SECTION 4. RISK ASSESSMENT

4.3 Hazard Profiles

4.3.1 Dam/Levee Failure

This section presents information regarding the description, extent, location, previous occurrences and losses, climate change projections, and probability of future occurrences for the dam/levee failure hazard in Fort Bend County.

Hazard Profile

Hazard Description

Dam Failure

A dam failure is defined as systematic failure of dam structure resulting in the uncontrolled release of water, often resulting in floods that could exceed the 100-year flood plain boundaries. A dam failure could cause mass fatalities and extensive structural damage if populated and/or industrial areas are located near or downstream of the dam structure.

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

Dam failure is a collapse or breach in a dam. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage amounts can cause significant downstream flooding. Dam failures in the United States typically occur from any one or combination of the following:

- Overtopping of the primary dam structure can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure.
- Failure due to piping and seepage are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves are typically caused by the piping of embankment material into conduits through joints or cracks.

Many dam failures in the United States have been secondary results from other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies (FEMA 2019).

Levee Failure

A levee is a physical barrier constructed to protect areas from rising floodwaters. Levees typically remove valuable floodplain storage and block the ability of the channel to move water. There are also concerns with rainfall that falls on the levee itself. Most important is the possibility for catastrophic and sudden failure under extreme flood events, potentially resulting in loss of life and total destruction of property (National Geographic 2022).

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. Earthen levees can be damaged in several ways. Strong river currents and waves can erode the surface. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure (FEMA 2016).

The complicated nature of levee protection was made evident by events such as Hurricane Katrina. Flooding can be exacerbated by levees that are breached or overtopped. As a result, FEMA and USACE are re-evaluating their policies regarding enforcement of levee maintenance and post-flood rebuilding. Both agencies are also conducting stricter inspections to determine how much protection individual levees provide (Federal Register 2021). The Texas Water Development Board's (TWDB) mission is to provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas. TWDB will assist qualifying entities who are in good standing with the National Flood Insurance Program (NFIP) through technical and financial assistance. TWDB assistance may include grant funding, participation in levee inspections, assistance in developing Maintenance Deficiency Correction Plans, site visits, and participation in public hearings. In addition, the TWDB will also discourage the construction of new levees to protect new developments and instead encourage other types of flood mitigation projects (Texas Water Development Board n.d.).

Location

Dam Failure

The majority of dams and lakes in Texas are used for water supply. Dams also provide benefits such as irrigation for agriculture, hydropower, flood control, maintenance of lake levels, and recreation. However, despite the benefits and importance of dams to our public works infrastructure, many safety issues exist for dams as with any complex infrastructure; the most serious threat is dam failure.

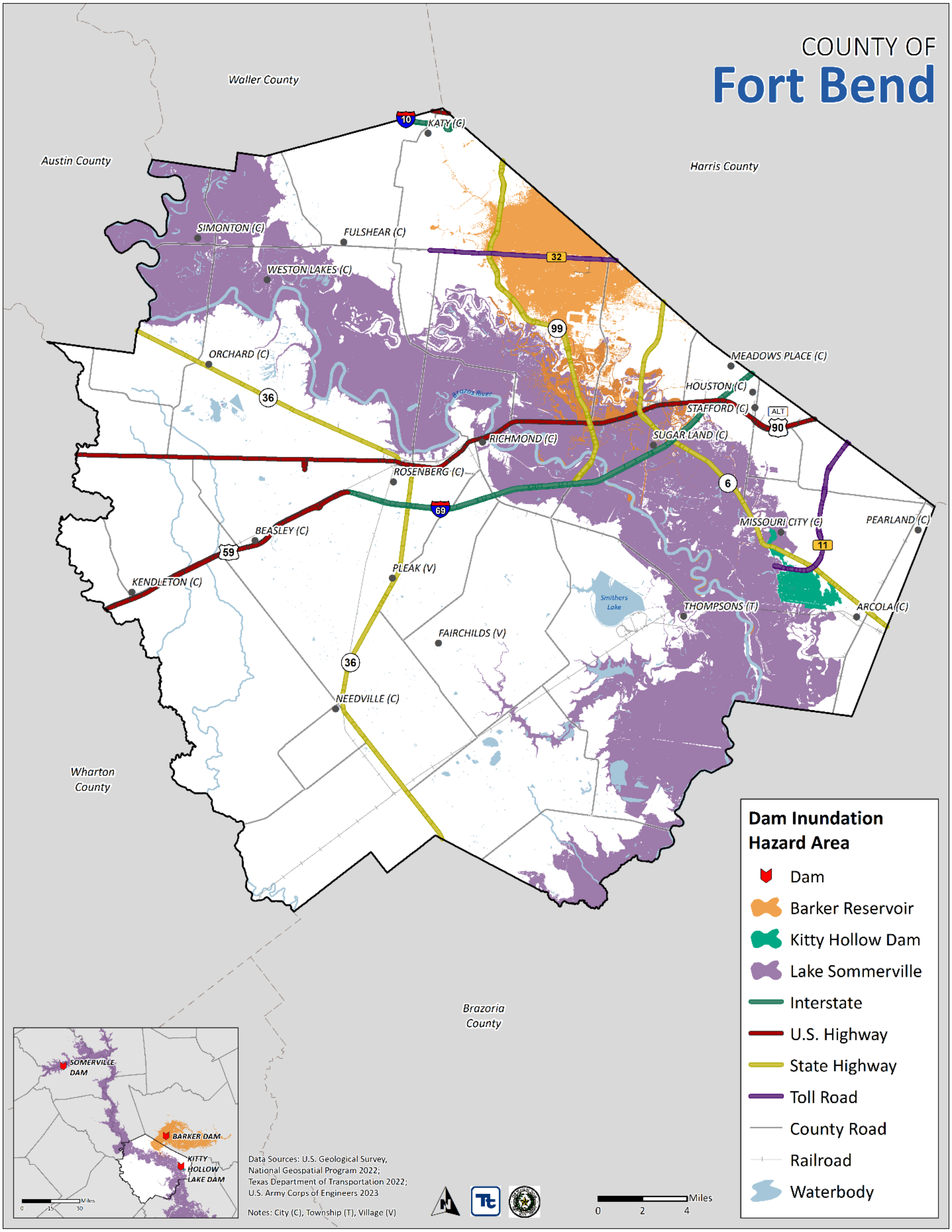
There are 19 dams located in Fort Bend County; of which, two are listed as having a high hazard potential and 17 are listed as having a low hazard potential. All 19 dams are state regulated (USACE 2022). Table 4.3.1-1 lists the documented dams in Fort Bend County. Figure 4.3.1-1 shows the dam inundation hazard areas for the three major dams located in the County. To view the dam inundation hazard area for individual jurisdictions, refer to Section 9, Jurisdictional Annexes.

