SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.4 Flood

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the flood hazard in Fort Bend County.

Hazard Profile

Hazard Description

Flooding occurs when water overflows onto land that is normally dry. Flooding can happen during heavy rains, rapid snow melt, or when dams or levees break (NOAA National Severe Storms Laboratory 2023). Floods are one of the most frequent and costly natural disasters in the United States and the State of Texas.

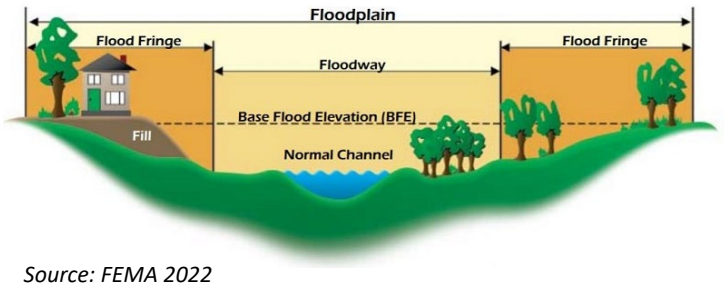
The flood-related hazards most likely to impact Fort Bend County are riverine (inland) flooding, flash flooding, stormwater/urban flooding due to insufficient drainage during heavy rain events, and flooding as a result of a dam or levee break. Dam and levee failure are discussed in Section 4.3.1 (Dam and Levee Failure).

Riverine Flooding

Riverine flooding, or fluvial flooding, is when streams and rivers exceed the capacity of their natural or constructed channels to accommodate water flow and water overflows the banks, spilling out into adjacent low-lying, dry land. This occurs when the flow of a river exceeds the bank sides and causes damage or obstruction to a nearby floodplain. Riverine flooding can turn into a flash flood if the river is at or above its flood stage and if the soil is saturated (FEMA 2019).

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. In Fort Bend County, floodplains line the rivers, streams, and lakes of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques.

Figure 4.3.4-1. Floodplain

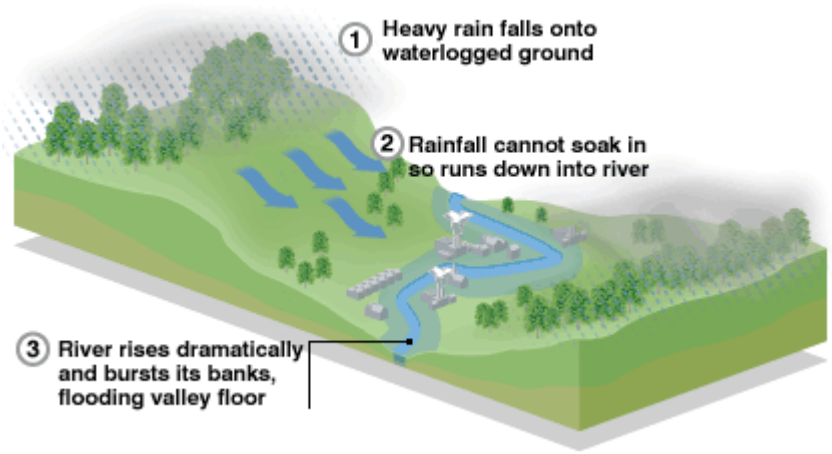


Source: FEMA 2022

Flash Flooding

A flash flood is a rapid inundation of low-lying areas caused by heavy rain associated with severe thunderstorms, tropical systems, or melting water from ice or snow. Flash flooding also occurs far away from water bodies when a large volume of water cannot be absorbed by the soil or storm water systems and travels overland unimpeded (NWS 2019).

Figure 4.3.4-2. How Flash Floods Occur



Source: BBC News 2005

Urban/Stormwater Flooding

Local (urban) drainage systems collect groundwater from heavy rainfall in developed areas. Water that does not evaporate or become absorbed by the ground is carried by conduits to waterways such as creeks, rivers, or the ocean. These systems have two purposes: (1) to control storm water runoff during periods of heavy rainfall; and (2) to minimize disruption of activity from more frequently occurring, less significant storms. Flooding occurs when runoff exceeds system capacity, or because systems are blocked from lack of maintenance. Flooding which results from poorly designed or blocked drainage systems is categorized as urban/stormwater flooding (NOAA 2022).

Dam and Levee Failure

The Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam have the potential to impact over 246,000 Fort Bend County residents and damage over 104,000 buildings. There are 1,265 community lifelines located in the dam inundation areas of all three dams. For details on the risk to dam and levee failure in Fort Bend County, refer to Section 4.3.1 (Dam and Levee Failure).

Location

Texas has the most flash flood deaths of any state in the country. Since 1960, over 600 people have been killed by floods in the State of Texas, with 65 percent of those deaths in vehicles (Fort Bend Homeland Security and Emergency Management 2022). The terrain in the Gulf Coast Prairie area of Texas, in which Fort Bend County is mostly located (a sliver of the western County is in the Flood Plains), is punctuated soils formed in alluvial and marine sediments of (primarily) Quaternary age that were deposited under fluctuating sea-level conditions. The soils are a mix of well-developed, clayey soils with high shrink-swell properties and soils with loamy surface textures and a loamy and clayey subsoil (USDA, NRCS 2008). Shrink-swell soils, also known as expansive soils, can cause significant pressure of homes, foundations, roads, and other infrastructure during heavy rain periods and flooding conditions (Cahoon 2011). For more information on expansive soils, refer to Section 4.3.5 (Geologic Hazards).

Other factors contributing to floods in the area include its location to the Gulf of Mexico. As weather systems stall and dissipate over Texas, they drop intense rains over small areas. In the past, Fort Bend has had significant floods along the Brazos River; however, these floods have been reduced by quality flood mitigation and control

efforts, including levees and drainage basins. This has also helped to reduce the impacts of seasonal floods in the County.

In Fort Bend County, floodplains line the rivers and streams of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques.

See Figure 4.3.4-3 below, which visualizes the FEMA-designated flood hazard areas for Fort Bend County. To view the flood hazard area for individual jurisdictions, refer to Section 9, Jurisdictional Annexes.

Riverine Flooding

Fort Bend County lies completely within the Brazos River basin. The Brazos River runs west to southeast in this area along the northeast boundary, through the center of the County, and exits on the east boundary. Some local waterbodies include Bessies Creek as well as multiple lakes: Fulshear, Triangle, Smithers, Worthington, and Frost. There are additional, non-named bodies of water along the border with Harris County, where residential areas have been constructed (Texas Water Development Board n.d.).

Runoff in Fort Bend County is captured to fill several lakes and reservoirs in the County. The Fort Bend County Levee Improvement Districts (1-19) operate and maintain several levees, drainage ditches, and pump stations throughout the County (Fort Bend County 2022).

