



SECTION 4. RISK ASSESSMENT

4.2 Methodology and Tools

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- Exposure identification—Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, environment, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for the 2023 Fort Bend County Hazard Mitigation Plan (HMP) update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)).

To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

The following describes the methodology and tools used to conduct the risk assessment for the 2023 Fort Bend County HMP update.

4.2.1 Risk Assessment Tools

Mapping

National, State of Texas, and Fort Bend County databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document.

Hazus

In 1997, the Federal Emergency Management Agency (FEMA) developed the standardized Hazards U.S. (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural



disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Administered by the local government and can be used to manage and update an HMP throughout its implementation.

Level of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- Level 1—All of the information needed to produce an estimate of losses is included in the software’s default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- Level 2—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory as well as data about utilities and critical facilities. This information is needed in a GIS format.
- Level 3—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

4.2.2 Risk Assessment Approach

The risk assessments in this plan describe the risks associated with each hazard of concern identified. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
 - Geographic areas most affected by the hazard
 - Event frequency estimates
 - Severity estimates
 - Warning time likely to be available for response
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA’s hazard-modeling program Hazus were used for this assessment for the earthquake, flood, and hurricane hazards. Outputs like those from Hazus were generated for other hazards using data generated through GIS.



Dam/Levee Failure

The Dam Inundation hazard data was provided by the Fort Bend County Drainage District and the U.S. Army Corp of Engineers. Three Dam Inundation areas were assessed: Barker Reservoir Dam, Lake Sommerville Dam, and Kitty Hollow Dam. Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from dam failure, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from dam failure.

Drought

To assess the vulnerability of Fort Bend County to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms and farmland areas was extracted from the report and summarized in the vulnerability assessment. Additional resources from the Texas HMP, Texas Commission on Environmental Quality, and the Environmental Protection Agency were used to assess the potential impacts to the population from a drought event.

Extreme Temperature

All of Fort Bend County is exposed to extreme temperature events. A qualitative assessment was conducted for the extreme temperature hazard. Information from the National Weather Service (NWS), Centers for Disease Control and Prevention (CDC), stakeholder plans/reports, the Texas State HMP, and the Planning Partnership were used to assess the potential impacts to the County's assets.

Geologic Hazards

This updated HMP referenced inland erosion and expansive soil hazard areas to assess the County's risk to the geologic hazards.

The best available data was used to assess Fort Bend County's vulnerability to expansive soils. To help understand the geographic distribution of expansive soils, USDA Natural Resources Conservation Service's (NRCS) 2022 soil data for Fort Bend County was referenced. Soils with linear extensibility greater than or equal to 6 percent were selected as expansive soils. Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from expansive soils, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from expansive soils.

To assess the vulnerability of the County to inland erosion events and its associated impacts, a quantitative assessment was conducted using the best available data. To help understand the geographic distribution of inland erosion, USDA's NRCS's 2022 soil data for Fort Bend County was referenced. Soils with k-factor greater than or equal to 0.49 were selected as susceptible soil. K-Factor is soil erodibility factor that represents both susceptibility of soil to erosion and the rate of runoff. To estimate potential exposure to the subsidence hazard area, assets (population, building stock, critical facilities and lifelines, new development) with their centroid in the hazard area were totaled to estimate the numbers and values exposed to the subsidence hazard boundary.



Flood

The 1 percent and 0.2 percent annual chance flood events were examined to evaluate the County’s risk from the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the National Flood Insurance Program (NFIP).

The following data was used to evaluate exposure and determine potential future losses for this plan update:

- The Fort Bend County effective FEMA Digital Flood Insurance Rate Map (DFIRM) dated January 29, 2021
- The depth grid was developed by the Fort Bend County Drainage District in May 2023. The depth grids that Fort Bend County Drainage District created did not cover the entirety of FEMA’s 1 percent annual chance flood event. The effective Fort Bend County FEMA DFIRM published in 2021 was used to fill in these gaps for the depth grids to evaluate exposure and determine potential future losses. The depth grid was generated using the effective DFIRM and a 1-meter resolution Digital Elevation Model (DEM) provided by the County. The final depth grid was integrated into the Hazus v5.1 riverine flood model used to estimate the potential losses for the 1 percent annual chance flood events.

To estimate exposure to the 1 percent and 0.2 percent annual chance flood events, the effective DFIRM flood boundaries were overlaid on the centroids of updated assets (population, building stock, and critical facilities) Centroids that intersected the flood boundaries were totaled to estimate the building replacement cost value and population vulnerable to the flood inundation areas. A Level 2 Hazus riverine flood analysis was performed in Hazus v5.1. Both the critical facility and building inventories were formatted to be compatible with Hazus and its Comprehensive Data Management System (CDMS). Once updated with the inventories, the Hazus riverine flood model was run to estimate potential losses in Fort Bend County for the 1 percent annual chance flood events. A user-defined analysis was also performed for the building stock. Buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. Hazus calculated the estimated potential losses to the population (default 2010 U.S. Census data across dasymetric blocks), potential damages to the general building stock, and potential damages to critical facility inventories based on the depth grid generated and the default Hazus damage functions in the flood model.

Pandemic/Disease Outbreak

All of Fort Bend County is exposed to disease outbreak events. A qualitative assessment was conducted. Research from the Centers for Disease Control and Prevention was utilized to qualitatively assess the most recent COVID-19 outbreak.

Severe Weather

All of Fort Bend County is exposed to severe summer weather. A qualitative analysis was conducted for this hazard, and information from the State of Texas 2019 HMP, NWS, and FEMA National Risk Index was used to develop the hazard profile and to determine risk and exposure.

