
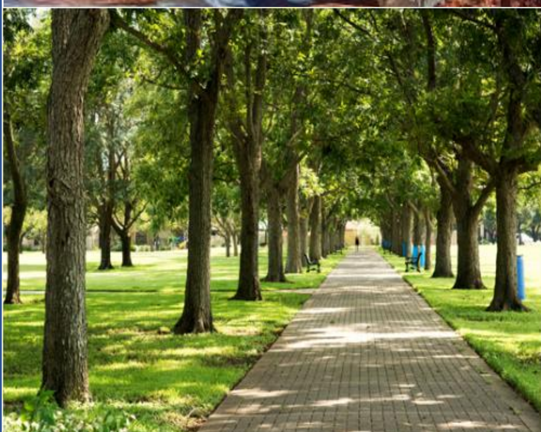

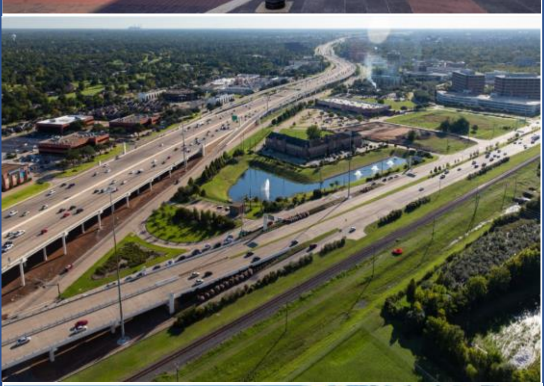
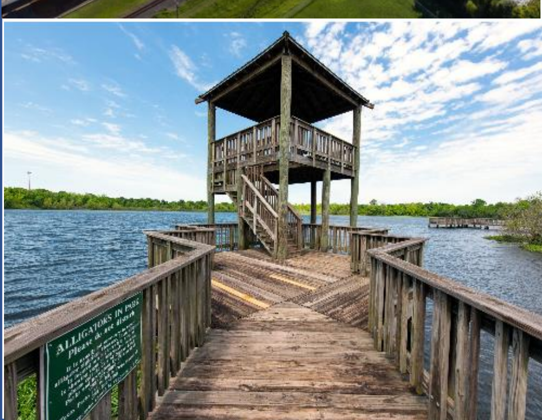

CITY OF SUGAR LAND HAZARD MITIGATION PLAN

2021 UPDATE

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SECTION 1. INTRODUCTION

1.1 BACKGROUND

A Hazard Mitigation Plan (HMP) is a living document that communities use to reduce their vulnerability to hazards. It forms the foundation for a community's long-term strategy to reduce disaster losses and creates a framework for decision making to reduce damages to lives, property, and the economy from future disasters. Examples of mitigation projects include home acquisitions or elevations to remove structures from high risk areas, upgrades to critical public facilities, and infrastructure improvements. Ultimately, these actions reduce vulnerability, and communities are able to recover more quickly from disasters. The City of Sugar Land has demonstrated its commitment to reducing disaster losses by initially developing its HMP in 2015.

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), the City of Sugar Land developed this HMP, which represents a regulatory update to the 2015 "City of Sugar Land, Texas Hazard Mitigation Plan." The DMA 2000 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and is designed to improve planning for, response to, and recovery from disasters by requiring state and local entities to implement pre-disaster mitigation planning and develop HMPs. The Federal Emergency Management Agency (FEMA) has issued guidelines for HMPs. The Texas Division of Emergency Management (TDEM) also supports plan development for jurisdictions in the State of Texas.

Hazard Mitigation is any sustained action taken to reduce or eliminate the long-term risk and effects that can result from specific hazards.

FEMA defines a ***Hazard Mitigation Plan*** as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.

Specifically, the DMA 2000 requires that states, with support from local governmental agencies, develop and update HMPs on a five-year basis to prepare for and reduce the potential impacts of natural hazards. The DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. This enhanced planning better enables local and State governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

Fort Bend County, which includes the City of Sugar Land, has been included in 21 FEMA (major and emergency) declarations.

1.1.1 DMA 2000 Origins - The Stafford Act

In the early 1990s, a new federal policy regarding disasters began to evolve. Rather than reacting whenever disasters strike communities, the federal government began encouraging communities to first assess their vulnerability to various disasters and proceed to take actions to reduce or eliminate potential risks. The logic is that a disaster-resistant community can rebound from a natural disaster with less loss of property or human injury, at much lower cost, and, consequently, more quickly. Moreover, these communities minimize other costs associated with disasters, such as the time lost from productive activity by business and industries.