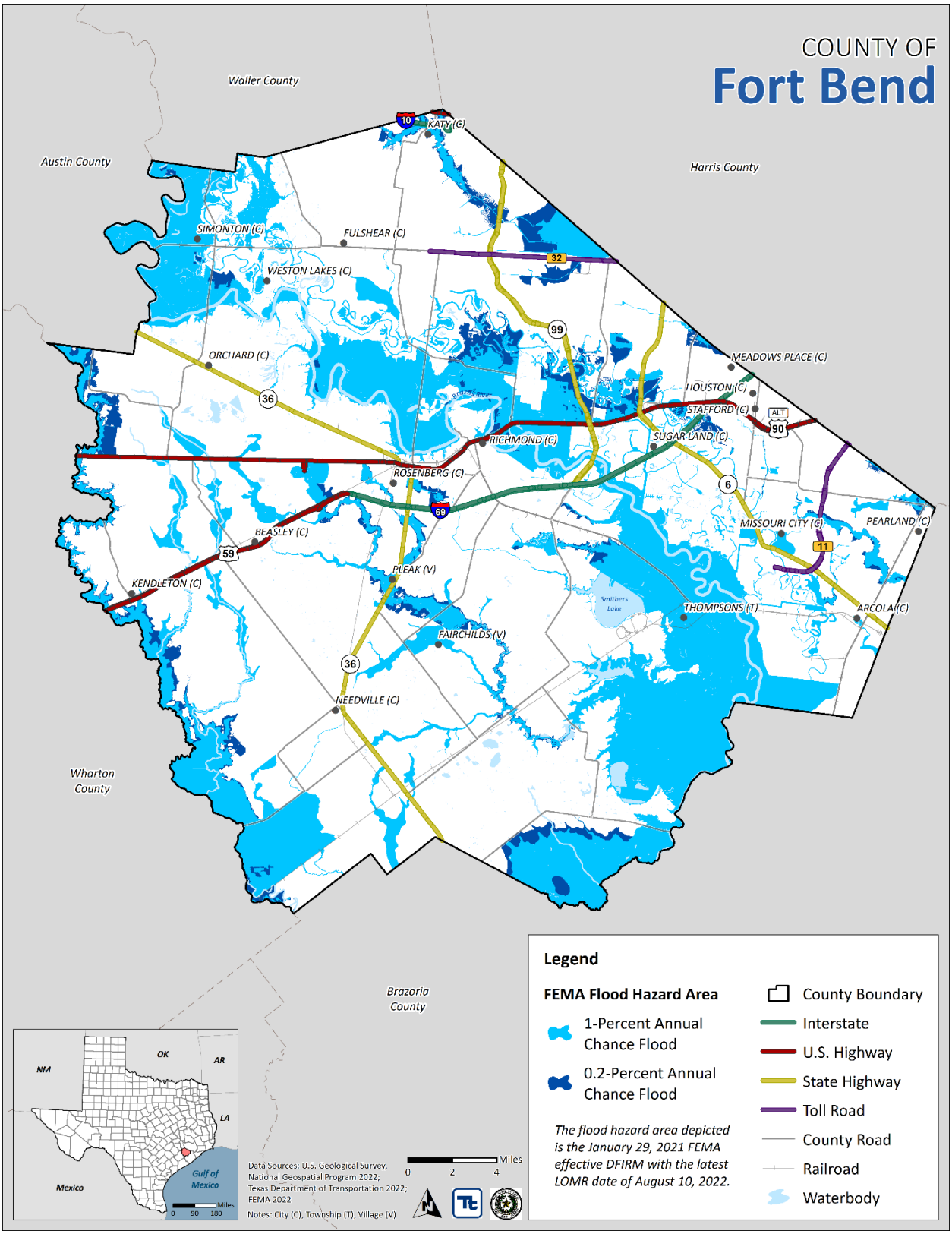
Flash Flooding

Flash flooding poses a deadly danger to residents of the Brazos River Basin. Several roads run through low-lying areas that are prone to sudden and frequent flooding during heavy rains. Motorists often attempt to drive through barricaded or flooded roadways; just 6 inches of slowly moving water is enough to float and carry most cars, even SUVs. Floating cars easily get swept downstream, making rescues difficult and dangerous (Fort Bend Homeland Security and Emergency Management 2022).

Urban/Stormwater Flooding

Urbanization increases runoff two to six times over what would occur on natural terrain. During periods of urban flooding, streets can become swift-moving rivers (NWS 2014). This type of flooding occurs throughout Fort Bend County, particularly in areas where land has been converted from fields or woodlands to roads and parking lots. This causes the ground to lose its ability to absorb rainfall.

Figure 4.3.4-3. Location of the Flood Hazard Area in Fort Bend County



Extent

The strength or magnitude of a flood varies based on meteorological, environmental, and geological factors, including latitude, altitude, topography, and atmospheric conditions. Flood is also affected by seasonal variation, storm characteristics, warning time, speed of onset, and duration. Most floods are preceded by a warning period that allows emergency managers to communicate the need to prepare for the event. A flood may last from minutes to days (O'Connor, Grant and Costa 2002).

Figure 4.3.4-4. NWS Flood Advisories

Source: National Weather Service 2023

Warnings issued through official sources, such as the National Weather Service (NWS) and the Storm Prediction Center, provide the most reliable and timely preparedness information, but the exact flood location and depth depends on the amount, duration, and location of rainfall. Many floods, especially flash floods, occur outside of FEMA-designated flood zones.

Figure 4.3.4-5. NWS Flash Flood Advisories

Source: National Weather Service 2023

In the case of riverine flood hazard, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - Minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding - Some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NOAA 2021).

The severity of a flood depends not only on the amount of water that accumulates in a period of time but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2001).

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1 percent chance

of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1 percent annual probability of occurrence (the base flood or 100-year flood) is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance, as well as the regulatory flood boundary by many agencies. Also referred to as the Special Flood Hazard Area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the water elevation resulting from a given discharge level, which is one of the most important factors used in estimating flood damage. A structure located within an SFHA shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

The term "500-year flood" is the flood that has a 0.2 percent chance of being equaled or exceeded each year. The 500-year flood could occur more than once in a relatively short period of time. Statistically, the 0.2 percent (500-year) flood has a 6 percent chance of occurring during a 30-year period of time, the length of many mortgages. The 500-year floodplain is referred to as Zone X500 for insurance purposes on Flood Insurance Rate Maps (FIRM). Base flood elevations or depths are not shown within this zone, and insurance purchase is not required in this zone (FEMA 2022).

To estimate population exposure to the 1 percent- and 0.2 percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 17,793 residents living in the 1 percent annual chance floodplain and an estimated 49,450 residents living in the 0.2 percent annual chance floodplain. The Unincorporated Areas of Fort Bend County has the greatest number of residents living in the 1 percent annual chance flood event hazard area with approximately 10,435 residents, followed by the City of Houston (1,620). The Unincorporated Areas of Fort Bend County also has the greatest number of residents living in the 0.2 percent annual chance flood event with approximately 31,576 residents, followed by The City of Rosenburg (3,302). Table 4.3.4-1 summarizes the population exposed to the flood hazard by jurisdiction.

Table 4.3.4-1. Estimated Persons in Fort Bend County Living in the 1 Percent and 0.2 Percent Annual Chance Flood Event Hazard Areas

Jurisdiction	Estimated Population Located in the Flood Hazard Areas	
	Persons Located in the 1 Percent Annual Chance Flood Event Hazard Area	Persons Located in the 0.2 Percent Annual Chance Flood Event Hazard Area
Arcola (C)	125	125
Beasley (C)	0	0
Fairchilds (V)	181	209
Fulshear (C)	0	0
Houston (C)	1,620	2,420
Katy (C)	244	2,949
Kendleton (C)	7	20
Meadows Place (C)	0	79
Missouri City (C)	627	945
Needville (C)	0	0
Orchard (C)	0	0
Pearland (C)	57	1,303
Pleak (V)	232	455

Jurisdiction	Estimated Population Located in the Flood Hazard Areas	
	Persons Located in the 1 Percent Annual Chance Flood Event Hazard Area	Persons Located in the 0.2 Percent Annual Chance Flood Event Hazard Area
Richmond (C)	1,490	1,724
Rosenberg (C)	1,279	3,302
Simonton (C)	711	711
Stafford (C)	0	0
Sugarland (C)	101	2,948
Thompsons (T)	223	223
Weston Lakes (C)	462	462
Unincorporated Area	10,435	31,576
Fort Bend County (Total)	**17,793**	**49,450**

Source: U.S. Census Bureau 2021; STATS America; FEMA 2022

Table 4.3.4-2 summarizes the number of structures located in the 1 percent and 0.2 percent annual chance flood events by jurisdiction. In summary, there are 8,241 buildings located in the 1 percent annual chance flood boundary with an estimated $17.8 billion of replacement cost value (i.e., building and content replacement costs). In addition, there are 21,033 buildings located in the 0.2 percent annual chance flood boundary with an estimated $25.8 billion of building stock and contents exposed.