Table 4.3.1-1. Dams in Fort Bend County

Dam Name	Hazard Potential Classification	Primary Purpose	State Regulated?	Federally Regulated?	Emergency Action Plan (EAP)
40 Acre Lake Dam	Low	Recreation	Yes	No	Not Required
Booth Estate Pond Dam	Low	Irrigation	Yes	No	Not Required
Dam No 1	Low	Irrigation	Yes	No	Not Required
Dam No 2	Low	Irrigation	Yes	No	Yes
Dam No 3	High	Irrigation	Yes	No	Yes
Delaro Gss	Low	Other	Yes	No	Not Required
Elm Lake Dam	Low	Recreation	Yes	No	Not Required
Frost Reservoir No 2 Dam	Low	Recreation	Yes	No	Not Required
G Fowler Gss	Low	Other	Yes	No	Not Required
Hale Lake Dam	Low	Recreation	Yes	No	Not Required
Horseshoe Lake Dam	Low	Recreation	Yes	No	Not Required
Katy Mills Dam	Low		Yes	No	Not Required
Kitty Hollow Lake Dam	High	Recreation	Yes	No	Yes
Lake Paw Paw Dam	Low	Recreation	Yes	No	Not Required
Old Second Lift Dam	Low	Irrigation	Yes	No	Not Required
Penny Lake Dam	Low	Recreation	Yes	No	Not Required
Pilant Lake Dam	Low	Recreation	Yes	No	Not Required
Smithers Lake Dam	Low	Flood Risk Reduction	Yes	No	Yes
Tx No Name No 43 Dam	Low	Fire Protection, Stock, Or Small Fish Pond	Yes	No	Not Required

Source: USACE 2022

Figure 4.3.1-1. Dam Inundation Areas in Fort Bend County



Levee Failure

The majority of dams and lakes in Texas are used to prevent rivers from flooding cities in a storm surge. Levees may be used to increase available land for habitation or divert a body of water so the fertile soil of a river may be used for agriculture.

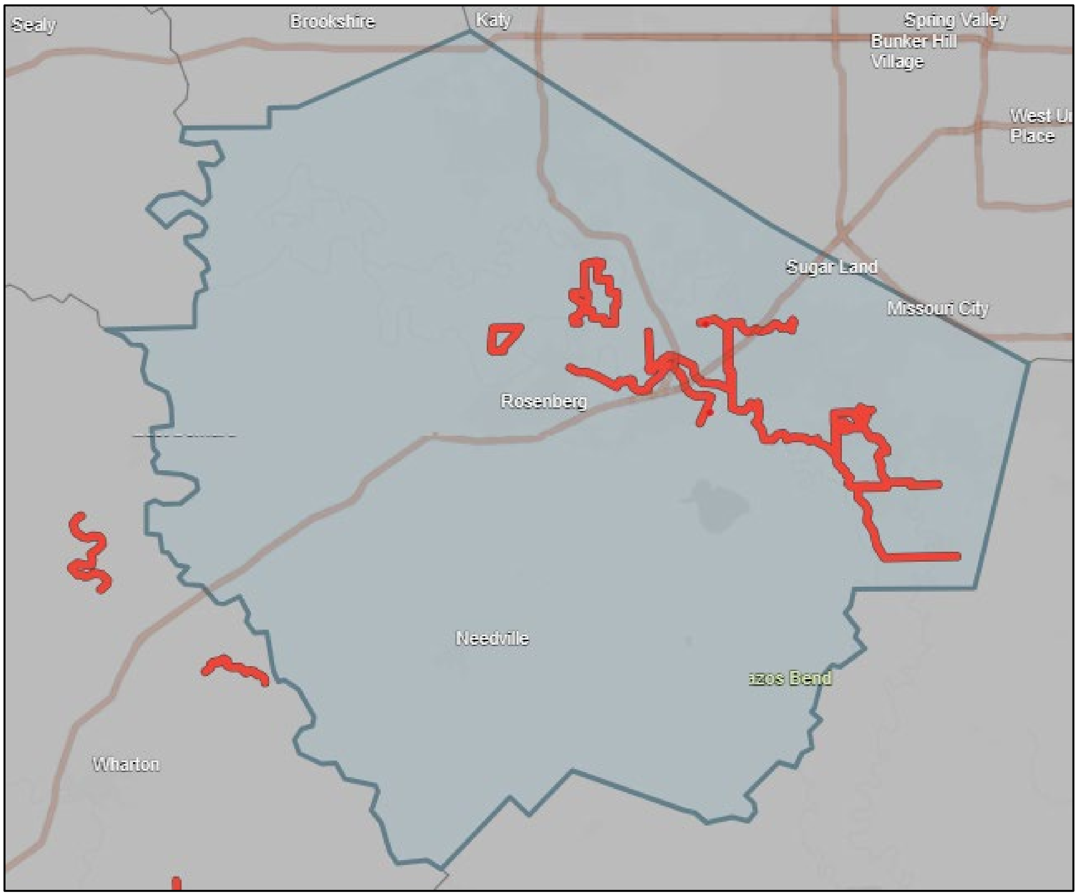
There are 12 total levees located in Fort Bend County, all of which are locally constructed, operated, and maintained (USACE 2023). Table 4.3.1-2 shows the documented levees in Fort Bend County. Figure 4.3.1-2 shows the location of levees in Fort Bend County.