The DMA 2000 provides an opportunity for states, tribes, and local governments to take a new and revitalized approach to mitigation planning. The DMA 2000 amended the Stafford Act by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of requirements (Section 322). Section 322 sets forth the requirements that communities evaluate natural hazards within their respective jurisdictions and develop an appropriate plan of action to mitigate those hazards, while emphasizing the need for State, tribal and local governments to closely coordinate mitigation planning and implementation efforts.

The amended Stafford Act requires that each local jurisdiction identify potential natural hazards to the health, safety, and well-being of its residents and identify and prioritize actions that the community can take to mitigate those hazards—before disaster strikes. To remain eligible for hazard mitigation assistance from the federal government, communities must first prepare and then maintain and update an HMP (this plan).

Responsibility for fulfilling the requirements of Section 322 of the Stafford Act and administering the FEMA Hazard Mitigation Program has been delegated to the State of Texas, specifically to TDEM. FEMA also provides support through guidance, resources, and plan reviews.

1.1.2 Benefits of Mitigation Planning

The planning process helps prepare citizens and government agencies to better respond when disasters occur. Also, mitigation planning allows the City of Sugar Land to remain eligible for mitigation grant funding for mitigation projects that will reduce the impact of future disaster events. Eligible projects include property acquisition and structure demolition, structure elevation, localized flood risk reduction projects, infrastructure retrofit, soil stabilization, wildfire mitigation, post-disaster code enforcement, wind retrofit for one- and two-family residences, and planning related activities. The long-term benefits of mitigation planning include the following:

National Benefit-Cost Ratio (BCR) Per Peril *BCR numbers in this study have been rounded	Beyond Code Requirements	Federally Funded
Overall Hazard Benefit-Cost Ratio	$4:1	$6:1
Riverine Flood	$5:1	$7:1
Hurricane Surge	$7:1	Too few grants
Wind	$5:1	$5:1
Earthquake	$4:1	$3:1
Wildland-Urban Interface Fire	$4:1	$3:1

Source: FEMA 2018; Federal Insurance Mitigation Administration 2018
Note: Natural hazard mitigation saves $6 on average for every $1 spent on federal mitigation grants.

- An increased understanding of hazards faced by the City of Sugar Land.
- Building a more sustainable and disaster-resistant City.
- Increasing education and awareness of hazards and their threats, as well as their risks.
- Developing implementable and achievable actions for risk reduction in the City.
- Financial savings through partnerships that support planning and mitigation efforts.
- Focused use of limited resources on hazards that have the biggest impact on the community.
- Reduced long-term impacts and damages to human health and structures.
- Reduced repair costs.

1.1.3 Organizations Involved in the Mitigation Planning Effort

The City of Sugar Land intends to implement this HMP with full coordination and participation of local departments, organizations and groups, and relevant state and federal entities. Coordination helps to ensure that stakeholders have established communication channels and relationships necessary to support mitigation planning and mitigation actions included in Section 6 (Mitigation Strategy).

Multiple Agency Support for Hazard Mitigation

Primary responsibility for the development and implementation of mitigation strategies and policies lies with local governments. However, local governments are not alone; various partners and resources at the regional, state, and federal levels are available to assist communities in the development and implementation of mitigation strategies. Within the State of Texas, TDEM is the lead agency providing hazard mitigation planning assistance to local jurisdictions. TDEM provides guidance to support mitigation planning. In addition, FEMA provides grants, tools, guidance, and training to support mitigation planning.

Additional input and support for this planning effort was obtained from a range of agencies and through public involvement (as discussed in Section 2). The Steering Committee for the City's HMP update provided project management and oversight of the planning process. A list of Steering Committee and municipal POCs is provided in Section 2 (Planning Process), while Appendix B (Participation Matrix) provides further documentation of the broader level of municipal involvement.

This HMP was prepared in accordance with the following regulations and guidance:

- FEMA *Local Mitigation Planning Handbook*, March 2013.
- FEMA *Integrating Hazard Mitigation into Local Planning*, March 1, 2013.
- FEMA *Plan Integration: Linking Local Planning Efforts*, July 2015.
- *Local Mitigation Plan Review Guide*, October 1, 2011.
- DMA 2000 (Public Law 106-390, October 30, 2000).
- 44 Code of Federal Regulations (CFR) Parts 201 and 206 (including: Feb. 26, 2002, Oct. 1, 2002, Oct. 28, 2003, and Sept. 13, 2004 Interim Final Rules).
- FEMA *How-To Guide for Using HAZUS for Risk Assessment* FEMA Document No. 433, February 2004.
- FEMA *Mitigation Planning How-to Series* (FEMA 386-1 through 4, 2002), available at: http://www.fema.gov/fima/planhowto.shtm.
- FEMA *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*, January 2013.
- State of Texas Hazard Mitigation Plan, October 2018.