Table 4.3.4-2. Estimated General Building Stock Located in the 1 Percent and 0.2 Percent Annual Chance Flood Event

Jurisdiction	Estimated Building Stock Located in the Flood Hazard Area			
	Number of Buildings Located in the 1 Percent Annual Chance Flood Event Hazard Area	Total Replacement Cost Value of Buildings	Number of Buildings Located in the 0.2 Percent Annual Chance Flood Event Hazard Area	Total Replacement Cost Value of Buildings
Arcola (C)	28	$6,848,591	28	$6,848,591
Beasley (C)	0	$0	0	$0
Fairchilds (V)	46	$12,377,306	54	$14,867,714
Fulshear (C)	0	$0	0	$0
Houston (C)	452	$232,720,019	738	$1,075,713,672
Katy (C)	57	$484,627,324	336	$1,026,315,015
Kendleton (C)	8	$3,151,602	19	$5,576,265
Meadows Place (C)	0	$0	28	$11,235,359
Missouri City (C)	278	$1,292,817,133	392	$1,334,766,510
Needville (C)	0	$0	0	$0
Orchard (C)	0	$0	0	$0
Pearland (C)	2	$2,881,232	24	$13,777,412
Pleak (V)	65	$114,074,323	118	$209,781,091
Richmond (C)	413	$486,151,762	488	$601,868,913
Rosenberg (C)	450	$8,167,637,250	1,027	$8,390,874,747
Simonton (C)	323	$203,181,632	323	$203,181,632
Stafford (C)	0	$0	0	$0
Sugarland (C)	53	$254,975,690	998	$949,440,223
Thompsons (T)	113	$187,849,175	113	$187,849,175
Weston Lakes (C)	195	$130,112,101	195	$130,112,101
Unincorporated Area	5,758	$6,229,188,001	16,152	$11,659,322,197
Fort Bend County (Total)	**8,241**	**$17,808,593,141**	**21,033**	**$25,821,530,616**

Source: FEMA 2022; Fort Bend County 2016, 2022; RS Means 2022

Flood Gages

The USGS uses stream gages to determine the severity of flood at different points along a body of water. There are 15 gages Fort Bend County. These gages are used to determine the height of rivers during heavy rain events and to determine evacuation procedures, if needed.

Table 4.3.4-3. Stream Gage Statistics for Fort Bend County

Gage Site Number	Site Name	Action Stage (feet)	Minor Flood Stage (feet)	Moderate Flood Stage (feet)	Major Flood Stage (feet)	Record Flood
08072300	Buffalo Bayou near Katy	N/A	N/A	N/A	N/A	N/A
08072350	Buffalo Bayou nr Fulshear, TX	N/A	N/A	N/A	N/A	N/A
08072400	Buffalo Bayou nr Clodine, TX	N/A	N/A	N/A	N/A	N/A
08114000	Brazos Rv at Richmond, TX	20	45	48	60	55.19 on 9/1/2017
08114100	Brazos Rv nr Sugar Land, TX	40	65.5	68.5	70.5	65.5 on 6/6/2021
08114500	Brazos Rv nr Juliff, TX	N/A	N/A	N/A	N/A	N/A
08114900	Seabourne Ck nr Rosenberg, TX	N/A	N/A	N/A	N/A	N/A
08115000	Big Ck nr Needville, TX	16	19	21	23	N/A
08115500	Fairchild Ck nr Needville, TX	N/A	N/A	N/A	N/A	N/A
08116000	Big Ck nr Guy, TX	16	19	21	23	N/A
08116400	Dry Ck nr Rosenberg, TX	N/A	N/A	N/A	N/A	N/A
08116500	Dry Ck nr Richmond, TX	N/A	N/A	N/A	N/A	N/A
08116650	Brazos Rv nr Rosharon, TX	40	43	47	51.3	52.65 on 8/29/2017
08117500	San Bernard Rv nr Boling, TX	14	18	22	32	43.79 on 8/31/2017
08117800	Mound Ck Trib at Guy, TX	N/A	N/A	N/A	N/A	N/A

Source: USGS 2023
N/A Not available

Water Level Data

A hydrograph shows how a water level changes over time at a specific location to enable a review of historic water levels which are useful in floodplain management planning. The gages in the Planning Area provide the probabilistic and deterministic forecast for specific bodies of water. These forecast hydrographs are useful to reference when flooding is expected or to determine the observed water level for the past few days. The hydrographs for the gages provide water levels for the action, minor flooding, moderate flooding, and major flooding stages. They also display the flood of record (or the highest recorded water level) for the specific gage. These stages are defined as follows:

- Action Stage - the stage which; when reached by a rising stream, lake, or reservoir represents the level where the NWS or a partner/user needs to take some type of mitigation action in preparation for possible significant hydrologic activity.
- Minor Flooding - minimal or no property damage, but possibly some public threat.
- Moderate Flooding - some inundation of structures and roads near stream. Some evacuations of people and/or transfer of property to higher elevations.

- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.
- Record Flooding - flooding which equals or exceeds the highest stage or discharge at a given site during the period of record keeping.
- Stage - level of the water surface in a river measured with reference to some datum.
- Flow - volume of water passing a given point per unit of time.
- kcfs - measurement of water flow equivalent to 1000 cubic feet of water passing a given point for an entire second (NWS 2020).

Worst-Case Scenario

An intense, short-duration storm could move slowly across the County, creating significant flash floods with little or no warning. Injuries or fatalities may result if residents are caught off guard by the flood event. Stormwater systems could be overwhelmed, and significant flooding could impact a substantial portion of structures within the planning area. Transportation routes could be cut off due to floodwaters, isolating portions of the County. These impacts may last after the floodwater recedes, as flash floods in the area have been known to cause extensive damage to roadway infrastructure. Areas that have recently experienced wildfires would contribute to the extent of flooding impacts. The major issues for flooding are the following:

- Flash flooding that occurs with little or no warning will continue to impact the planning area.
- The duration and intensity of storms contributing to flooding issues may increase due to climate change.
- Flooding may be exacerbated by other hazards, such as wildfires.
- Damages resulting from flood may impact tourism, which may have significant impacts on the local economy.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.

Jurisdictions along the Brazos River and its tributaries are most at risk to a worst-case scenario. Refer to Figure 4.3.4-3 which displays the 1- and 0.2-percent annual chance flood hazard areas. Refer to Table 4.3.4-8 to view the estimated population at risk to the 1- and 0.2-percent annual chance flood hazard areas, separated by jurisdiction.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, the State of Texas was included in 40 disaster (DR) or emergency (EM) declarations for flood-related events (FEMA 2021). 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. Fort Bend County was included in five disaster (DR) or emergency (EM) declarations for flood-related events (FEMA 2021). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.4-4. FEMA Disaster Declarations for Flood in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
December 20, 1991 – January 14, 1992	December 21, 1991	DR-930-TX	Severe Storm, Thunderstorms

Date(s) of Event	Declaration Date	FEMA Declaration Number	Description
October 14, 1994 – November 8, 1994	October 18, 1994	DR-1041-TX	Severe Storm, Thunderstorms, Flooding
October 17, 1998 – November 15, 1998	October 21, 1998	DR-1257-TX	Severe Storms, Flooding and Tornadoes
April 17, 2016 – April 30, 2016	April 25, 2016	DR-4269-TX	Severe Storms and Flooding
May 22, 2016 – June 24, 2016	June 11, 2016	DR-4272-TX	Severe Storms 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 2017 and 2022, Fort Bend County was included in one flood-related agricultural disaster declaration (USDA FSA 2022).

