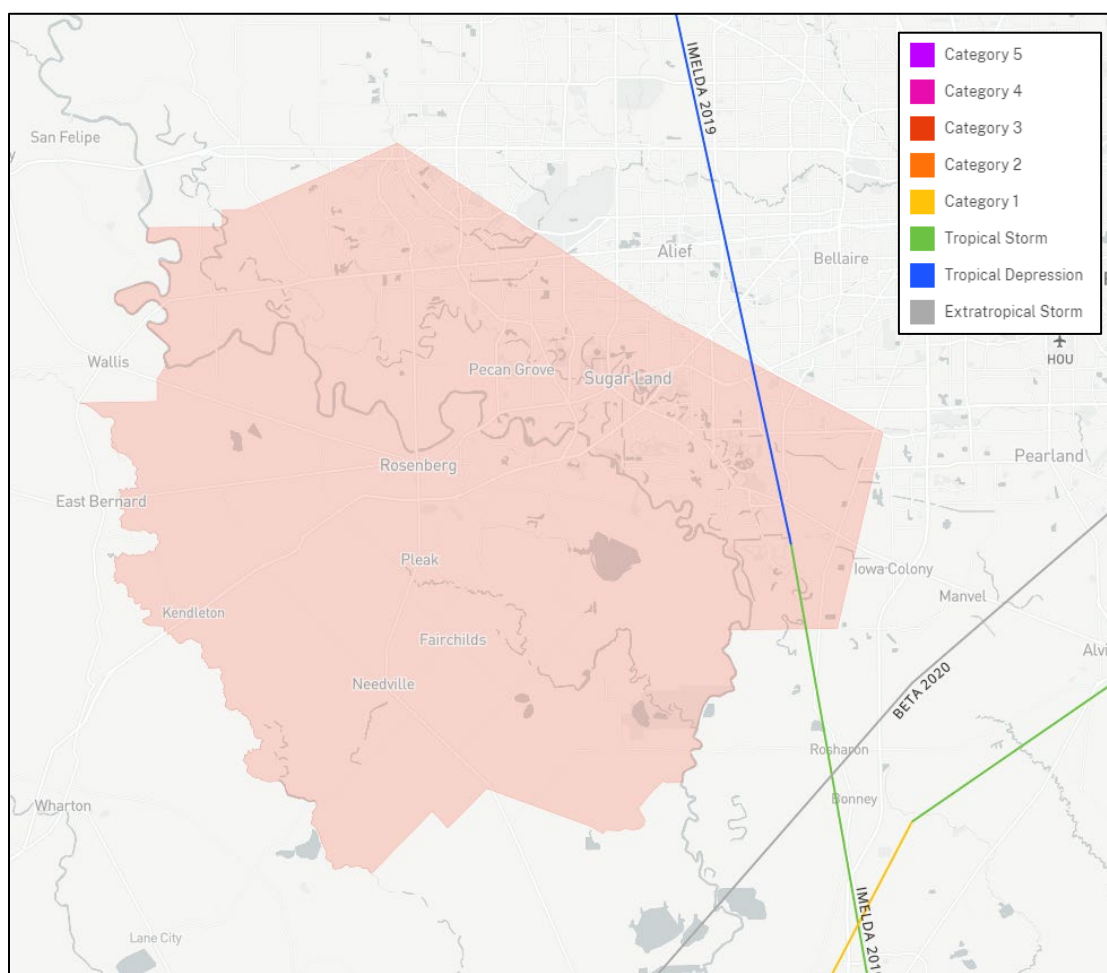


Tropical cyclones can produce intense rainfall resulting in flooding, battering wave action, storm surge, localized coastal erosion, and significant winds.

Location

Fort Bend County and its jurisdictions are at risk of exposure to hurricanes and tropical storms. Fort Bend’s proximity to the coastline increases the likelihood of hurricanes and tropical storms. The location of the County also increases the chances of second-hand windstorm from hurricanes and tropical storms that touched down in proximity to the County. Figure 4.3.6-2 displays tropical cyclone tracks that tracked within 65 nautical miles of Fort Bend County between 2018 and 2022 (only two events – Tropical Storms Marco and Laura and Hurricane Hanna in 2020). Refer to the Previous Occurrences and Losses section for further information regarding hurricane and tropical storm events that impacted Fort Bend County.

Figure 4.3.6-2. Historical Tropical Storm and Hurricane Tracks Impacting Fort Bend County 2018-2022



Source: NOAA 2023

Extent

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1–5 based on a hurricane’s increasing sustained wind speed.



This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered *major hurricanes* because of their potential for significant loss of life and damage. Tropical storms and Category 1 and 2 storms are still dangerous and require preventative measures (NWS NOAA n.d.). Table 4.3.6-1 below shows the categories in the Saffir-Simpson Hurricane Wind Scale and the types of damage associated with each category.

Table 4.3.6-1. Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds (miles per hour)	Types of Damage Due to Hurricane Winds
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (Major)	111-129	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (Major)	157 or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NOAA n.d.

Note: Other non-hurricane classifications are tropical storms (39-73 miles per hour) and tropical depressions (0-38 miles per hour)

The NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

*Hurricane Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparation activities become difficult once winds reach tropical storm force, the warning is issued 36-hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.

*Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48-hours prior to the anticipated onset of tropical storm-force winds.



*Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.

*Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, subtropical, or post-tropical storm (NHC NOAA 2010).

*Mean Return Period*

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. The MRP is the average period of time in years between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance.

Peak wind speed projections were generated using Hazus v5.0. Hazus v5.0 estimated the maximum 3-second gust wind speeds for Fort Bend County:

- 100-year MRP – between 96 and 129 mph (Category 2 and 3)
- 500-year MRP – between 111 and 129 mph (Category 3)

Refer to Figure 4.3.6-3 and Figure 4.3.6-4 below to view the 100- and 500-year MRPs, respectively. Table 4.3.6-2 identifies the extent which each jurisdiction will be impacted by the 100- and 500-year MRP events. To view the 100- and 500-year MRP hazard area for individual jurisdictions, refer to Section 9, Jurisdictional Annexes.