Table 4.3.1-2. Levees in Fort Bend County

Name	Authorization Category	Levee Sponsor(s)
LID 10-11-6_MUD 121 System	Locally Constructed, Locally Operated and Maintained	FBCLID 6, FBCLID 10, FBCLID 11, FBMUD 121
LID 20 Levee System	Locally Constructed, Locally Operated and Maintained	FBCLID 20
LID 7-17 System	Locally Constructed, Locally Operated and Maintained	FBCLID 7, FBCLID 17
MUD 49 Levee	Locally Constructed, Locally Operated and Maintained	FBCMUD 49
Palmer MUD Levee	Locally Constructed, Locally Operated and Maintained	Palmer Plantation MUD 1, Palmer Plantation MUD 2
Pecan Grove LID Levee System	Locally Constructed, Locally Operated and Maintained	Pecan Grove MUD
Pecan Lakes Flood Protection System	Locally Constructed, Locally Operated and Maintained	Pecan Grove MUD
Rio Vista Levee System	Locally Constructed, Locally Operated and Maintained	FBCMUD 145
Sienna Plantation LID South	Locally Constructed, Locally Operated and Maintained	Sienna Parks and Levee Improvement District
Sienna Plantation Levee Systems	Locally Constructed, Locally Operated and Maintained	Sienna Parks and Levee Improvement District
Sugarstone	Locally Constructed, Locally Operated and Maintained	FBCLID 2, FBCLID 14, First Colony LID, First Colony LID 2, FBCLID 15, FBCLID 19, FBCMUD 46
West Wastewater Treatment Plant Levee System	Locally Constructed, Locally Operated and Maintained	City of Sugar Land / Brazos River Authority

Source: USACE 2023; Fort Bend County Levee Districts 2023

Figure 4.3.1-2. Levees in Fort Bend County



Source: USACE 2023

Extent

Dam failures have caused property and environmental damages, and have led to thousands of fatalities. To understand the potential severity of a dam failure, dams are classified as high, significant, or low hazard potential. There are two factors that influence the potential severity of a full or partial dam failure are: (1) the amount of water impounded; and (2) the density, type, and value of development and infrastructure located downstream (Association of State Dam Safety Officials 2020).

There are currently 7,384 dams in the State of Texas, of which 1,589 are classified as high hazard potential, 561 classified as significant hazard potential, and 5,234 classified as low hazard potential. In addition to USACE classifications, the Texas Commission on Environmental Quality (TCEQ) classifies hazards of dams based on potential loss of human life or property damage in the event of failure or malfunction. Table 4.3.1-3 provides the hazard classification definitions for TCEQ and USACE.

Table 4.3.1-3. USACE and TCEQ Dam Classification Criteria

Category	TCEQ Definition	USACE Definition
Low	A dam in the low-hazard potential category has: no loss of human life expected (no permanent habitable structures in the breach inundation area downstream of the dam); and	Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental

Category	TCEQ Definition	USACE Definition
	minimal economic loss (located primarily in rural areas where failure may damage occasional farm buildings, limited agricultural improvements, and minor highways.	losses. Losses are principally limited to the owner's property.
Significant	A dam in the significant-hazard potential category has: loss of human life possible (one to six lives or one or two habitable structures in the breach inundation area downstream of the dam); or appreciable economic loss, located primarily in rural areas where failure may cause: damage to isolated homes; damage to secondary highways as defined in §299.2(58); damage to minor railroads; or interruption of service or use of public utilities, including the design purpose of the utility.	Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be in areas with population and significant infrastructure.
High	A dam in the high-hazard potential category has: loss of life expected (seven or more lives or three or more habitable structures in the breach inundation area downstream of the dam); or excessive economic loss, located primarily in or near urban areas where failure would be expected to cause extensive damage to: public facilities; agricultural, industrial, or commercial facilities; public utilities, including the design purpose of the utility; main highways railroads used as a major transportation system.	Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Sources: USACE 2023; Texas Commission on Environmental Quality 2009

In Fort Bend County, there are two high hazard dams. A failure would impact population and structures located within the dam inundation areas. Table 4.3.1-4 summarizes the potential impacts and losses for assets located in the dam inundation areas for three dams: Barker Reservoir Dam (Harris County), Lake Somerville Dam (Burleson County), and Kitty Hollow Dam (Fort Bend County). It should be noted that two of the dams are located outside of Fort Bend County; however, if a dam failure were to occur at either dam, Fort Bend County would be impacted. The Lake Somerville Dam would impact Fort Bend County the most due to the total number of people living in the inundation areas (186,820 or 23.2% of the total population) and structures in the inundation areas (75,604 or 26.9% of total structures).

Table 4.3.1-4. Dam Inundation Areas in Fort Bend County

Jurisdiction	Barker Reservoir Dam Inundation Area			Lake Sommerville Dam Inundation Area			Kitty Hollow Dam Inundation Area		
	Number of People Exposed	Number of Building Exposed	Number of Lifelines Exposed	Number of People Exposed	Number of Building Exposed	Number of Lifelines Exposed	Number of People Exposed	Number of Building Exposed	Number of Lifelines Exposed
Arcola (C)	0	0	-	4	1	-	22	5	-
Beasley (C)	0	0	-	0	0	-	0	0	-
Fairchilds (V)	0	0	-	0	0	-	0	0	-
Fulshear (C)	0	0	-	2,166	975	-	0	0	-
Houston (C)	0	0	-	0	0	-	0	0	-
Katy (C)	0	0	-	0	0	-	0	0	-
Kendleton (C)	0	0	-	0	0	-	0	0	-
Meadows Place (C)	0	0	-	0	0	-	0	0	-