Table 4.3.4-5. FEMA Disaster Declarations for Flood in Fort Bend County (1954–2022)

Date(s) of Event	Declaration Date	USDA Declaration Number	Description
September 3, 2018 – January 28, 2019	March 11, 2019	S4476	Flood – Flash Flooding and Excessive Rain

Source: USDA FSA 2022

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known flood events that impacted the County between 2017 and 2022 are discussed below. For events prior to 2017, refer to the 2018 Fort Bend County HMP.

Table 4.3.4-6. Flood 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 18, 2017	Flash Flood	N/A	N/A	Showers and thunderstorms produced 4–6 inches of rainfall totals along and near the U.S. 59 corridor from the Kendleton area to Sugar Land to the Houston area. Several roads were flooded and impassable in and around the U.S. 59 corridor, including the Highway 90A and the Newton Drive areas in and around Richmond. $500,000.00 in property damages were incurred.
January 20, 2017	Flash Flood	N/A	N/A	Slow-moving showers and thunderstorms produced hail and flash flooding in the afternoon through early evening hours. There were several road closures in and around the Rosenberg area. No damages to property or crops were recorded.
April 18, 2017	Flash Flood	N/A	N/A	Strong storms produced high rainfall rates that lead to isolated flash flooding. The intersection of U.S. Highway 59 and FM 762 was flooded. $554,000.00 in property damages were incurred.
August 26–29, 2017	Flash Flood, Hurricane Harvey	DR-4332-TX	Yes	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 and 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 led to catastrophic flooding. Thousands of homes, businesses, and roads were flooded due to flash flooding and sheet flow from long-duration, intense rain. Main stem rivers and adjoining tributaries, creeks, and bayous reached full capacity and came out of their banks, and this also contributed to the massive flooding across southeastern Texas. There was water over roadways FM 655 and CR 521 near the town of Rosharon. Sections of FM 762 were flooded around SH 69 south of Richmond. FM 1093 closed east of FM 723 due to flooding. 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. Sections of FM 1463 and FM 359 between Fulshear and the Grand Parkway were closed due to flooding. Flooding was reported in or within homes in Missouri City, with water rescues being conducted off the Westpark Tollway in the Jeanetta Sharpstown area. 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. $41.124 billion in property damages and $340,000.00 in crop damages were incurred.
June 19, 2018	Flash Flood	N/A	N/A	Flash flooding led to a road closure near the intersection of Highway 59 and the 540 Loop in Beasley. No damages to property or crops were recorded.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Fort Bend County Included in Declaration?	Description
September 3, 2018 – January 28, 2019	Flood – Flash Flooding and Excessive Rain	S4476	Yes	Excessive moisture and flooding. Declared for Fort Bend County on March 11, 2019.
May 7, 2019	Flash Flood	N/A	N/A	Slow-moving thunderstorms produced several inches of rain near Kingwood and over Fort Bend County. There was street flooding and road closures in the town of Richmond. There were flooded cars at Highway 59 and Williams Trace Blvd. All major roadways were impassable due to flooding in Sugar Land. $245,000.00 in property damages were incurred.
September 19, 2019	Remnants of Tropical Storm Imelda	N/A	N/A	Tropical Storm Imelda brought heavy rains across southeast Texas, with rainfall totals exceeding 40 inches in some areas. In Fort Bend County, street flooding was reported in Stafford and Sugar Land. Approximately $565.4 million in property damage was reported in the County.
May 15, 2020	Flash Flood	N/A	N/A	Slow-moving thunderstorms in Fort Bend County led to roadway flooding with reports of knee to waist-high water in the First Colony area. Most of the flooding reports were located between First Colony and Oyster Creek Park or near the Dulles Road and Cartwright intersection. $100,000.00 in property damages were incurred from this storm.
June 25, 2020	Flash Flood	N/A	N/A	A slow-moving line of showers and thunderstorms produced heavy rain across the Houston metropolitan area. This led to instances of flash flooding to the Southwest of the City of Houston over a period of several hours. There were multiple flooded roads from just south of Katy to Simonton and Fulshear, including FM 1489 and FM 1093. $10,010.00 in property damages were incurred.
May 1, 2021	Flash Flood	N/A	N/A	A series of thunderstorms resulted in flash flooding in Brazoria and Fort Bend counties. Feeder roads and the FM 1093 exit along State Highway 99 were closed due to flooding. $5,000.00 in property damages were incurred.
October 1, 2021	Flash Flood	N/A	N/A	A cluster of showers and thunderstorms developed over southeast Texas during the morning of October 1, producing periods of heavy rain across the area. Heavy downpours resulted in several instances of street flooding, making roads impassable. Heavy rainfall resulted in the US 90 underpass at Thompson Rd becoming impassable due to floodwaters. No damages to property or crops were recorded.

Sources: NOAA 2022; USDA FSA 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 flood events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, and the previous Fort Bend County HMP was used to identify the number of flood events that occurred between 1950 and 2022. Table 4.3.4-7 presents the probability of future flood events in Fort Bend County.

Table 4.3.4-7. Probability of Future Flood Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Flash Flood	48	65.75%
Flood	2	2.77%
Total	**50**	**68.49%**

Sources: NOAA NCEI 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 flood 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 Fort Bend County, seasonal flooding on the Brazos River, its tributaries, and the surrounding lakes, creeks, and bayous have increased over time due to increased rainfall events and weather patterns. Flash floods are still considered to be highly likely to occur, with nearly a 65.75 percent chance of occurrence in any given year. This probability is based on the 48 events over 72 years reported in the National Climatic Data Center Storm Events Database and other historical records (local knowledge and news sources).

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 "frequent".

Climate Change Projections

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 flood (Centers for Climate and Energy Solutions n.d.).

High-frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 1 percent annual chance flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, floodways, bypass channels, and levees, as well as the design of local sewers and storm drains.

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. To quantitatively assess Fort Bend County's risk to the flood hazard, a spatial analysis was conducted using the January 20, 2021 FEMA effective Digital Flood Insurance Rate Map (DFIRM), with the latest Letter of Map Revision (LOMR) date of August 10, 2022. The 1 and 0.2 percent annual chance flood events were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA Hazus riverine flood model. These results are summarized below.

Impact on Life, Health, and Safety

The impact of flooding on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

To estimate population exposure to the 1 percent- and 0.2 percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 17,793 residents living in the 1 percent annual chance floodplain, or 2.2 percent of the County's total population. There are an estimated 49,450 residents living in the 0.2 percent annual chance floodplain, or 6.1 percent of the County's total population. The Unincorporated Areas of Fort Bend County has the greatest number of residents living in the 1 percent annual chance flood event hazard area with approximately 10,435 residents, followed by the City of Houston (1,620). The Unincorporated Areas of Fort Bend County also has the greatest number of residents living in the 0.2 percent annual chance flood event with approximately 31,576 residents, followed by The City of Rosenburg (3,302). Table 4.3.4-8 summarizes the population exposed to the flood hazard by jurisdiction.