**Table 4.3.6-2. FEMA Disaster Declaration for the Project Area (1954-2022)**

Jurisdiction	100-Year MRP Event				500-Year MRP Event			
	Tropical Storm	Cat. 1	Cat. 2	Cat. 3	Tropical Storm	Cat. 1	Cat. 2	Cat. 3
Arcola (C)	-	-	-	X	-	-	-	X
Beasley (C)	-	-	X	-	-	-	-	X
Fairchilds (V)	-	-	-	X	-	-	-	X
Fulshear (C)	-	-	X	-	-	-	-	X
Houston (C)	-	-	X	-	-	-	-	X
Katy (C)	-	-	X	-	-	-	-	X
Kendleton (C)	-	-	X	-	-	-	-	X
Meadows Place (C)	-	-	X	-	-	-	-	X
Missouri City (C)	-	-	-	X	-	-	-	X
Needville (C)	-	-	X	-	-	-	-	X
Orchard (C)	-	-	-	-	-	-	-	X
Pearland (C)	-	-	-	X	-	-	-	X
Pleak (V)	-	-	-	X	-	-	-	X
Richmond (C)	-	-	X	-	-	-	-	X
Rosenberg (C)	-	-	X	-	-	-	-	X
Simonton (C)	-	-	X	-	-	-	-	X
Stafford (C)	-	-	X	-	-	-	-	X
Sugarland (C)	-	-	X	-	-	-	-	X
Thompsons (T)	-	-	-	X	-	-	-	X
Weston Lakes (C)	-	-	X	-	-	-	-	X

Note: Cat. = Category



Figure 4.3.6-3. Wind Speeds for the 100-Year MRP Event in Fort Bend County

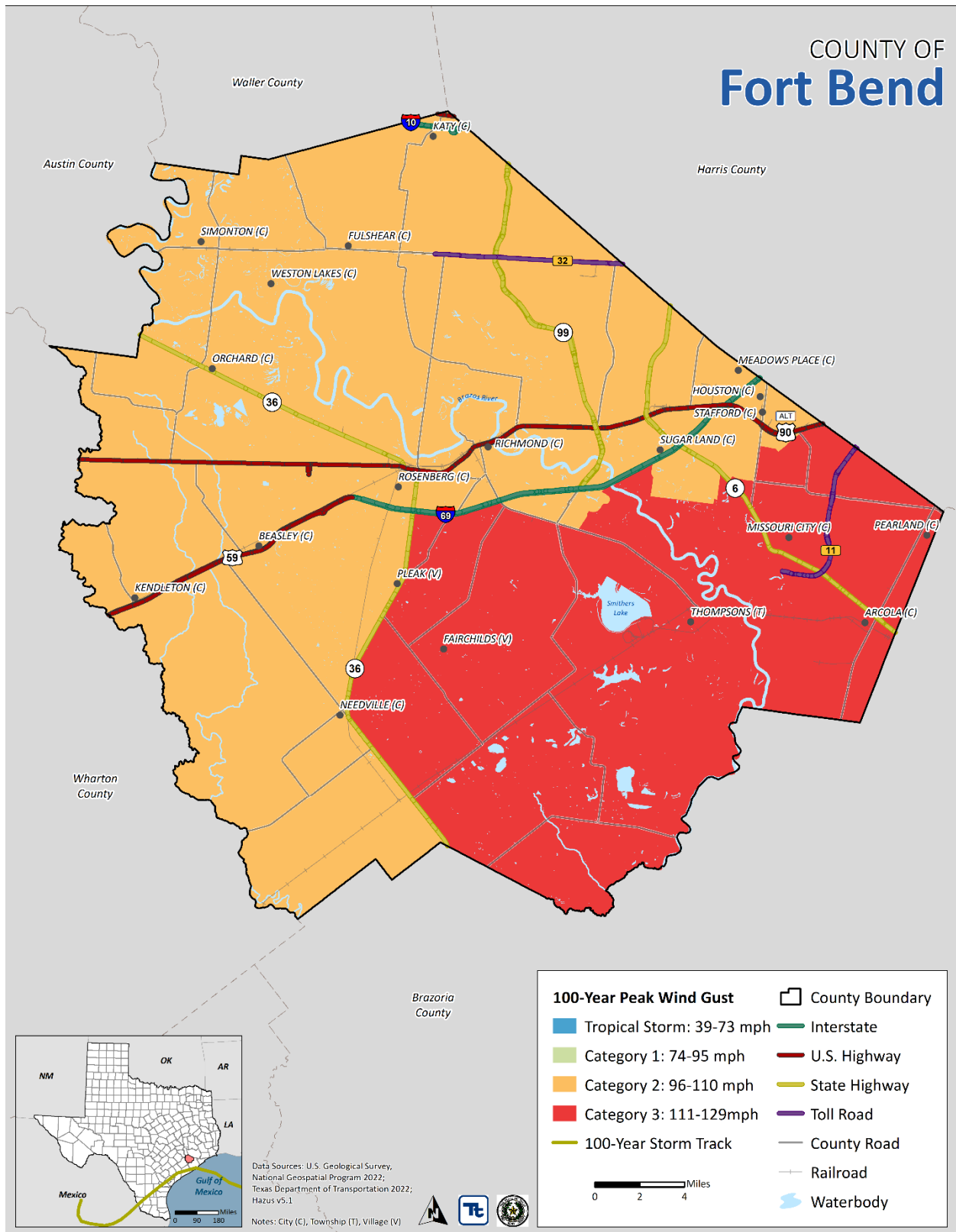
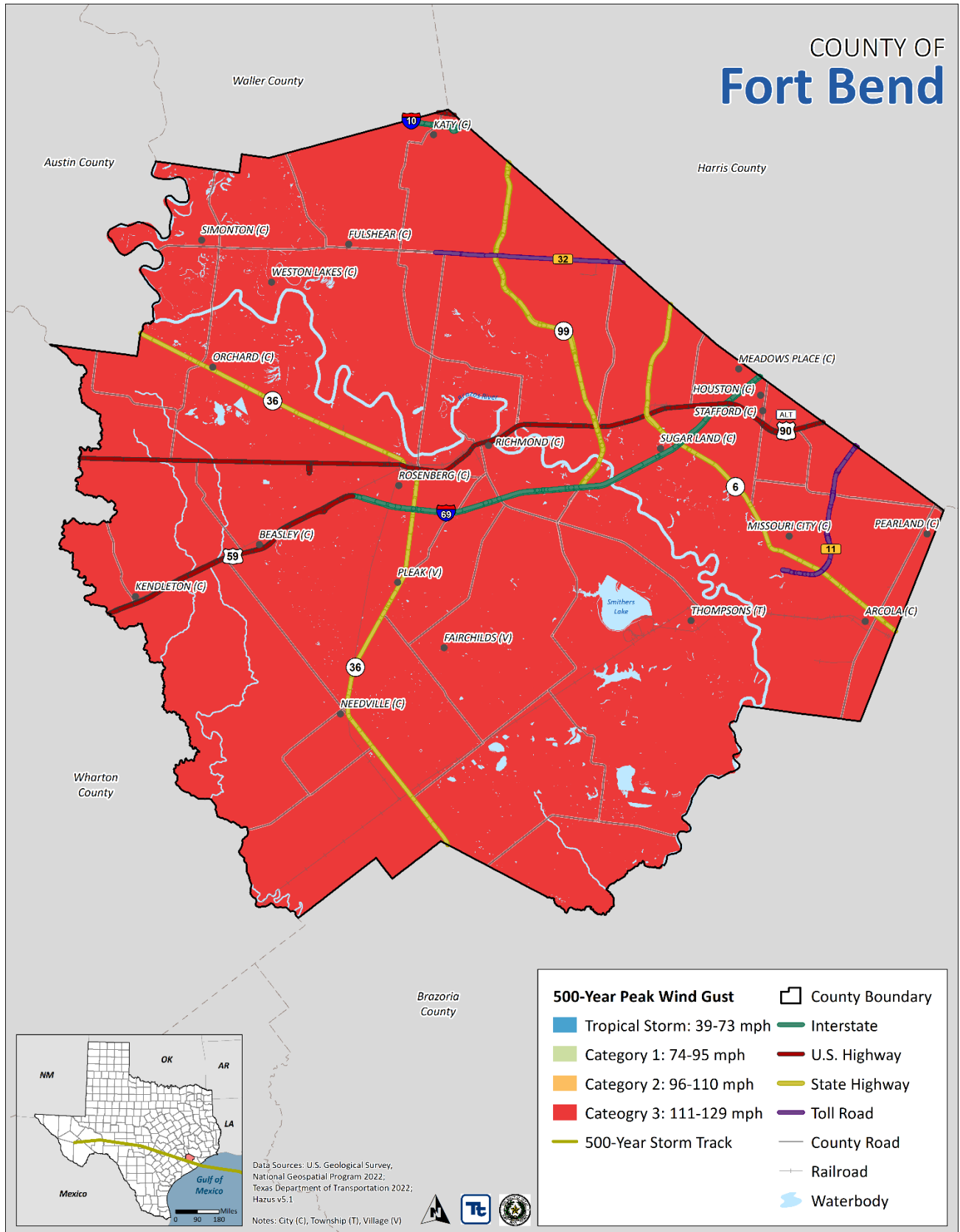