Jurisdiction	Barker Reservoir Dam Inundation Area			Lake Sommerville Dam Inundation Area			Kitty Hollow Dam Inundation Area		
	Number of People Exposed	Number of Building Exposed	Number of Lifelines Exposed	Number of People Exposed	Number of Building Exposed	Number of Lifelines Exposed	Number of People Exposed	Number of Building Exposed	Number of Lifelines Exposed
Missouri City (C)	0	0	-	25,043	9,395	-	1,584	623	-
Needville (C)	0	0	-	0	0	-	0	0	-
Orchard (C)	0	0	-	0	0	-	0	0	-
Pearland (C)	0	0	-	0	0	-	0	0	-
Pleak (V)	0	0	-	0	0	-	0	0	-
Richmond (C)	0	0	-	3,190	872	-	0	0	-
Rosenberg (C)	0	0	-	670	211	-	0	0	-
Simonton (C)	0	0	-	819	382	-	0	0	-
Stafford (C)	0	0	-	0	0	-	0	0	-
Sugarland (C)	410	158	-	80,871	27,280	-	0	0	-
Thompsons (T)	0	0	-	110	56	-	0	0	-
Weston Lakes (C)	0	0	-	3,639	1,537	-	0	0	-
Unincorporated Area	57,665	28,325	-	70,308	34,895	-	113	57	-
Fort Bend County (Total)	**58,074**	**28,483**	**292**	**186,820**	**75,604**	**940**	**1,719**	**685**	**33**

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

Levee Failure

The classification of a levee is dependent on several factors, such as risk assessments, design deviations, policy issues, and life safety. The United States Army Corps of Engineers (USACE) classifies levees to help prioritize its resources and does not define risk (USACE 2021).

- **Very Low:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very low risk.
- **Low:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in low risk.
- **Moderate:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in moderate risk.
- **High:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in high risk.
- **Very High:** Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very high risk (USACE 2021).

There are 12 levee systems in Fort Bend County. Table 4.3.1-5 provides details on the three systems including their classifications and what is at risk (population, buildings, and property value). The overall risk in Fort Bend County is as follows:

Table 4.3.1-5. Fort Bend County Levee Systems

System Name	Total Levee Miles	Total Leveed Area (mi2)	Population at Risk	Buildings at Risk	Property Value	NFIP/FIRM Status
LID 10-11-6_MUD 121 System	17.83	9.93	31,642	10,890	$5.91 billion	Accredited
LID 20 Levee System	4.08	0.83	888	614	$250 million	Accredited
LID 7-17 System	14.11	6.71	31,603	8,585	$4.87 billion	Accredited
MUD 49 Levee	1.89	0.17	1,084	309	$124 million	Accredited
Palmer MUD Levee	1.23	0.99	5,343	1,216	$637 million	Accredited
Pecan Grove LID Levee System	8.51	2.45	15,919	4,488	$1.9 billion	Accredited

System Name	Total Levee Miles	Total Leveed Area (mi2)	Population at Risk	Buildings at Risk	Property Value	NFIP/FIRM Status
Pecan Lakes Flood Protection System	0.89	0.25	1,331	397	$206 million	Accredited
Rio Vista Levee System	1.14	0.30	717	492	$206 million	Non-Accredited
Sienna Plantation LID South	10.41	10.93	18,289	6,588	$3.55 billion	Accredited
Sienna Plantation Levee Systems North	9.4	9.31	7,900	4,022	$2.35 billion	Accredited
Sugarstone	19.46	17.61	100,269	22,620	$14.2 billion	Accredited
West Wastewater Treatment Plant Levee System	0.52	0.015	0	1	$6.15 million	Accredited

Worst-Case Scenario

While the probability of a dam or levee failure is low, a worst-case scenario would be a hurricane or tropical storm that would stall over Fort Bend County, causing a dam or levee to breach and impacting areas that are supposed to be protected. Overall, if all three dams failed, 246,613 people (30% of total population) in Fort Bend County would be impacted. If all 12 levees breached, 214,985 people (26% of total population) in Fort Bend County would be impacted. Details regarding the amount and depth of water in the event of a failure or breach was not available at the time of the HMP update.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Fort Bend County was not included in any disaster (DR) or emergency (EM) declarations for dam or levee failure-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).

U.S. Department of Agriculture Disaster Declarations

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

Previous Events

For this 2023 Hazard Mitigation Plan (HMP) update, known dam or levee failure-related events that impacted the County were researched. No events were identified.

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 dam and levee failure events for Fort Bend County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2018 Fort Bend County HMP, and the USACE were used to identify the number of dam and levee failure events that occurred between 1950 and 2022. Using these sources ensures the most accurate probability estimates possible. Table 4.3.1-6 presents the probability of future occurrence of dam and levee failure events in Fort Bend County.

Table 4.3.1-6. Probability of Future Dam/Levee Failure Events in Fort Bend County

Hazard Type	Number of Occurrences Between 1950 and 2022	Percent Chance of Occurrence in Any Given Year
Dam Failure	0	0
Levee Failure	0	0
Total	**0**	**0**

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 dam/levee failure events since 1968.

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 dam failure in the County is considered "occasional".

Climate Change Projections

The climate of Texas is changing. Most of the state has warmed between .5 and 1 degree Fahrenheit 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 dam and levee failure (Centers for Climate and Energy Solutions n.d.).

Assumptions about a river's flow behavior, expressed as hydrographs, are influences for dam and levee design. Changes in weather patterns can significantly affect the hydrograph used for the design of a dam or levee. If the hygrograph changes, the dam or levee conceivably could lose some or all of its designed margin of safety, also known as freeboard. Loss of designed margin of safety increases possibility that floodwaters would overtop the dam or levee or create unintended loads, which could lead to a failure.

Vulnerability Assessment

Impact on Life, Health, and Safety

Dam Failure

The impact of dam failure on life, health, and safety is dependent on several factors, such as the class of dam, the area that the dam is protecting, the location of the dam, and the proximity of structures, infrastructure, and critical facilities to the dam structure. The USACE classifies dams based on the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities. Please refer to Table 4.3.1-7 below.