Table 4.3.4-8. Estimated Number of Persons in Fort Bend County Living in the 1 Percent and 0.2 Percent Annual Chance Flood Event Hazard Areas

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in the Flood Hazard Areas			
		Number of Persons Located in the 1 Percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2 Percent Annual Chance Flood Event Hazard Area	Percent of Total
Arcola (C)	2,593	125	4.8%	125	4.8%
Beasley (C)	957	0	0.0%	0	0.0%
Fairchilds (V)	755	181	23.9%	209	27.7%
Fulshear (C)	17,259	0	0.0%	0	0.0%
Houston (C)	41,279	1,620	3.9%	2,420	5.9%
Katy (C)	21,926	244	1.1%	2,949	13.4%
Kendleton (C)	341	7	2.0%	20	5.8%
Meadows Place (C)	4,755	0	0.0%	79	1.7%
Missouri City (C)	73,682	627	0.9%	945	1.3%
Needville (C)	3,059	0	0.0%	0	0.0%
Orchard (C)	219	0	0.0%	0	0.0%
Pearland (C)	122,609	57	0.0%	1,303	1.1%
Pleak (V)	1,756	232	13.2%	455	25.9%
Richmond (C)	11,768	1,490	12.7%	1,724	14.6%
Rosenberg (C)	37,871	1,279	3.4%	3,302	8.7%
Simonton (C)	838	711	84.9%	711	84.9%
Stafford (C)	17,170	0	0.0%	0	0.0%
Sugarland (C)	110,272	101	0.1%	2,948	2.7%
Thompsons (T)	265	223	84.0%	223	84.0%
Weston Lakes (C)	3,763	462	12.3%	462	12.3%
Unincorporated Area	333,360	10,435	3.1%	31,576	9.5%
Fort Bend County (Total)	**806,497**	**17,793**	**2.2%**	**49,450**	**6.1%**

Source: U.S. Census Bureau 2021; STATS America; FEMA 2022

Flooding events can displace populations along steep topography, particularly in cases when flood waters surge into residential properties or alter the terrain into unsafe conditions requiring evacuation. Displaced populations were estimated for the 1 percent annual chance flood event. It is important to note that the impacts to the households in the FEMA flood hazard area are assessed using the riverine flood model in Hazus. Using 2021 American Community Survey data, Hazus estimates 21,765 people may be displaced by flooding with 1,657 people potentially seeking short-term sheltering. These statistics, by jurisdiction, are presented in Table 4.3.4-9.

Table 4.3.4-9. Estimated Population Seeking Short-Term Shelter from the 1 Percent Annual Chance Flood Event

Jurisdiction	Total Population	1 Percent Annual Chance Flood Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Arcola (C)	2,593	82	12
Beasley (C)	957	0	0
Fairchilds (V)	755	241	8
Fulshear (C)	17,259	0	0
Houston (C)	41,279	1,826	130
Katy (C)	21,926	244	32
Kendleton (C)	341	16	1
Meadows Place (C)	4,755	0	0
Missouri City (C)	73,682	721	81
Needville (C)	3,059	0	0

Jurisdiction	Total Population	1 Percent Annual Chance Flood Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Orchard (C)	219	0	0
Pearland (C)	122,609	0	0
Pleak (V)	1,756	399	14
Richmond (C)	11,768	557	24
Rosenberg (C)	37,871	1,928	132
Simonton (C)	838	687	19
Stafford (C)	17,170	0	0
Sugarland (C)	110,272	632	112
Thompsons (T)	265	165	4
Weston Lakes (C)	3,763	314	57
Unincorporated Area	333,360	13,954	1,031
Fort Bend County (Total)	**806,497**	**21,765**	**1,657**

Source: U.S. Census Bureau 2021; STATS America; Fort Bend County Drainage District 2023, Hazus v5.1

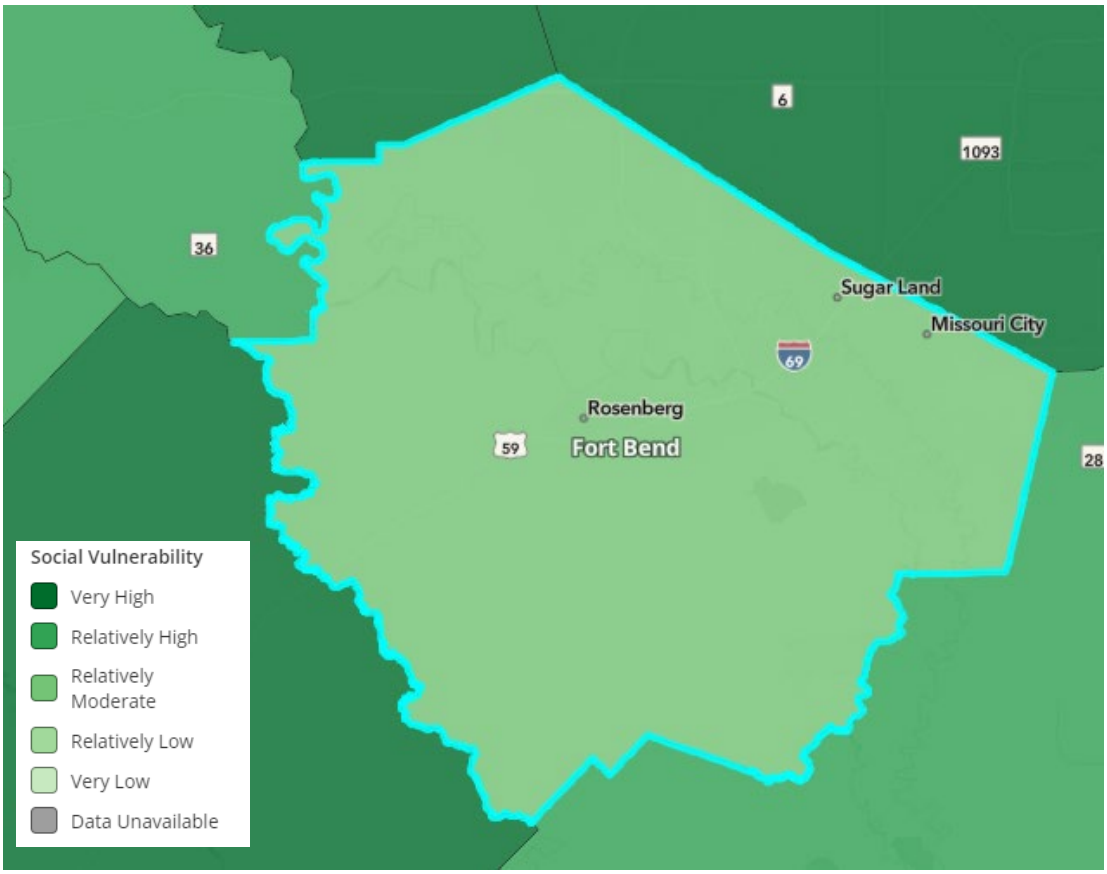
Socially Vulnerable Populations

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 riverine flooding, when compared to the rest of the United States (FEMA n.d.).

Vulnerable populations are all populations residing or located in the floodplain that are incapable of escaping the area within the required timeframe to reach safety. However, exposure should not be limited only to those who reside within a defined hazard zone but everyone who may be affected by a hazard event (e.g., people are considered at risk if they are traveling in flooded areas or their access to emergency services is compromised during an event). Flash floods can be localized events that affect areas outside of the floodplain due to localized drainage issues and can directly impact populations and comprise access to emergency services. The degree of that impact varies and is not strictly measurable. Refer to Figure 4.3.4-6 for the social vulnerability index for riverine flooding.

Figure 4.3.4-6. FEMA Social Vulnerability Index for Riverine Flooding



Source: FEMA NRI

Impact on General Building Stock

After considering the population exposed and potentially vulnerable to the flood hazard, the built environment was evaluated. Exposure includes those buildings located in the flood hazard areas. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content replacement cost values.

Table 4.3.4-10 summarizes the number of structures located in the 1 percent and 0.2 percent annual chance flood events by jurisdiction. In summary, there are 8,241 buildings located in the 1 percent annual chance flood boundary with an estimated $17.8 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 2.9 percent of the County's total general building stock inventory. In addition, there are 21,033 buildings located in the 0.2 percent annual chance flood boundary with an estimated $25.8 billion of building stock and contents exposed. This represents approximately 7.5 percent of the County's total general building stock inventory.