Figure 4.3.6-4. Wind Speeds for the 500-Year MRP Event in Fort Bend County





*Worst-Case Scenario*

The 500-year MRP event (Category 3 Hurricane for Fort Bend County) would be the worst-case scenario. A storm of this magnitude could cause severe damages to 18,372 occupied buildings and would destroy 10,299 occupied buildings. Critical facilities in the County would likely sustain moderate to severe damages, particularly to police and educational facilities. There would be over \$12.6 billion in building damages, causing over 2 million tons of debris. The winds associated with a Category 3 (speeds between 111 and 129 mph) would cause devastating damage. Well-built framed homes may incur major damage or removal of roof decking and gable ends; trees will be snapped or uprooted, blocking numerous roads; and electricity and water will be unavailable for several days to weeks after the storm passes.

*Previous Occurrences and Losses*

*FEMA Disaster Declarations*

Between 1954 and 2022, Fort Bend County was included in 11 disaster (DR) or emergency (EM) declarations for hurricane/tropical storm-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).

**Table 4.3.6-3. FEMA Disaster Declaration for the Project Area (1954-2022)**

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
August 18 – 20, 1983	August 19, 1983	DR-689-TX	Texas Hurricane Alicia
August 22 – 31, 1998	August 26, 1998	DR-1239-TX	Texas Tropical Storm Charley
August 29, 2005 – October 1, 2005	September 2, 2005	EM-3216-TX	Texas Hurricane Katrina evacuation
September 20, 2005 – October 14, 2005	September 21, 2005	EM-3261-TX	Texas Hurricane Rita
September 20, 2005 – October 14, 2005	September 24, 2005	DR-1606-TX	Texas Hurricane Rita
August 17, 2007 – September 5, 2007	August 18, 2007	EM-3277-TX	Texas Hurricane Dean
August 27, 2008 – September 7, 2008	August 29, 2008	EM-3290-TX	Texas Hurricane Gustav
September 7-26, 2008	September 10, 2008	EM-3294-TX	Texas Hurricane Ike
September 7, 2008 – October 2, 2008	September 13, 2008	DR-1791-TX	Texas Hurricane Ike
August 23, 2017 – September 15, 2017	August 25, 2017	DR-4332-TX	Texas Hurricane Harvey
July 25 – 31, 2020	July 26, 2020	EM-3530-TX	Texas Hurricane Hanna
August 23 – 27, 2020	August 24, 2020	EM-3540-TX	Texas Tropical Storms Marco and Laura

Source: FEMA 2023

*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 included in one hurricane and tropical storm-related agricultural disaster declaration.

**Table 4.3.6-4. USDA Disaster Declaration for the Project Area (2012–2022)**

USDA Declaration Number	Date(s) of Event	Event Name
2021-S5115	September 14, 2021	Hurricane Nicholas

Source: USDA 2023

*Previous Events*

Between 2017 and 2022, Fort Bend County was impacted by four tropical depression, tropical storm, or hurricane events.