Table 4.3.1-7. USACE Hazard Potential Classifications for Dams

Hazard Category (a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses (e)
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential,	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

Hazard Category (a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses (e)
	commercial, or industrial development			

Sources: FEMA 2004
Notes:
a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

The estimation for population exposure to the dam inundation hazard area is limited to the following dams – the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Though the Barker Reservoir Dam is located in Harris County, the dam inundation hazard area spans into Fort Bend County. Based on the spatial analysis, there are an estimated 58,074 residents living in the Barker Reservoir Dam Inundation Area, or 7.2 percent of the County's total population. There are an estimated 186,820 residents living in the Lake Sommerville Dam Inundation Area, or 23.2 percent of the County's total population. There are an estimated 1,719 residents living in the Kitty Hollow Dam Inundation Area, or 0.2 percent of the County's total population. The Unincorporated Areas of Fort Bend County has the greatest number of residents living in the Barker Reservoir Dam Inundation Area with approximately 57,665 residents. The City of Sugarland has the greatest number of residents living in the Lake Sommerville Dam Inundation Area with approximately 80,871 residents. Missouri City has the greatest number of residents living in the Kitty Hollow Dam Inundation Area with approximately 1,584 residents. Table 4.3.1-8 summarizes the population exposed to the dam failure hazard by jurisdiction.

Table 4.3.1-8. Estimated Number of Persons in Fort Bend County Living in Dam Inundation Areas

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in Dam Inundation Area					
		Barker Reservoir Dam Inundation Area		Lake Sommerville Dam Inundation Area		Kitty Hollow Dam Inundation Area	
		Number of People	Percent of Total	Number of People	Percent of Total	Number of People	Percent of Total
Arcola (C)	2,593	0	0.0%	4	0.2%	22	0.9%
Beasley (C)	957	0	0.0%	0	0.0%	0	0.0%
Fairchilds (V)	755	0	0.0%	0	0.0%	0	0.0%
Fulshear (C)	17,259	0	0.0%	2,166	12.6%	0	0.0%
Houston (C)	41,279	0	0.0%	0	0.0%	0	0.0%
Katy (C)	21,926	0	0.0%	0	0.0%	0	0.0%
Kendleton (C)	341	0	0.0%	0	0.0%	0	0.0%
Meadows Place (C)	4,755	0	0.0%	0	0.0%	0	0.0%
Missouri City (C)	73,682	0	0.0%	25,043	34.0%	1,584	2.1%
Needville (C)	3,059	0	0.0%	0	0.0%	0	0.0%
Orchard (C)	219	0	0.0%	0	0.0%	0	0.0%
Pearland (C)	122,609	0	0.0%	0	0.0%	0	0.0%
Pleak (V)	1,756	0	0.0%	0	0.0%	0	0.0%
Richmond (C)	11,768	0	0.0%	3,190	27.1%	0	0.0%

Jurisdiction	Total Population (American Community Survey 2021)	Estimated Population Located in Dam Inundation Area					
		Barker Reservoir Dam Inundation Area		Lake Sommerville Dam Inundation Area		Kitty Hollow Dam Inundation Area	
		Number of People	Percent of Total	Number of People	Percent of Total	Number of People	Percent of Total
Rosenberg (C)	37,871	0	0.0%	670	1.8%	0	0.0%
Simonton (C)	838	0	0.0%	819	97.7%	0	0.0%
Stafford (C)	17,170	0	0.0%	0	0.0%	0	0.0%
Sugarland (C)	110,272	410	0.4%	80,871	73.3%	0	0.0%
Thompsons (T)	265	0	0.0%	110	41.5%	0	0.0%
Weston Lakes (C)	3,763	0	0.0%	3,639	96.7%	0	0.0%
Unincorporated Area	333,360	57,665	17.3%	70,308	21.1%	113	<0.1%
Fort Bend County (Total)	**806,497**	**58,074**	**7.2%**	**186,820**	**23.2%**	**1,719**	**0.2%**

Source: U.S. Census Bureau 2021, STATS America; U.S. Army Corp of Engineers 2023

Levee Failure

The classification of a levee is dependent on several factors, such as the risk assessments, design deviations, policy issues, and life safety. The USACE classifies levees to help prioritize its resources and does not define risk (USACE 2021). Please refer to Table 4.3.1-9 below.

Table 4.3.1-9. USACE Levee Safety Action Classification Table

Risk Classification	Actions for Levee Systems and Leveed Areas in This Class	Risk Characteristics of This Class
Very High (1)	Based on risk drivers, take immediate action to implement interim risk reduction measures. Increase frequency of levee monitoring, communicate risk characteristics to the community within an expedited timeframe; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning systems and evacuation procedures; and recommend purchase of flood insurance. Support risk reduction actions as very high priority.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very high risk.
High (2)	Based on risk drivers, implement interim risk reduction measures. Increase frequency of levee monitoring; communicate risk characteristics to the community within an expedited timeframe; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend purchase of flood insurance. Support risk reduction actions as high priority.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in high risk.
Moderate (3)	Based on risk drivers, implement interim risk reduction measures as appropriate. Verify risk information is current and implement routine monitoring program; assure operation and maintenance is up-to-date; communicate risk characteristics to the community in a timely manner; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend purchase of flood insurance. Support risk reduction actions as a priority.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in moderate risk.
Low (4)	Verify risk information is current and implement routine monitoring program and interim risk reduction measures if appropriate. Assure operation and maintenance is up-to-date; communicate risk characteristics to the community as appropriate; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in low risk.

Risk Classification	Actions for Levee Systems and Leveed Areas in This Class	Risk Characteristics of This Class
	purchase of flood insurance. Support risk reduction actions to further reduce risk to as low as practicable.	
Very Low (5)	Continue to implement routine levee monitoring program, including operation and maintenance, inspections, and monitoring of risk. Communicate risk characteristics to the community as appropriate; verify emergency plans and flood inundation maps are current; ensure community is aware of flood warning and evacuation procedures; and recommend purchase of flood insurance.	Likelihood of inundation due to breach and/or system component malfunction in combination with loss of life, economic, or environmental consequences results in very low risk.
No Verdict	Not enough information is available to assign a Levee Safety Action Classification.	