Table 4.3.4-10. Estimated General Building Stock Located in the 1 Percent and 0.2 Percent Annual Chance Flood Event

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located in the Flood Hazard Area							
			Number of Buildings Located in the 1 Percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total	Number of Buildings Located in the 0.2 Percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	28	4.1%	$6,848,591	0.5%	28	4.1%	$6,848,591	0.5%
Beasley (C)	367	$467,087,536	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Fairchilds (V)	190	$58,400,161	46	24.2%	$12,377,306	21.2%	54	28.4%	$14,867,714	25.5%
Fulshear (C)	7,869	$6,124,915,172	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Houston (C)	11,589	$5,814,576,859	452	3.9%	$232,720,019	4.0%	738	6.4%	$1,075,713,672	18.5%
Katy (C)	2,206	$4,980,024,025	57	2.6%	$484,627,324	9.7%	336	15.2%	$1,026,315,015	20.6%
Kendleton (C)	329	$241,970,568	8	2.4%	$3,151,602	1.3%	19	5.8%	$5,576,265	2.3%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%	28	1.7%	$11,235,359	0.9%
Missouri City (C)	27,170	$23,213,328,025	278	1.0%	$1,292,817,133	5.6%	392	1.4%	$1,334,766,510	5.8%
Needville (C)	1,346	$1,362,324,702	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Orchard (C)	180	$170,795,761	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Pearland (C)	2,171	$1,063,851,539	2	0.1%	$2,881,232	0.3%	24	1.1%	$13,777,412	1.3%
Pleak (V)	436	$672,927,271	65	14.9%	$114,074,323	17.0%	118	27.1%	$209,781,091	31.2%
Richmond (C)	3,296	$4,128,822,403	413	12.5%	$486,151,762	11.8%	488	14.8%	$601,868,913	14.6%
Rosenberg (C)	11,894	$22,921,973,230	450	3.8%	$8,167,637,250	35.6%	1,027	8.6%	$8,390,874,747	36.6%
Simonton (C)	395	$372,092,732	323	81.8%	$203,181,632	54.6%	323	81.8%	$203,181,632	54.6%
Stafford (C)	4,222	$10,638,345,589	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Sugarland (C)	37,506	$36,732,455,899	53	0.1%	$254,975,690	0.7%	998	2.7%	$949,440,223	2.6%
Thompsons (T)	143	$404,590,514	113	79.0%	$187,849,175	46.4%	113	79.0%	$187,849,175	46.4%
Weston Lakes (C)	1,589	$1,145,826,270	195	12.3%	$130,112,101	11.4%	195	12.3%	$130,112,101	11.4%
Unincorporated Area	166,035	$103,633,654,804	5,758	3.5%	$6,229,188,001	6.0%	16,152	9.7%	$11,659,322,197	11.3%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**8,241**	**2.9%**	**$17,808,593,141**	**7.9%**	**21,033**	**7.5%**	**$25,821,530,616**	**11.4%**

Source: FEMA 2022; Fort Bend County 2016, 2022; RS Means 2022

The Hazus flood model estimated potential damages to the buildings in Fort Bend County at the structure level using the custom structure inventory developed for this HMP and the depth grid generated using the effective DFIRM data. The potential damage estimated by Hazus to the general building stock inventory associated with the 1 percent annual chance flood is approximately $1.5 billion. The Unincorporated Area of the County has the greatest amount of estimated building loss—approximately $950 million. Refer to Table 4.3.4-11 for the estimated losses by jurisdiction.

Table 4.3.4-11. Estimated General Building Stock Potential Loss to the 1 Percent Annual Chance Flood Event

Jurisdiction	Total Replacement Cost Value (RCV)	Estimated Loss for All Occupancies	Percent of Total	Estimated Loss for Residential Properties	Estimated Loss for Commercial Properties	Estimated Loss for All Other Occupancies
Arcola (C)	$1,374,107,673	$1,070,987	0.1%	$1,070,987	$0	$0
Beasley (C)	$467,087,536	$0	0.0%	$0	$0	$0
Fairchilds (V)	$58,400,161	$3,744,959	6.4%	$3,699,306	$0	$45,653
Fulshear (C)	$6,124,915,172	$0	0.0%	$0	$0	$0
Houston (C)	$5,814,576,859	$26,571,929	0.5%	$14,287,959	$12,283,970	$0
Katy (C)	$4,980,024,025	$87,481,760	1.8%	$1,636,998	$85,526,620	$318,142
Kendleton (C)	$241,970,568	$351,484	0.1%	$331,710	$0	$19,774
Meadows Place (C)	$1,270,821,734	$0	0.0%	$0	$0	$0
Missouri City (C)	$23,213,328,025	$54,145,888	0.2%	$12,351,146	$28,023,854	$13,770,889
Needville (C)	$1,362,324,702	$0	0.0%	$0	$0	$0
Orchard (C)	$170,795,761	$0	0.0%	$0	$0	$0
Pearland (C)	$1,063,851,539	$137,121	0.0%	$137,121	$0	$0
Pleak (V)	$672,927,271	$17,374,315	2.6%	$5,475,752	$10,531,941	$1,366,621
Richmond (C)	$4,128,822,403	$66,533,619	1.6%	$15,620,594	$47,366,386	$3,546,639
Rosenberg (C)	$22,921,973,230	$109,752,058	0.5%	$14,745,008	$92,768,213	$2,238,838
Simonton (C)	$372,092,732	$67,123,498	18.0%	$39,906,502	$22,391,480	$4,825,515
Stafford (C)	$10,638,345,589	$0	0.0%	$0	$0	$0
Sugarland (C)	$36,732,455,899	$63,024,577	0.2%	$5,756,286	$56,968,320	$299,971
Thompsons (T)	$404,590,514	$67,813,091	16.8%	$7,888,960	$57,310,194	$2,613,937
Weston Lakes (C)	$1,145,826,270	$8,109,050	0.7%	$7,552,840	$556,210	$0
Unincorporated Area	$103,633,654,804	$952,308,691	0.9%	$302,783,447	$567,442,720	$82,082,525
Fort Bend County (Total)	**$226,792,892,467**	**$1,525,543,027**	**0.7%**	**$433,244,616**	**$981,169,908**	**$111,128,504**

Source: FEMA 2022; Fort Bend County 2016, 2022; RS Means 2022

NFIP Statistics

Participating in the NFIP is voluntary and to join, a community must complete an application; adopt a resolution of intent to participate and cooperate with FEMA; and adopt and submit a floodplain management ordinance that meets or exceeds the minimum NFIP criteria, and the ordinance must also adopt any FIRM or FHBM for the community. By participating, communities agree to adopt and implement local floodplain management regulations that protect lives and reduce risk from future flooding. In return, the federal government makes flood insurance available to property owners throughout the community (FEMA 2020) (FEMA 2022). Table 4.3.4-12 summarizes the NFIP community statistics for Fort Bend County. All jurisdictions participate in the NFIP.

Table 4.3.4-12. NFIP Community Statistics for Llano and San Saba Counties

Community Name	Community Identification Number	Participates in the NFIP?
Arcola (C)	481619	Yes
Beasley (C)	481654C	Yes
Fairchilds (V)	481675C	Yes
Fulshear (C)	481488C	Yes
Houston (C)	480296A	Yes
Katy (C)	480301	Yes
Kendleton (C)	481551C	Yes
Meadows Place (C)	481563	Yes
Missouri City (C)	480304G	Yes
Needville (C)	480820C	Yes
Orchard (C)	481655	Yes
Pearland (C)	480077G	Yes
Pleak (V)	481615C	Yes
Richmond (C)	480231	Yes
Rosenberg (C)	480232C	Yes
Simonton (C)	481564C	Yes
Stafford (C)	480233G	Yes
Sugar Land (C)	480234	Yes
Thompsons (C)	481642C	Yes
Weston Lakes (C)	481197C	Yes

Source: FEMA 2023

Limited NFIP data was available for the County of Fort Bend. Table 4.3.4-13 summarizes the NFIP policies for Fort Bend County. According to available data, as of 2022, there were 24,961 policies in the County. Over 2,000 claims have been submitted, with over $226 million in paid claims.