Table 4.3.6-5. Hurricane and Tropical Storm Events in Fort Bend County (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
August 23 – September 15, 2017	Hurricane	DR-4332-TX	Yes	<p>Hurricane Harvey made landfall as a Category 4 hurricane near Rockport, Texas during the evening of August 25th. The storm then weakened to a tropical storm and slowed, looping back and tracking over SE Texas, then back over the Gulf of Mexico, making a second landfall along the Louisiana coast during the early morning hours of August 30th. Over that 5 day period over Southeast Texas, Harvey produced catastrophic flooding with a large area of 30 to 60 inches of rain, 23 tornadoes, tropical storm-force winds, and a moderate storm surge near Matagorda Bay. In some of the heavier bands, rain fell at a rate of over 5 inches per hour. This copious record amount of rain over a led to catastrophic flooding.</p> <p>There was water over roadways FM 655 and CR 521 near the town of Rosharon. Major record-level flooding of both the Brazos and San Bernard Rivers caused significant home flooding from Richmond to Rosharon. Massive flooding occurred in Tierra Grande subdivision along the San Bernard River in southwestern Fort Bend County. Home flooding occurred at Valley Lodge in Simonton, along Edgewood and Baudet Roads in Richmond, along Bar, Barker, Cumings, Sixth Street, Avenue B, and Rio Brazos Roads in Rosenberg. Sections of FM 2759 as well as the Grand River, Rivers Edge and Pecan Estates in Thompsons flooded. Many countywide roads became inundated in flood waters, including, but not limited to Highway 90A, Pitts Road, FM 1489, FM 723, FM 1093, FM 359, SH 6 feeder roads, Sienna Parkway, Carrol Road, McKeever Road, Knights Court, Miller Road, river Oaks Road, Thompsons Ferry Road, Strange Drive, Greenwood Drive, Second Street and low lying roads in Quail Valley in Missouri City. Due to record pool levels in Barker Reservoir, homes in Cinco Ranch flooded. Big Creek flooding in Needville caused the flooding of homes on Ansel Road. FM 1093 was closed east of FM 723 due to flooding.</p> <p>There were numerous road closures around the Rosenberg and Richmond areas. Some of these roads included Highway 90 at Highway 36 and Lane Drive, Lane Drive at Mustang Road, and I-69 at FM 762 and Reading Road. Major record-level flooding of both the Brazos and San Bernard Rivers caused significant home flooding from Richmond to Rosharon. Massive flooding occurred in Tierra Grande subdivision along the San Bernard River in southwestern Fort Bend County. Home flooding occurred at Valley Lodge in Simonton, along Edgewood and Baudet Roads in Richmond, along Bar, Barker, Cumings, Sixth Street, Avenue B, and Rio Brazos Roads in Rosenberg. Sections of FM 2759 as well as the Grand River, Rivers Edge, and Pecan Estates in Thompsons flooded. Many countywide roads became inundated in flood waters, including but not limited to Highway 90A, Pitts Road, FM 1489, FM 723, FM 1093, FM 359, SH 6 feeder</p>



Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
				<p>roads, Sienna Parkway, Carrol Road, McKeever Road, Knights Court, Miller Road, river Oaks Road, Thompsons Ferry Road, Strange Drive, Greenwood Drive, Second Street and low lying roads in Quail Valley in Missouri City.</p> <p>Due to record pool levels in Barker Reservoir, homes in Cinco Ranch flooded. Big Creek flooding in Needville caused the flooding of homes on Ansel Road. Flooding was reported within homes in Missouri City, with water rescues being conducted off of the Westpark Tollway in the Jeanetta Sharpstown area.</p> <p>Roof damage to a home near Westpark Tollway and Grand Parkway resulted in \$30,000 in property damage.</p> <p>An EF-1 tornado resulted in damage to 28 homes in the Woodland West subdivision. Damage path extends from Stafford into Missouri City. \$2 million in property damage was reported.</p> <p>An EF-1 tornado touched down near Trailer World RV and Boat Storage facility, then crossed Interstate 10. It did minor damage to Bucees car wash area, then ripped large air conditioning units off top of Pepperl Fuchs building. Finally, it damaged awnings near Builders First building. Tornado crossed from Fort Bend into Waller County. \$800,000 in property damage occurred.</p> <p>An EF-1 tornado touched down southeast of Juliff and tracked from Brazoria into Fort Bend County. Damage occurred to some roofs. Several trees there were either snapped or downed. The damage path crossed the county line from Brazoria to Fort Bend County. \$500,000 in property damages occurred.</p> <p>An EF-1 tornado tracked across Sienna Plantation subdivision, downing trees and damaging roofs on about 25 homes. Vieux Carre Ct and Steve Ct were hardest hit. \$500,000 in property damages occurred.</p>
July 25 – 31, 2020	Hurricane	EM-3530-TX	Yes	Texas Hurricane Hanna
August 23 – 27, 2020	Tropical Storm	EM-3540-TX	Yes	Texas Tropical Storms Marco and Laura
September 13 – 14, 2021	Hurricane	2021-S5115	Yes	<p>Nicholas formed on September 12 in the Southwestern Gulf of Mexico, slowly advancing northeastward along the Middle Texas Coast. It eventually made landfall 10 miles west of Sargent just after midnight on September 14, with maximum sustained wind speeds of 75 mph. Heavy rain bands associated with Nicholas brought widespread rainfall totals of 6 to 10 inches to the Southeast Texas Coast, while strong wind gusts</p>



Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County included in Declaration?	Description
				resulted in tree and structural damage as well as widespread power outages across the area. Hurricane Nicholas produced several hours of tropical storm-force sustained winds and gusts. There were numerous power outages and minor to moderate damage to some structures and roofs.

Source: FEMA 2022; USDA 2023; NOAA NCEI 2023



### Probability of Future Occurrences

For the 2023 Hazard Mitigation Plan (HMP) update, the most up-to-date data was collected to calculate the probability of future occurrence of flood events for the County. Information from NOAA’s Historical Hurricane Track tool was used to identify the number of hurricane and tropical storm events that came within 60 nautical miles of Fort Bend County between 1950 and 2022. Table 4.3.6-6 presents the probability of future events for the hurricane and tropical storm hazard. Fort Bend County has historically experienced hurricane or tropical storm impacts every other year.