Tornado

All of Fort Bend County is exposed to tornadoes. A qualitative analysis was conducted for this hazard, and information from the State of Texas 2019 HMP, NWS, and FEMA National Risk Index was used to develop the hazard profile and to determine risk and exposure.





Wildfire

The 2022 wildfire threat hazard area obtained through Texas A&M Forest Service was referenced to delineate wildfire hazard areas. Wildfire threat was measured by the Texas A&M Forest Service using the Wildland Fire Susceptibility Index (WFSI), which is defined as the likelihood of an acre burning. This data is derived at a 30-meter resolution.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from wildfires, the County’s assets were overlaid with the hazard area. Assets with their centroid located within the wildfire hazard areas were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from wildfire events.

Hurricane

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Fort Bend County for the 100-year and 500-year mean return period events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with the County. Hazus contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the jurisdiction level. Because there are multiple census tracts that contain more than one jurisdiction, a density analysis was used to extract the percent of each jurisdiction within each tract. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Winter Weather

All of Fort Bend County is exposed and vulnerable to the winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. Information and data from the State of Texas 2019 HMP, NWS, and FEMA National Risk Index was used to develop the hazard profile and to determine risk and exposure.

All Other Assessed Hazards

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: drought, extreme temperature, hail, lightning, pandemic, thunderstorm wind, and tornadoes.

4.2.3 Sources of Data Used in Hazus Modeling and Exposure Analyses

Fort Bend County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Fort Bend County assessed exposure vulnerability of the following types of assets: population, buildings, critical facilities/infrastructure, and new development. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.



Building and Cost Data

The data for general building stock was provided by Fort Bend County, last updated in 2016. The general building stock is analyzed at the aggregate Census Block and Census Tract levels and incorporates 2010 Census data with the 2022 RS Means replacement cost values. Structural and content replacement cost values (RCV) were calculated for each building utilizing available assessor data and RS Means 2022 values; a regional location factor for Fort Bend County was applied (0.85 for residential structures located within a Houston zip code; 0.77 for residential structures located within a Wharton zip code; 0.80 for residential structures located within a Galveston zip code. 0.85 for all other structure types located within a Houston zip code; 0.82 for all other structure types located within a Wharton zip code; 0.82 for all other structure types located within a Galveston zip code.).

The occupancy classes were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

Critical Facilities and Lifelines

The 2023 HMP critical facility inventory, which includes essential facilities, utilities, government offices, transportation features, and user-defined facilities, was updated by Fort Bend County. The update involved a review for accuracy, additions, or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA’s definition. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

Population

Fort Bend County used the total population statistics from the 2017–2021 American Community Survey (ACS) 5-year estimate to estimate the exposure and potential impacts to the County’s population in place of the 2010 U.S. Census block estimates. City, Township, and Village populations were extracted directly from the Census Bureau and ACS. Limitations of these analyses are recognized, and thus, the results are used only to provide a general estimate for planning purposes.

As discussed in Section 3.0 (County Profile), research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. Vulnerable populations in Fort Bend County included in the risk assessment are children, elderly, and people living in low-income households.

Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The depth grid was developed by the Fort Bend County Drainage District in May 2023. The depth grids that Fort Bend County Drainage District created did not cover the entirety of FEMA’s 1 percent annual chance flood event. The effective Fort Bend County FEMA DFIRM published in 2021 and a 1-meter resolution DEM provided by the County was used to develop a depth grid that could fill in the entirety of FEMA’s 1 percent annual chance flood to evaluate exposure and determine potential future losses. The final depth grid was integrated into the Hazus v5.1 riverine flood model used to estimate the potential losses for the 1 percent annual chance flood events.
- **Hurricane**—Hazus hurricane probabilistic data were used for the analysis of this hazard.



Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Expansive Soils**—2022 USDA’s Natural Resources Conservation Service’s soil data for soil types with a linear extensibility >6 percent
- **Inland Erosion** —2022 USDA’s Natural Resources Conservation Service’s soil data of a K-Factor >=0.49
- **Wildfire**—2022 Texas A&M Forest Service wildfire threat hazard area
- **Dam Inundation Areas** – 2023 Fort Bend County Drainage District; 2023 U.S. Army Corp of Engineers’ dam inundation areas based on maximum high (MH) Breach

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: drought, extreme temperature, pandemic, severe weather, and winter weather.

Data Source Summary

Table 4.2.3-1 summarizes the data sources used for the risk assessment for this plan.

Table 4.2.3-1. Data Source Summary

Data	Source	Date	Format
Population Data	U.S. Census Bureau; American Community Survey 5-Year Estimates	2010/2020; 2017-2021	Digital (GIS) Format; CSV
Building Inventory	Fort Bend County	2016	Digital (GIS) Format
Critical Facilities	Fort Bend County; Hazus v5.1	2023	Digital (GIS) Format
Digitized Effective FIRM Data	FEMA	2021	Digital (GIS) Format
Digital Elevation Model	Texas Natural Resources Information System	2019	Digital (GIS) Format
Flood Depth Grid	Fort Bend County Drainage District	2023	Digital (GIS) Format
Expansive Soils	USDA	2022	Digital (GIS) Format
Dam Inundation	Fort Bend County Drainage District; U.S. Army Corps of Engineers	2023	Digital (GIS) Format
Inland Erosion	USDA	2022	Digital (GIS) Format
Wildfire	Texas A&M Forest Service	2022	Digital (GIS) Format

Notes: FEMA – Federal Emergency Management Agency; USDA – United States Department of Agriculture; USGS – United States Geological Survey



4.2.4 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents has to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Fort Bend County will collect additional data to assist in estimating potential losses associated with other hazards.