Table 4.3.4-13. Policies per Flood Zone

Municipality	Policies in Force[a]	Number of Paid Claims[a]	Amount of Paid Claims[a]	Number of NFIP RL Properties[b]	Number of NFIP SRL Properties[b]
Arcola (C)	47	14	$626,007.05	0	0
Beasley (C)	9	0	None Documented	0	0
Fairchilds (V)	42	19	$536,771.43	0	0
Fulshear (C)	1,316	39	$1,306,218.55	4	N/A
Katy (C)	313	58	$7,229,784.44	N/A	N/A

Municipality	Policies in Force[a]	Number of Paid Claims[a]	Amount of Paid Claims[a]	Number of NFIP RL Properties[b]	Number of NFIP SRL Properties[b]
Kendleton (C)	12	4	$61,312.99	0	0
Meadows Place (C)	354	54	$280,204.52	1	N/A
Missouri City (C)	3,449	823	$10,260,560.59	37	N/A
Needville (C)	145	39	$1,535,039.29	2	N/A
Orchard (C)	8	6	$213,258.75	0	0
Pearland (C)	421	3	None Documented	N/A	N/A
Pleak (V)	94	48	$2,870,389.62	0	0
Richmond (C)	338	226	$4,391,812.52	13	0
Rosenberg (C)	946	114	$1,558,635.13	11	N/A
Simonton (C)	170	595	$49,505,014.02	32	N/A
Stafford (C)	511	91	$1,188,509.92	9	N/A
Sugar Land (C)	3,440	296	$3,008,495.48	20***	0***
Thompsons (C)	17	22	$932,569.16	0	0
Weston Lakes (C)	684	52	$7,426,026.12	0	0
TOTAL* **	**24,961**	**2,682**	**$174,918,997.57**	**270**	**29**

Sources:

a BureauNet 2022 (https://nfipservices.floodsmart.gov/reports-flood-insurance-data)

b 2018 Fort Bend County HMP

Notes: Due to a contractual agreement with FEMA, detailed information at the municipal level was not available to incorporate into the 2023 HMP Update. The information presented here was collected from data provided by the State of Texas and from FEMA's HUDEX Report.

**Number of RL and SRL properties provided by the State of Texas*

***Total policies in force and paid claims collected from FEMA's OpenFEMA Dataset: FIMA NFIP Redacted Claims*

****Countywide statistics provided by TDEM on October 7, 2022*

RL Repetitive Loss

SRL Severe Repetitive Loss

Table 4.3.4-14 summarizes the NFIP policies and claims in Fort Bend County by occupancy class. Overall, the majority of policies and claims are related to single family homes, followed by non-residential properties. As of October 2022, Fort Bend County has 24,961 policies, 2,682 paid losses, and over $174 million in paid claims.

Table 4.3.4-14. NFIP Statistics, by Occupancy Class, for Fort Bend County

Property Type	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses
Single Family	24,667	$12,803,667	$8,259,915,400	2,539	$165,125,972.67
2-4 Family	14	$7,710	$3,181,000	10	$554,724.53
All Other Residential	39	$19,093	$17,531,400	14	$2,310,707.86
Non-Residential	241	$455,227	$106,624,000	119	$6,927,592.51
Fort Bend County (Total)	**24,961**	**$13,285,697**	**$8,387,251,800**	**2,682**	**$174,918,997.57**

Source: TDEM 2022

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure that may be at risk to flooding and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to reach vulnerable populations or to make repairs.

Critical facility exposure to the flood hazard was examined. Table 4.3.4-15 and Table 4.3.4-16 list the number of critical facilities and lifelines within the 1 Percent and 0.2 Percent annual chance flood event hazard areas. A majority of the critical facilities located in the 1 Percent and 0.2 Percent annual chance flood event boundaries are the Unincorporated Areas of Fort Bend County and the City of Sugarland.

Table 4.3.4-17 displays the number of facilities in each lifeline category located in the 1 percent and 0.2 percent annual chance flood event hazard area. Of the 684 critical facilities located in the 1 percent annual chance flood event boundary, the greatest number are transportation facilities (368). Additionally, there are 789 critical facilities located in the 0.2 percent annual chance flood event boundary, 379 of which are transportation facilities.

Table 4.3.4-15. Critical Facilities and Lifeline Facilities Located in the 1 Percent Annual Chance Flood Event Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 1 Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	3	13.6%	3	14.3%
Beasley (C)	18	14	0	0.0%	0	0.0%
Fairchilds (V)	3	3	2	66.7%	2	66.7%
Fulshear (C)	43	40	1	2.3%	1	2.5%
Houston (C)	105	84	6	5.7%	6	7.1%
Katy (C)	53	51	16	30.2%	16	31.4%
Kendleton (C)	21	19	6	28.6%	6	31.6%
Meadows Place (C)	17	16	0	0.0%	0	0.0%
Missouri City (C)	339	297	25	7.4%	24	8.1%
Needville (C)	42	33	1	2.4%	1	3.0%
Orchard (C)	7	7	0	0.0%	1	14.3%
Pearland (C)	1	1	1	100.0%	0	0.0%
Pleak (V)	15	15	7	46.7%	7	46.7%
Richmond (C)	123	103	21	17.1%	21	20.4%
Rosenberg (C)	340	295	53	15.6%	52	17.6%
Simonton (C)	17	17	10	58.8%	10	58.8%
Stafford (C)	164	137	3	1.8%	3	2.2%
Sugarland (C)	631	575	100	15.8%	100	17.4%
Thompsons (T)	10	9	10	100.0%	9	100.0%
Weston Lakes (C)	7	7	2	28.6%	2	28.6%
Unincorporated Fort Bend County	1,756	1,654	432	24.6%	420	25.4%
Fort Bend County (Total)	**3,734**	**3,398**	**699**	**18.7%**	**684**	**20.1%**

Source: FEMA 2022; Fort Bend County 2022

Table 4.3.4-16. Critical Facilities and Lifeline Facilities Located in the 0.2 Percent Annual Chance Flood Event Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 0.2 Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	3	13.6%	3	14.3%
Beasley (C)	18	14	0	0.0%	0	0.0%
Fairchilds (V)	3	3	2	66.7%	2	66.7%
Fulshear (C)	43	40	1	2.3%	1	2.5%
Houston (C)	105	84	26	24.8%	17	20.2%
Katy (C)	53	51	23	43.4%	22	43.1%
Kendleton (C)	21	19	6	28.6%	6	31.6%
Meadows Place (C)	17	16	1	5.9%	1	6.3%
Missouri City (C)	339	297	25	7.4%	24	8.1%
Needville (C)	42	33	1	2.4%	1	3.0%
Orchard (C)	7	7	0	0.0%	0	0.0%
Pearland (C)	1	1	1	100.0%	1	100.0%
Pleak (V)	15	15	9	60.0%	9	60.0%
Richmond (C)	123	103	21	17.1%	21	20.4%
Rosenberg (C)	340	295	57	16.8%	55	18.6%
Simonton (C)	17	17	10	58.8%	10	58.8%
Stafford (C)	164	137	3	1.8%	3	2.2%
Sugarland (C)	631	575	128	20.3%	126	21.9%
Thompsons (T)	10	9	10	100.0%	9	100.0%
Weston Lakes (C)	7	7	2	28.6%	2	28.6%
Unincorporated Fort Bend County	1,756	1,654	491	28.0%	476	28.8%
Fort Bend County (Total)	**3,734**	**3,398**	**820**	**22.0%**	**789**	**23.2%**

Source: FEMA 2022; Fort Bend County 2022

Table 4.3.4-17. Lifeline Categories Located in the 1 Percent and 0.2 Percent Annual Chance Event Floodplain

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the 1 Percent Annual Chance Flood Event Hazard Area	Number of Lifelines Located in the 0.2 Percent Annual Chance Flood Event Hazard Area
Communications	44	7	7
Energy	584	22	30
Food, Water, Shelter	1,480	250	324
Hazardous Materials	13	3	3
Health and Medical	335	5	9
Safety and Security	282	29	37
Transportation	660	368	379
Fort Bend County (Total)	3,398	684	789

Source: FEMA 2022; Fort Bend County 2022

In cases where short-term functionality is impacted by flooding, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce flood impacts to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

Impact on Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, business interruption, impacts on tourism, and impacts on the tax base to Fort Bend County. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the Impact on General Building Stock subsection, which discusses direct impacts to buildings in Fort Bend County.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. Other economic components, such as loss of facility use, functional downtime, and socio-economic factors, are less measurable with a high degree of certainty. As a result of the 1 percent annual chance event, Hazus estimates approximately $105,250 in inventory losses, over $1.6 billion in relocation costs, over $1.2 billion in wage losses, $787,000 in rental losses, and over $769 million in income losses (see Table 4.3.4-18).