**Table 4.3.6-6. Probability of Future Hurricane and Tropical Storm Events**

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hurricane	12	16.44
Tropical Storm	26	35.62
<b>Total</b>	<b>38</b>	<b>52.05</b>

Sources: NOAA NHC 2023

Note: NOAA’s Historical Hurricane tracker was used to identify hurricanes and tropical storms in Fort Bend County. Because hurricanes and tropical storms are large storm systems, impacts extend well beyond the center of rotation. 60 nautical miles was used to determine the likely edge of impacts of hurricanes and tropical storms that passed by the County but did not have the center of rotation move over the County.

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 floods in the County is considered “occasional”.

### Climate Change Projections

Temperatures are predicted to increase in Fort Bend County. Ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. As oceans warm, the length of hurricane season may extend. Recent hurricane seasons have featured a tropical system occurring before the official start of the season. According to NOAA's database, 40 storms formed in the Atlantic Basin before June 1 from 1851 through 2021, a long-term average of one such early storm every four to five years. The 2010s had the most such storms, and there has been a steady increase since the 1990s. However, the 1950s had six such storms, the 1930s had four, and there was another four pre-season storm streak from 1887 through 1890. It is possible there were other such storms in the era before satellites – before the mid-1960s – that were missed by ship observations or reports from areas impacted. It is still unknown whether expansion of the traditional hurricane season is a long-term trend or a common occurrence (The Weather Channel 2020). It remains to be seen if other factors, such as steering currents, atmospheric shear, and the presence of Saharan dust, will increase or decrease the risk of hurricanes in the County.

### Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The County of Fort Bend is vulnerable to the hurricane and tropical storm hazard. The following text evaluates and estimates the potential impact of the hurricane and tropical storm hazard in the County.



Impact on Life, Health, and Safety

The impact of hurricanes and tropical storms on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time was provided to residents. All residents in Fort Bend County (806,497) are exposed to the hurricane and tropical storm hazard.

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Hazus estimates that 2,168 households in Fort Bend County will be displaced, and 1,547 persons will seek short-term shelter during the 100-year MRP hurricane wind event; in both instances, the greatest number of households and persons will be from the Unincorporated areas of Fort Bend County, followed by Missouri City. It is estimated that during the 500-year MRP hurricane wind event, 12,168 households will be displaced, and 8,542 persons will seek short-term shelter. The greatest number of households and persons will be from the Unincorporated areas of Fort Bend County, followed by the City of Sugarland. Please note that estimates are only based on wind speed and do not account for sheltering needs associated with flooding and storm surge that may accompany hurricane and tropical storm events.

**Table 4.3.6-7. Estimated Population Displaced and Seeking Short-Term Shelter from the 100-Year Mean Return Period Hurricane**

Jurisdiction	100-Year Mean Return Period Hurricane	
	Displaced Households	Persons Seeking Short-Term Sheltering
Arcola (C)	10	8
Beasley (C)	5	4
Fairchilds (V)	15	11
Fulshear (C)	2	1
Houston (C)	102	94
Katy (C)	1	0
Kendleton (C)	4	3
Meadows Place (C)	6	3
Missouri City (C)	239	164
Needville (C)	104	69
Orchard (C)	2	2
Pearland (C)	13	12
Pleak (V)	13	9
Richmond (C)	22	20
Rosenberg (C)	139	110
Simonton (C)	0	0
Stafford (C)	48	31
Sugarland (C)	230	134
Thompsons (T)	3	2
Weston Lakes (C)	2	1
Unincorporated Area	1,209	870
<b>Fort Bend County (Total)</b>	<b>2,168</b>	<b>1,547</b>

Source: Hazus v5.1



**Table 4.3.6-8. Estimated Population Displaced and Seeking Short-Term Shelter from the 500-Year Mean Return Period Hurricane**

Jurisdiction	500-Year Mean Return Period Hurricane	
	Displaced Households	Persons Seeking Short-Term Sheltering
Arcola (C)	37	28
Beasley (C)	38	32
Fairchilds (V)	19	13
Fulshear (C)	132	74
Houston (C)	368	336
Katy (C)	20	13
Kendleton (C)	37	30
Meadows Place (C)	43	23
Missouri City (C)	1,272	855
Needville (C)	129	86
Orchard (C)	20	16
Pearland (C)	40	35
Pleak (V)	35	26
Richmond (C)	298	281
Rosenberg (C)	1,067	878
Simonton (C)	7	4
Stafford (C)	231	154
Sugarland (C)	2,130	1,256
Thompsons (T)	9	6
Weston Lakes (C)	100	50
Unincorporated Area	6,136	4,344
<b>Fort Bend County (Total)</b>	<b>12,168</b>	<b>8,542</b>

Source: Hazus v5.1

*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.