Source: USACE 2021

Dam/levee failure impacts depend on several factors, including severity of the event and whether or not adequate warning time is provided to residents. The population living in or near the inundation areas is considered exposed to the hazard. However, exposure should not be limited to those who reside within a defined hazard zone but should include everyone who may be affected by a hazard event (e.g., people are at risk while traveling in flooded areas, and access to emergency services may be compromised during an event). The degree of that impact varies and is not strictly measurable.

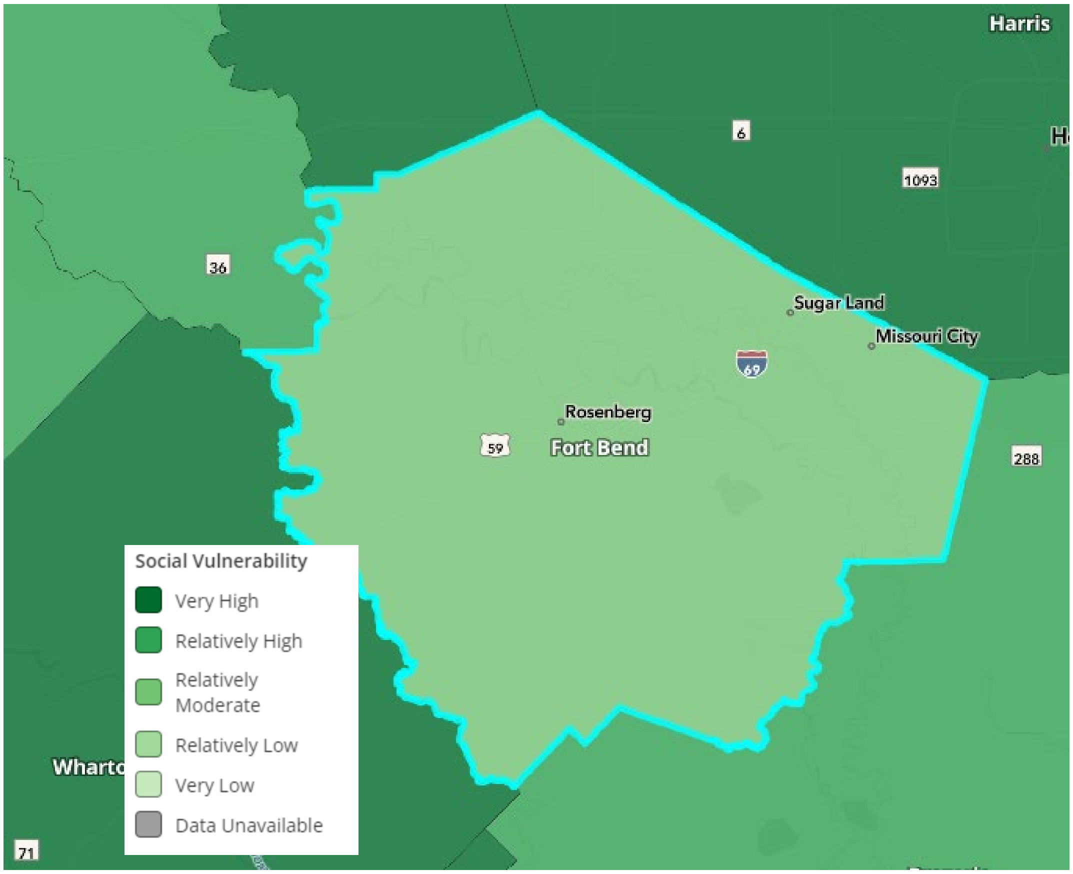
Socially Vulnerable Populations

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.

Vulnerable populations are all populations downstream from dam/ levee failures that are incapable of escaping the area within the allowable time frame. This population includes elderly individuals, children, and individuals with disabilities or access and functional needs who may be unable to get themselves out of the inundation area. The vulnerable population also includes individuals who would not have adequate warning from the emergency warning system (e.g., television or radio); this would include residents and visitors. The population adversely affected by a dam failure may also include those beyond the disaster area who rely on the dam for providing potable water.

Floods created from a dam/levee failure and their aftermath present numerous threats to public health and safety, including exposure to unsafe food, contaminated drinking and washing water, mosquitoes, animals, mold, and mildew. For more detailed descriptions of these and additional threats to public health and safety, refer to Section 4.3.4 (Flood). Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to dam failure events. Refer to Figure 4.3.1-3 for the social vulnerability index for natural hazards.

Figure 4.3.1-3. FEMA Social Vulnerability Index for Natural Hazards



Source: FEMA NRI

Impact on General Building Stock

Vulnerable properties are those within the dam/levee failure inundation area. These properties would experience the largest, most destructive surge of water. Transportation routes are vulnerable to dam/ levee inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads, and bridges in the path of the dam/levee inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable, and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Dam Failure

Table 4.3.1-10 summarizes the number of structures located in the dam inundation hazard area is limited to the following dams – the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Though the Barker Reservoir Dam is located in Harris County, the dam inundation hazard area spans into Fort Bend County. In summary, there are 28,483 buildings located in the Barker Reservoir Dam Inundation Area with an estimated $17.1 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 10.1 percent of the County's total general building stock inventory. In addition, there are 75,604 buildings located in the Lake Sommerville Dam Inundation Area with an estimated $59.6 billion of building stock and contents exposed, representing 26.9 percent of the County's total general building stock inventory. Lastly, there are 685 buildings located in the Lake Sommerville Dam Inundation Area with an estimated $1.2

billion of building stock and contents exposed, which represents approximately 0.2 percent of the County's total general building stock inventory.

Levee Failure

Spatial analysis is unavailable for the levee inundation areas.