Table 4.3.4-18. Estimated Economic Impacts from the 1 Percent Annual Chance Flood Event

Flood Hazard	Inventory Loss	Relocation Loss	Wage Loss	Rental Loss	Income Loss
1 Percent Annual Chance Flood Event	$105,250,000	$1,616,890,000	$1,201,940,000	$787,000,000	$769,410,000

Source: Hazus v5.1

Debris management may also be a large expense after a flood event. Hazus estimates the amount of debris generated from the 1 Percent annual chance event. The model breaks down debris into three categories: (1) finishes (drywall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 4.3.4-19 summarizes the debris Hazus estimates for these events. As a result of the 1 percent annual chance event, Hazus estimates approximately 130,683 tons of debris will be generated in total.

Table 4.3.4-19. Estimated Debris Generated from the 1 Percent Annual Chance Flood Event

Jurisdiction	1 Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Arcola (C)	66	34	17	15
Beasley (C)	0	0	0	0
Fairchilds (V)	1,111	427	206	478
Fulshear (C)	0	0	0	0
Houston (C)	4,146	1,252	1,492	1,402
Katy (C)	1,020	302	450	268
Kendleton (C)	82	64	6	13
Meadows Place (C)	0	0	0	0
Missouri City (C)	8,169	3,711	2,647	1,811
Needville (C)	0	0	0	0
Orchard (C)	0	0	0	0
Pearland (C)	68	13	23	32
Pleak (V)	2,401	1,683	256	462
Richmond (C)	3,278	1,695	806	777
Rosenberg (C)	5,790	3,604	1,134	1,053
Simonton (C)	4,017	3,898	55	64
Stafford (C)	0	0	0	0

Jurisdiction	1 Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Sugarland (C)	8,167	3,057	2,855	2,255
Thompsons (T)	488	297	85	106
Weston Lakes (C)	1,237	949	120	168
Unincorporated Area	90,642	40,495	27,258	22,889
Fort Bend County (Total)	**130,683**	**61,482**	**37,409**	**31,792**

Source: Fort Bend County 2016, 2022; Fort Bend County Drainage District 2023; RS Means 2022; Hazus v5.1

Impact on Environment

Flood events will inevitably impact Fort Bend County's natural and local environment. Severe flooding not only influences the habitat of these natural land areas, but it can also be disruptive to species that reside in these natural habitats. 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).

Table 4.3.4-20 lists the number of acres exposed to the 1 and 0.2 percent annual chance flood extents.

Table 4.3.4-20. Land Acreage in Fort Bend County Located in 1 Percent and 0.2 Percent Flood Extents

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Flood Hazard Areas			
		Total Acres Located in the 1 Percent Annual Chance Flood Event	Percent of Total	Total Acres Located in the 0.2 Percent Annual Chance Flood Event	Percent of Total
Arcola (C)	1,664	129	7.8%	129	7.8%
Beasley (C)	673	0	0.0%	0	0.0%
Fairchilds (V)	831	189	22.7%	211	25.4%
Fulshear (C)	7,962	163	2.1%	163	2.1%
Houston (C)	7,440	2,396	32.2%	2,763	37.1%
Katy (C)	2,843	433	15.2%	758	26.6%
Kendleton (C)	850	92	10.8%	113	13.3%
Meadows Place (C)	586	<.01	<0.1%	14	2.4%
Missouri City (C)	20,841	3,265	15.7%	3,373	16.2%
Needville (C)	1,264	5	0.4%	5	0.4%
Orchard (C)	250	0	0.0%	0	0.0%
Pearland (C)	839	25	2.9%	35	4.2%
Pleak (V)	1,193	344	28.9%	496	41.5%
Richmond (C)	2,752	652	23.7%	689	25.0%
Rosenberg (C)	23,442	4,244	18.1%	4,939	21.1%
Simonton (C)	1,487	1,024	68.9%	1,024	68.9%
Stafford (C)	4,467	14	0.3%	15	0.3%
Sugarland (C)	27,073	5,829	21.5%	7,240	26.7%
Thompsons (T)	995	852	85.6%	852	85.6%
Weston Lakes (C)	1,623	432	26.6%	432	26.6%
Unincorporated Area	449,862	128,615	28.6%	143,546	31.9%
Fort Bend County (Total)	**558,937**	**148,704**	**26.6%**	**166,798**	**29.8%**

Source: FEMA 2022; Fort Bend County 2022

Cascading Impacts on Other Hazards

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building

occupants, especially those with already compromised immune systems, such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Mold spores can grow in as short a period as 24–48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2020).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Floods of any type have the potential to impact water and power utilities, which may impact public and private use, as well as cause disruption to critical infrastructure. Refer to the list below to view flooding's harmful effects on the water supply:

- **Water Supply Contamination:** Excess floodwater can contaminate private drinking water sources, such as wells and springs. Floodwater picks up debris, increasing the number of bacteria, sewage, and other industrial waste and chemicals into the water source or leaky pipes. Excess water also makes it more difficult for water treatment plants to treat the water efficiently and effectively. If there is contamination at any step of the water flow process, this puts consumers at risk of exposure to dangerous toxins that could result in serious harm, such as wound infections, skin rashes, gastrointestinal illnesses, and tetanus; in extreme cases, death may occur.
- **Disruption to Clean Drinking and Cooking Water:** In the event of only having access to contaminated water, consumers are unable to cook or clean in their home the water is certified as safe. Depending on the severity of the flood and the storm, this could take days, weeks, months, and in some cases, even years. Without access to clean drinking and cooking water, consumers ultimately become reliant on bottled water. In impoverished communities, this reality is even more detrimental because those affected may not have the economic means to "stock up" on bottled water. Moreover, in a flood, retail locations are often inaccessible and/or low on water supply (Andrew 2021).

Floodwaters can also cause damage to power utilities. In particular, flooded buildings may have the utilities disrupted if the service panel, generator, meter, etc. are not elevated above the flood protection level. Oversaturated soils from periods of heavy rain and flooding may cause utility poles to tip over or fall completely, interrupting the power grid for a potentially large area, especially if the transformer is impacted.

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.

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 that has been occurring since 1970. Increased population trends will change the County's overall risk to flood events. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Climate Change

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 flood (Centers for Climate and Energy Solutions n.d.).

High-frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

Change in Vulnerability Since 2018 HMP

The County of Fort Bend continues to be vulnerable to floods. Since the 2018 HMP was drafted, updated inventory data has become available to assess additional flood hazard areas in Fort Bend County. This data includes the 2021 United States Census Bureau population estimates, updated 2022 tax assessor parcel data, 2022 general building stock data provided by the County, 2022 RS Means for building stock replacement cost valuation, and updated critical facility data provided by the County's Planning Partners. Hazus v5.1 was also used to assess the losses in the County to the overall risk from 100-year flood risk. Overall, this vulnerability

assessment uses a more accurate and updated asset inventory which provides more accurate estimated exposure to the flood hazard.