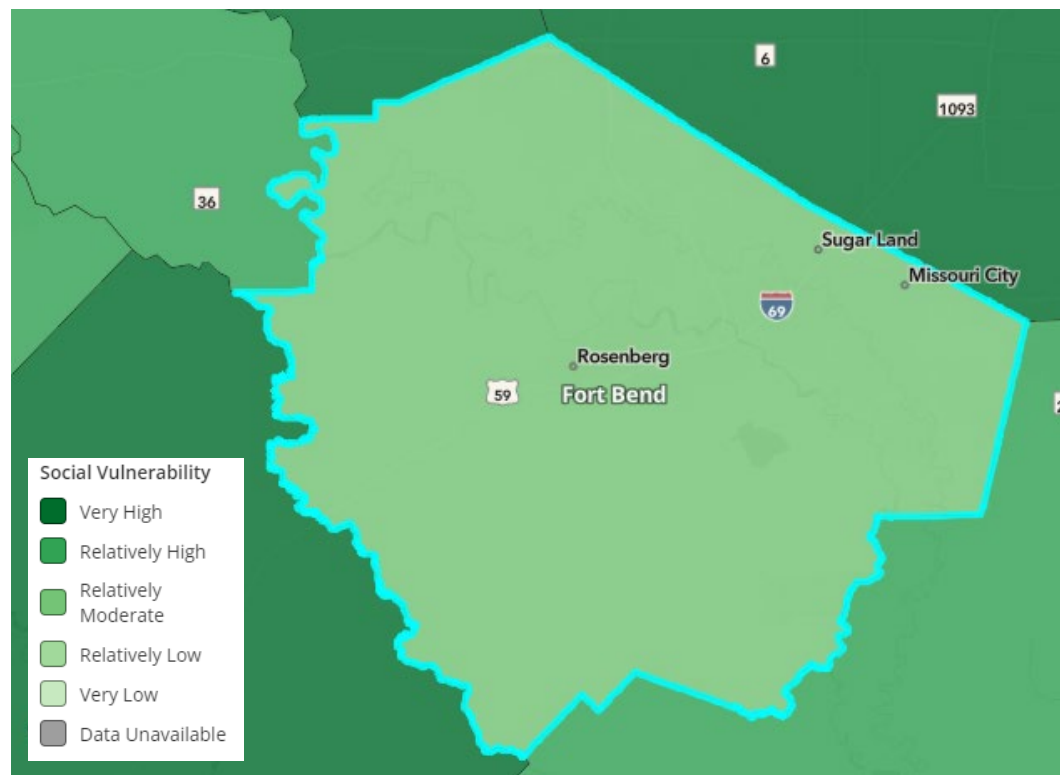
According to FEMA’s National Risk Index, socially vulnerable populations in Fort Bend County have a relatively moderate susceptibility to the adverse impacts of hurricanes, when compared to the rest of the United States (FEMA n.d.).

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors, including their physical and financial ability to react or respond during a hazard. Economically disadvantaged populations are vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also vulnerable and, physically, they may have more difficulty evacuating. Additionally, the elderly are considered vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event. Please refer to Section 3 (County Profile) for the statistics of these populations. Refer to Figure 4.3.6-5 for the social vulnerability index for hurricanes.





Figure 4.3.6-5: FEMA Social Vulnerability Index for Hurricane



Source: FEMA NRI

Impact on General Building Stock

Damage to buildings is dependent upon several factors, including wind speed, hail size, storm duration, and storm path. 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.

Table 4.3.6-9. Expected Damage for 100-Year Mean Return Period Hurricane Event in Fort Bend County

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	100-Year Mean Return Period Hurricane	
			Building Count	Percent of Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	271,123	NONE	173,130	63.9%
		MINOR	73,708	27.2%
		MODERATE	19,066	7.0%
		SEVERE	3,273	1.2%
		DESTRUCTION	1,946	0.7%
Commercial Buildings	7,129	NONE	4,693	65.8%
		MINOR	2,000	28.1%
		MODERATE	406	5.7%
		SEVERE	30	0.4%



Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	100-Year Mean Return Period Hurricane	
			Building Count	Percent of Buildings in Occupancy Class
		DESTRUCTION	0	0.0%
Industrial Buildings	163	NONE	106	64.7%
		MINOR	33	20.1%
		MODERATE	19	12.0%
		SEVERE	5	3.2%
		DESTRUCTION	0	0.0%
Government, Religion, Agricultural, and Education Buildings	2,870	NONE	1,456	50.7%
		MINOR	682	23.8%
		MODERATE	433	15.1%
		SEVERE	243	8.5%
		DESTRUCTION	56	2.0%

Source: Hazus v5.1

**Table 4.3.6-10. Expected Damage for 500-Year Mean Return Period Hurricane Event in Fort Bend County**

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	500-Year Mean Return Period Hurricane	
			Building Count	Percent of Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	271,123	NONE	80,028	29.5%
		MINOR	107,242	39.6%
		MODERATE	56,052	20.7%
		SEVERE	17,618	6.5%
		DESTRUCTION	10,182	3.8%
Commercial Buildings	7,129	NONE	2,179	30.6%
		MINOR	3,274	45.9%
		MODERATE	1,484	20.8%
		SEVERE	186	2.6%
		DESTRUCTION	5	0.1%
Industrial Buildings	163	NONE	56	34.6%
		MINOR	39	23.9%
		MODERATE	42	25.8%
		SEVERE	26	15.7%
		DESTRUCTION	0	0.0%
Government, Religion, Agricultural, and Education Buildings	2,870	NONE	647	22.5%
		MINOR	796	27.7%
		MODERATE	773	26.9%
		SEVERE	542	18.9%
		DESTRUCTION	112	3.9%

Source: Hazus v5.1

### Impact on Critical Facilities

Critical facilities are at risk of being impacted by high winds associated with structural damage or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. For example, vulnerable populations in the Planning Area are at risk if power loss results in interruption of heating and cooling services, stagnated hospital operations, and potable water supplies. Emergency personnel such as police, fire, and EMS will not be able to effectively respond in a power loss event to maintain the safety of its citizens.



Hazus estimates that critical facilities in Fort Bend County have increased probabilities of sustaining minor to moderate damages from the 100-year MRP hurricane wind event; similarly, during the 500-year MRP hurricane wind event, Fort Bend County has increased probabilities of experiencing moderate to severe damages.

**Table 4.3.6-11. Impact of 100-Year Mean Return Period Hurricane Event on Critical Facilities in Fort Bend County**

Facility Type	Loss of Days	100-Year Mean Return Period Hurricane Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Facilities	0-6	4.7% - 15.7%	1.0% - 41.8%	0.0% - 16.2%	0.0% - 1.2%
Police Stations	0	15.2% - 23.4%	5.7% - 30.1%	0.6% - 32.8%	0.0% - <0.1%
Fire Stations	0	3.3% - 14.8%	0.5% - 28%	<0.1% - 19.1%	0.0% - 1.5%
Schools	0-53	4.6% - 12.3%	2.6% - 46.7%	<0.1% - 26.9%	0.0% - 0.63%
EOC	0	16.8% - 20.8%	7.0% - 12.7%	0.75% - 2.2%	0.0%

Source: Hazus v5.1

**Table 4.3.6-12. Impact of 500-Year Mean Return Period Hurricane Event on Critical Facilities in Fort Bend County**

Facility Type	Loss of Days	500-Year Mean Return Period Hurricane Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Facilities	0-14	7.5% - 15.6%	21.0% - 42.2%	1.3% - 26.1%	<0.1% - 2.9%
Police Stations	0	14.7% - 23.5%	20.5% - 31.5%	7.3% - 38.8%	0.0% - <0.2%
Fire Stations	0	10.7% - 14.9%	13.3% - 30.2%	2.7% - 23.9%	0.04% - 2.3%
Schools	0-78	3.4% - 11.3%	31.5% - 47.9%	2.5% - 35.3%	0.0% - 1.3%
EOC	0	19.5% - 23.4%	23.1% - 30.6%	9.5% - 25.9%	0.0%

Source: Hazus v5.1

At this time, Hazus does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. Furthermore, evacuation routes are vulnerable to hurricane wind events.