Table 4.3.1-10. Estimated General Building Stock Located in the Dam Inundation Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located in Dam Inundation Area				Estimated Building Stock Located in Dam Inundation Area				Estimated Building Stock Located in Dam Inundation Area			
			Barker Reservoir Dam Inundation Area				Lake Sommerville Dam Inundation Area				Kitty Hollow Dam Inundation Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total	Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total	Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Arcola (C)	676	$1,374,107,673	0	0.0%	$0	0.0%	1	0.1%	$354,140	<0.1%	5	0.7%	$1,870,233	0.1%
Beasley (C)	367	$467,087,536	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Fairchilds (V)	190	$58,400,161	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Fulshear (C)	7,869	$6,124,915,172	0	0.0%	$0	0.0%	975	12.4%	$434,960,865	7.1%	0	0.0%	$0	0.0%
Houston (C)	11,589	$5,814,576,859	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Katy (C)	2,206	$4,980,024,025	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Kendleton (C)	329	$241,970,568	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Meadows Place (C)	1,676	$1,270,821,734	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Missouri City (C)	27,170	$23,213,328,025	0	0.0%	$0	0.0%	9,395	34.6%	$10,291,185,921	44.3%	623	2.3%	$1,210,610,629	5.2%
Needville (C)	1,346	$1,362,324,702	0	0.0%	$0	0.0%	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%	0	0.0%	$0	0.0%
Pearland (C)	2,171	$1,063,851,539	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Pleak (V)	436	$672,927,271	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Richmond (C)	3,296	$4,128,822,403	0	0.0%	$0	0.0%	872	26.5%	$1,030,063,800	24.9%	0	0.0%	$0	0.0%
Rosenberg (C)	11,894	$22,921,973,230	0	0.0%	$0	0.0%	211	1.8%	$243,543,331	1.1%	0	0.0%	$0	0.0%
Simonton (C)	395	$372,092,732	0	0.0%	$0	0.0%	382	96.7%	$337,450,141	90.7%	0	0.0%	$0	0.0%
Stafford (C)	4,222	$10,638,345,589	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Sugarland (C)	37,506	$36,732,455,899	158	0.4%	$479,222,553	1.3%	27,280	72.7%	$23,456,180,558	63.9%	0	0.0%	$0	0.0%
Thompsons (T)	143	$404,590,514	0	0.0%	$0	0.0%	56	39.2%	$42,732,786	10.6%	0	0.0%	$0	0.0%
Weston Lakes (C)	1,589	$1,145,826,270	0	0.0%	$0	0.0%	1,537	96.7%	$1,117,060,573	97.5%	0	0.0%	$0	0.0%
Unincorporated Area	166,035	$103,633,654,804	28,325	17.1%	$16,656,636,587	16.1%	34,895	21.0%	$22,664,273,409	21.9%	57	<0.1%	$26,614,331	<0.1%
Fort Bend County (Total)	**281,285**	**$226,792,892,466**	**28,483**	**10.1%**	**$17,135,859,140**	**7.6%**	**75,604**	**26.9%**	**$59,617,805,524**	**26.3%**	**685**	**0.2%**	**$1,239,095,192**	**0.5%**

Impact on Critical Facilities

Transportation routes are vulnerable to dam/levee inundation and have the potential to be wiped out, creating isolation issues and significant disruption to travel, including all roads, railroads, and bridges in areas in and around the dam. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power, cable, and phone lines in the inundation zone could also be vulnerable. If phone lines were lost, significant communication issues may occur in the planning area due to limited cell phone reception in many areas. In addition, emergency response would be hindered due to the loss of transportation routes as well as some protective-function facilities located in the inundation zone. Recovery time to restore many critical functions after an event may be lengthy, as wastewater, potable water, and other community facilities are located in the dam/levee inundation zone.

Dam Failure

Critical facility exposure to the dam inundation hazard area is limited to the following dams – the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Though the Barker Reservoir Dam is located in Harris County, the dam inundation hazard area spans into Fort Bend County. Table 4.3.1-11 lists the lifelines and number of critical facilities within the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam Inundation Areas. Of the 292 critical facilities located in the Barker Reservoir Dam Inundation Area, the greatest number are transportation facilities (116). Additionally, there are 940 critical facilities located in the Lake Sommerville Dam Inundation Area; 442 are food, water, and shelter facilities. There are 33 critical facilities located in the Kitty Hollow Dam Inundation Area; the greatest number are health and medical facilities (12). The majority of critical facilities located in the Barker Reservoir Dam Inundation Area are in the Unincorporated Areas of Fort Bend County (226); the majority of critical facilities located in the Lake Sommerville Dam Inundation Area are in the City of Sugarland (396); and the majority of critical facilities located in the Kitty Hollow Dam Inundation Area are in Missouri City (30), as shown in Table 4.3.1-12.

Table 4.3.1-11. Lifelines and Critical Facilities Located in the Dam Inundation Areas

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Barker Reservoir Dam Inundation Area	Number of Lifelines Located in the Lake Sommerville Dam Inundation Area	Number of Lifelines Located in the Kitty Hollow Dam Inundation Area
Communications	44	0	2	0
Energy	584	27	98	4
Food, Water, Shelter	1,480	110	442	7
Hazardous Materials	13	1	1	0
Health and Medical	335	18	112	12
Safety and Security	282	20	70	0
Transportation	660	116	215	10
Fort Bend County (Total)	**3,398**	**292**	**940**	**33**