**Impact on Economy**

Damage to structures from wind can be the most immediate result of hurricane and tropical storm events; however, this damage can have long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings.

**Table 4.3.6-13. Estimated Losses from the 100-Year and 500-Year Hurricane Events in Fort Bend County**

Mean Return Period (MRP)	Income Loss	Relocation Loss	Building Losses	Wages Losses	Rental Losses
100-Year	\$22,345,770	\$687,352,290	\$3,613,767,790	\$44,712,830	\$271,295,250
500-Year	\$45,910,040	\$2,674,113,840	\$12,626,493,300	\$87,903,200	\$1,013,279,800

Source: Hazus v5.1

Hazus estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the “Impact on General Building Stock” section discussed earlier.



Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

Building losses for the 100-year and 500-year hurricane events are categorized by structure type in Table 4.3.6-14 and Table 4.3.6-15. For the 100-year hurricane event, residential structures account for an estimated 66.46 percent of the total estimated building losses, commercial structures account for an estimated 27.39 percent, and all other occupancy structures are 6.15 percent of the total estimated building losses. For the 500-year hurricane event, residential structures account for an estimated 68.58 percent of the total estimated building losses, commercial structures account for an estimated 24.77 percent, and all other occupancy structures are 6.65 percent of the total estimated building losses.

**Table 4.3.6-14. Estimated Building Losses from the 100-Year Hurricane Event in Fort Bend County**

Jurisdiction	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane for Residential Structures Only	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane for Commercial Structures Only	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane for All Other Occupancies Structures Only
Arcola (C)	\$16,873,085	\$14,159,190	\$2,510,381	\$203,513
Beasley (C)	\$18,869,635	\$5,061,144	\$3,877,356	\$9,931,135
Fairchilds (V)	\$10,654,227	\$6,939,494	\$2,925,218	\$789,515
Fulshear (C)	\$29,245,741	\$24,510,066	\$4,452,452	\$283,223
Houston (C)	\$103,540,847	\$71,811,571	\$27,119,674	\$4,609,603
Katy (C)	\$6,958,886	\$5,671,061	\$1,261,680	\$26,145
Kendleton (C)	\$5,745,393	\$3,005,911	\$1,524,858	\$1,214,624
Meadows Place (C)	\$9,577,581	\$5,686,236	\$3,789,498	\$101,848
Missouri City (C)	\$402,194,047	\$285,511,668	\$109,160,806	\$7,521,572
Needville (C)	\$70,495,330	\$35,895,005	\$28,994,398	\$5,605,926
Orchard (C)	\$3,143,376	\$1,644,572	\$834,269	\$664,536
Pearland (C)	\$43,022,355	\$32,771,167	\$8,522,744	\$1,728,444
Pleak (V)	\$19,815,264	\$10,054,308	\$5,717,300	\$4,043,656
Richmond (C)	\$32,064,822	\$16,090,981	\$13,281,558	\$2,692,283
Rosenberg (C)	\$269,949,438	\$135,316,765	\$104,287,358	\$30,345,315
Simonton (C)	\$1,470,744	\$1,232,673	\$223,757	\$14,314
Stafford (C)	\$88,456,616	\$19,923,475	\$63,477,220	\$5,055,921
Sugarland (C)	\$455,114,155	\$295,811,460	\$148,766,848	\$10,535,848
Thompsons (T)	\$5,362,787	\$3,715,152	\$1,458,967	\$188,668
Weston Lakes (C)	\$9,900,512	\$8,419,447	\$1,280,292	\$200,773
Unincorporated Area	\$2,011,312,951	\$1,418,732,066	\$456,001,104	\$136,579,781
<b>Fort Bend County (Total)</b>	<b>\$3,613,767,790</b>	<b>\$2,401,963,413</b>	<b>\$989,467,736</b>	<b>\$222,336,641</b>

Source: Hazus v5.1



**Table 4.3.6-15. Estimated Building Losses from the 500-Year Hurricane Event in Fort Bend County**

Jurisdiction	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane for Residential Structures Only	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane for Commercial Structures Only	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane for All Other Occupancies Structures Only
Arcola (C)	\$38,111,410	\$32,189,632	\$5,424,743	\$497,036
Beasley (C)	\$71,949,106	\$18,427,027	\$13,917,424	\$39,604,655
Fairchilds (V)	\$12,494,022	\$8,145,014	\$3,443,703	\$905,305
Fulshear (C)	\$370,378,301	\$312,714,349	\$53,313,015	\$4,350,937
Houston (C)	\$231,125,969	\$159,513,051	\$58,338,518	\$13,274,400
Katy (C)	\$68,061,699	\$55,081,733	\$12,464,140	\$515,825
Kendleton (C)	\$23,453,115	\$12,041,283	\$6,156,380	\$5,255,453
Meadows Place (C)	\$31,963,900	\$19,476,238	\$11,992,850	\$494,811
Missouri City (C)	\$1,100,284,897	\$791,278,922	\$283,450,259	\$25,555,716
Needville (C)	\$81,059,222	\$41,236,900	\$33,464,769	\$6,357,553
Orchard (C)	\$12,831,492	\$6,587,936	\$3,368,232	\$2,875,324
Pearland (C)	\$83,803,524	\$64,528,310	\$15,701,051	\$3,574,163
Pleak (V)	\$47,878,436	\$21,356,313	\$12,056,946	\$14,465,176
Richmond (C)	\$190,950,919	\$93,824,329	\$69,930,423	\$27,196,168
Rosenberg (C)	\$928,117,050	\$418,776,577	\$383,986,546	\$125,353,927
Simonton (C)	\$18,618,819	\$15,721,816	\$2,677,621	\$219,381
Stafford (C)	\$262,176,152	\$63,118,478	\$177,855,834	\$21,201,841
Sugarland (C)	\$1,821,366,191	\$1,221,069,967	\$539,838,347	\$60,457,877
Thompsons (T)	\$11,417,672	\$7,932,744	\$3,083,081	\$401,847
Weston Lakes (C)	\$114,716,515	\$99,447,793	\$12,942,331	\$2,326,391
Unincorporated Area	\$7,105,734,888	\$5,197,203,063	\$1,423,418,608	\$485,113,217
<b>Fort Bend County (Total)</b>	<b>\$12,626,493,299</b>	<b>\$8,659,671,473</b>	<b>\$3,126,824,823</b>	<b>\$839,997,003</b>

Source: Hazus v5.1

Debris management can be costly and may also impact the local economy. Hazus estimates the amount of building and tree debris that may be produced as result of the 100- and 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the Hazus Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates.

Hazus estimates the 100-year and 500-year hurricane events in Fort Bend County would generate a combined total of 673,661 tons and 2,077,726 tons of debris, respectively.



**Table 4.3.6-16. Estimated Debris Created During the 100-Year Mean Return Period Hurricane Wind Event in Fort Bend County**

Jurisdiction	Estimated Debris Created During the 100-Year Mean Return Period Hurricane Wind Event			
	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Arcola (C)	2,848	16	118	276
Beasley (C)	1,615	8	0	0
Fairchilds (V)	1,688	27	532	260
Fulshear (C)	5,298	0	1,048	951
Houston (C)	18,577	38	169	333
Katy (C)	1,282	0	74	65
Kendleton (C)	908	7	0	0
Meadows Place (C)	1,949	0	53	473
Missouri City (C)	74,104	183	1,989	9,876
Needville (C)	10,865	108	3,405	1,883
Orchard (C)	497	4	0	0
Pearland (C)	7,171	21	588	967
Pleak (V)	2,679	16	440	271
Richmond (C)	6,133	6	542	1,840
Rosenberg (C)	44,578	128	3,742	5,099
Simonton (C)	266	0	53	48
Stafford (C)	18,760	9	19	142
Sugarland (C)	88,301	171	3,050	14,216
Thompsons (T)	869	4	131	96
Weston Lakes (C)	1,784	0	31,431	583
Unincorporated Area	333,249	1,486	621	38,382
<b>Fort Bend County (Total)</b>	<b>623,422</b>	<b>2,233</b>	<b>48,006</b>	<b>75,761</b>

Source: Hazus v5.1

**Table 4.3.6-17. Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event in Fort Bend County**

Jurisdiction	Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event			
	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Arcola (C)	6,174	46	157	368
Beasley (C)	5,407	70	0	0
Fairchilds (V)	1,973	34	532	260
Fulshear (C)	61,036	353	3,144	2,854
Houston (C)	38,034	159	174	355
Katy (C)	11,679	49	222	195
Kendleton (C)	3,564	83	0	0
Meadows Place (C)	5,750	23	80	710
Missouri City (C)	183,775	881	2,458	12,557
Needville (C)	12,411	134	3,405	1,883
Orchard (C)	1,950	45	0	0
Pearland (C)	13,220	64	588	967
Pleak (V)	5,476	52	440	271
Richmond (C)	28,897	143	1,099	3,577
Rosenberg (C)	135,160	731	3,999	6,264
Simonton (C)	3,068	18	159	144
Stafford (C)	46,506	59	29	212
Sugarland (C)	304,425	1,244	4,391	21,092
Thompsons (T)	1,780	12	133	99
Weston Lakes (C)	18,512	126	39,574	1,750





Jurisdiction	Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event			
	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Unincorporated Area	1,114,786	7,370	1,862	58,468
<b>Fort Bend County (Total)</b>	<b>2,003,584</b>	<b>11,696</b>	<b>62,446</b>	<b>112,026</b>

Source: Hazus v5.1

### Impact on Environment

Wind from hurricanes and tropical storms can knock over power lines sparking fires, which can destroy forests and habitats. Winds can also carry debris and litter across areas, which can negatively impact ecosystems and habitats, including water bodies.

Flooding from hurricane and tropical storms impact the natural and local environment. The surrounding environment may not be able to withstand and recover from flash flood events. Flash floods can destroy wildlife habitats, pollute rivers and streams, carry sediment and silt that can impact water quality, destroy crops and farms, uproot trees, and cause erosion of streambanks and other areas, (eSchoolToday 2021). Riverine flooding not only influences the habitat of natural land areas, but it can also be disruptive to species that reside in the natural habitats.

### 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

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. New development that has occurred in the last five years within the County, and potential future development in the next five years as identified by the County and each municipality, is included in the jurisdictional annexes in Section 9, along with an indication of proximity to known hazard zones. Refer to Section 3 and Volume II, Section 9 for more information about the potential new development in Fort Bend County.

Any areas of growth could be potentially impacted by the hurricane and tropical storm hazard because the entire Planning Area is exposed and vulnerable; however, due to increased standards and codes, new development can be less vulnerable to the hazard compared with the aging building stock in the Planning Area.

### Projected Changes in Population

According to the 2021 United States Census Bureau population estimates, the population of the County has increased by approximately 40.4 percent since 2010. The County’s population is anticipated to increase over the next decade, continuing with the population growth trend which has been occurring since 1970. Increased population trends will change the County’s overall risk to hurricane and tropical storm events. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.



### *Climate Change*

As noted previously, the entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Temperatures are predicted to increase in Fort Bend County and ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. As oceans warm, the length of hurricane season may extend. Overall, the County will continue to remain vulnerable to the hurricane and tropical storm hazard.

### *Change in Vulnerability Since 2018 HMP*

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Fort Bend County continues to be vulnerable to hurricanes and tropical storms. Building losses were based on annualized losses instead of the 100 and 500-year mean return period events analyzed in this HMP update. Overall, the vulnerability assessment presented in this update uses Hazus v5.1 and a more accurate and updated building inventory. This provides more accurate estimated exposure and potential losses for the County.