Source: Fort Bend County 2022; U.S. Army Corp of Engineers 2023

Table 4.3.1-12. 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 Dam Inundation Hazard Area											
			Barker Reservoir Dam Inundation Area				Lake Sommerville Dam Inundation Area				Kitty Hollow Dam Inundation Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines	Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines	Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Arcola (C)	22	21	0	0.0%	0	0.0%	1	4.5%	1	4.8%	1	4.5%	1	4.8%
Beasley (C)	18	14	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Fairchilds (V)	3	3	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Fulshear (C)	43	40	0	0.0%	0	0.0%	5	11.6%	4	10.0%	0	0.0%	0	0.0%
Houston (C)	105	84	3	2.9%	3	3.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Katy (C)	53	51	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Kendleton (C)	21	19	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Meadows Place (C)	17	16	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Missouri City (C)	339	297	3	0.9%	3	1.0%	174	51.3%	155	52.2%	30	8.8%	29	9.8%
Needville (C)	42	33	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Orchard (C)	7	7	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pearland (C)	1	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pleak (V)	15	15	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Richmond (C)	123	103	0	0.0%	0	0.0%	35	28.5%	33	32.0%	0	0.0%	0	0.0%
Rosenberg (C)	340	295	0	0.0%	0	0.0%	12	3.5%	9	3.1%	0	0.0%	0	0.0%
Simonton (C)	17	17	0	0.0%	0	0.0%	14	82.4%	14	82.4%	0	0.0%	0	0.0%
Stafford (C)	164	137	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Sugarland (C)	631	575	63	10.0%	63	11.0%	396	62.8%	374	65.0%	0	0.0%	0	0.0%
Thompsons (T)	10	9	0	0.0%	0	0.0%	3	30.0%	2	22.2%	0	0.0%	0	0.0%
Weston Lakes (C)	7	7	0	0.0%	0	0.0%	7	100.0%	7	100.0%	0	0.0%	0	0.0%
Unincorporated Fort Bend County	1,756	1,654	226	12.9%	223	13.5%	361	20.6%	341	20.6%	3	0.2%	3	0.2%
Fort Bend County (Total)	**3,734**	**3,398**	**295**	**7.9%**	**292**	**8.6%**	**1,008**	**27.0%**	**940**	**27.7%**	**34**	**0.9%**	**33**	**1.0%**

Source: Fort Bend County 2022; U.S. Department of Agriculture, Natural Resources Conservation Service 2022; U.S. Army Corp of Engineers 2023

Levee Failure

Spatial analysis to identify critical facility exposure is unavailable for the levee inundation areas.

Impact on Economy

Severe flooding that follows an event like a dam/levee failure can cause extensive structural damage and withhold essential services. The cost to recover from flood damages after a surge will vary depending on the hazard risk of each dam. Severe flooding that follows an event like a dam/levee failure 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. Debris from surrounding buildings can accumulate should the dam mimic major flood events, such as the 1-percent annual chance flood event that is discussed in Section 4.3.4 (Flood).

Dam/levee failure events can significantly impact the local and regional economy. Similar to flooding, losses include but are not limited to damages to buildings and infrastructure, agricultural losses, business interruption, and impacts on tax base. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation.

Impact on Environment

The environmental impacts of a dam/levee failure can include significant water quality and debris-disposal issues or severe erosion that can impact local ecosystems. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals may get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties.

Dam Failure

A dam failure event would inevitably impact Fort Bend County’s natural and local environment. Should a dam failure event occur, the land within the inundation area would be altered. Table 4.3.1-13 lists the number of acres exposed to the Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam Inundation Areas.

Table 4.3.1-13. Land Acreage in Fort Bend County Located in the Dam Inundation Areas

Jurisdiction	Total Acres of Land Area	Barker Reservoir Dam Inundation Area		Lake Sommerville Dam Inundation Area		Kitty Hollow Dam Inundation Area	
		Total Acres of Land Area (Excluding Waterbodies) Located in the Dam Inundation Hazard Area	Percent of Total	Total Acres of Land Area (Excluding Waterbodies) Located in the Dam Inundation Hazard Area	Percent of Total	Total Acres of Land Area (Excluding Waterbodies) Located in the Dam Inundation Hazard Area	Percent of Total
Arcola (C)	1,664	0	0%	26	2%	44	3%
Beasley (C)	673	0	0%	0	0%	0	0%
Fairchilds (V)	831	0	0%	0	0%	0	0%
Fulshear (C)	7,962	0	0%	2,068	26%	0	0%
Houston (C)	7,440	2,327	31%	0	0%	0	0%
Katy (C)	2,843	15	1%	0	0%	0	0%
Kendleton (C)	850	0	0%	0	0%	0	0%
Meadows Place (C)	586	2	0%	0	0%	0	0%
Missouri City (C)	20,841	192	1%	9,299	45%	2,027	10%
Needville (C)	1,264	0	0%	0	0%	0	0%
Orchard (C)	250	0	0%	0	0%	0	0%
Pearland (C)	839	0	0%	0	0%	0	0%
Pleak (V)	1,193	0	0%	0	0%	0	0%
Richmond (C)	2,752	64	2%	1,104	40%	0	0%
Rosenberg (C)	23,442	0	0%	1,804	8%	0	0%
Simonton (C)	1,487	0	0%	1,454	98%	0	0%
Stafford (C)	4,467	3	0%	0	0%	0	0%
Sugarland (C)	27,073	2,815	10%	19,859	73%	0	0%
Thompsons (T)	995	0	0%	468	47%	0	0%
Weston Lakes (C)	1,623	0	0%	1,584	98%	0	0%
Unincorporated Area	449,862	18,535	4%	112,627	25%	433	<0.1%
Fort Bend County (Total)	**558,937**	**23,953**	**4%**	**150,293**	**27%**	**2,503**	**<0.1%**

Source: Fort Bend County 2022; U.S. Army Corp of Engineers 2023

Levee Failure

Spatial analysis is unavailable for the levee inundation areas.

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

Any areas of growth in Fort Bend County could be potentially impacted by the dam/levee failure hazard because these areas are exposed and vulnerable. Areas downstream of dams or levees are the most vulnerable to losses; therefore, any development in these areas will be more susceptible to dam/levee failure impacts.

Projected Changes in Population

The County has experienced an increase in population between the 2010 American Community Survey (541,983) and the estimated 2020 American Community Survey population of 790,892. The population of the County is expected to increase over the next few years. Increases in population in dam/levee failure inundation areas will result in increased risk to life to the dam/levee failure hazard.

Climate Change

An increasing average annual temperature will directly impact the atmospheric moisture potential. The probability of expanding atmospheric moisture leads to an increasing amount of rainfall during storm events. The increased potential volume of rainfall will directly lead to an increasing pressure placed on dam and levee systems during future riverine flood events (State of Texas HMP 2018).

Change in Vulnerability Since 2018 HMP

Overall, Fort Bend County's vulnerability has increased. As the population of Fort Bend County continues to rise, the number of persons exposed and vulnerable to dam/levee failure events, especially those located within or near downstream inundation zones, will continue to increase.