Table 1-1 summarizes the requirements outlined in the DMA 2000 Interim Final Rule and provides the section where each is addressed in this HMP.

Table 1-1. FEMA Local Mitigation Plan Review Crosswalk

Plan Criteria	Primary Location in Plan
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Section 6; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Section 2
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Sections 4.2
Profiling Hazards: §201.6(c)(2)(i)	Section 4.4
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Section 4.4
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Section 3 Section 4.4
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Section 4.4
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Section 3 and Section 6
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Section 6
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Section 6
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Section 6
Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	Section 6
Plan Maintenance Process	

Plan Criteria	Primary Location in Plan
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Section 7
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Section 7
Continued Public Involvement: §201.6(c)(4)(iii)	Section 7

1.1.4 Organization

The City of Sugar Land HMP update is organized in a one volume containing seven sections.

Goals and Objectives

The planning process included a review and update of the prior mitigation goals and the addition of all new objectives as a basis for the planning process and to guide the selection of appropriate mitigation actions addressing all hazards of concern. Further, the goal development process considered the mitigation goals expressed in the State of Texas HMP, as well as other relevant county and local planning documents, as discussed in Section 6 (Mitigation Strategy).

The eight goals of the City of Sugar Land HMP

- Goal 1: Warning — Enhance predictive measure including the expansion and protection of warning systems and supporting technologies.
- Goal 2: Data Collection/Studies/Planning — Enhance the quality of assessments, analysis and planning through the development and collection of data.
- Goal 3: Public Outreach — Develop and enhance communications and education capabilities to the public regarding hazards, including the steps that can be taken to mitigate their impact.
- Goal 4: Mitigate Structures/Protect Lives — Implement protective measures to reduce the effect of natural, technological and human caused hazards including measures that enhance public safety and reduce the risk of damage to public and private property.
- Goal 5: Protect Natural Resources — Reduce adverse environmental, natural resource, and economic impacts from natural, technological, and human-caused hazard events.
- Goal 6: Code Enforcement — Review update, adopt and enforce local, state and federal plans, codes and regulations to reduce the impacts of natural hazards.
- Goal 7: Coordination — Enhance coordination between private sector, local, state, tribal, and federal agencies to improve mitigation capabilities and reduce the risk of natural, technological and human caused hazard events.
- Goal 8: Continuity of Operations — Support continuity of operations pre-, during, and post- hazard events including the support of community lifelines.

Hazards of Concern

The City of Sugar Land reviewed the hazards that caused measurable impacts based on events, losses, and information available since the development of the 2015 City of Sugar Land HMP and the 2018 State of Texas HMP Update. The City evaluated the risk and vulnerability due to each of the hazards of concern on the assets of the City. While the overall hazard rankings were calculated for the City, the overall hazard rankings displayed reflect municipal input. The hazard risk rankings were used to focus and prioritize the City's mitigation strategies.

Plan Integration into Other Planning Mechanisms

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the City there are many existing plans and programs that support hazard risk management, and thus it is critical that this HMP integrates, coordinates with, and complements those mechanisms. Comprehensive plans, codes and ordinances, and local watershed plans are among the sources of information to update the City's capabilities, to identify mitigation strategies, and to identify potential areas of future integration.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal state, county, and local) that support hazard mitigation within the City. Also in this section, the City identified how they have integrated hazard risk management into their existing planning, regulatory, and operational/administrative framework (*existing integration*), and how they intend to promote this integration (*opportunities for future integration*).

1.1.5 Implementation of Prior and Existing Local Hazard Mitigation Plans

Section 6 (Mitigation Strategy) of the plan presents the status of the mitigation projects identified in the 2015 City of Sugar Land HMP. Numerous projects and programs have been implemented that have reduced hazard vulnerability to assets in the planning area. Plan maintenance procedures in Section 7 (Plan Maintenance) were developed to include specific, implementable activities. Future actions include integrating hazard mitigation goals into comprehensive plan updates; reviewing the HMP during updates of codes, ordinances, zoning, and development; and ensuring a more thorough integration of hazard mitigation, with its related benefits, will be completed within the upcoming five-year planning period.

1.1.6 Implementation of the Planning Process

The planning process and findings are required to be documented in local HMPs. To support the planning process in developing this HMP, the City of Sugar Land has accomplished the following:

- Developed a Steering Committee and Core Planning Team.
- Reviewed the 2015 *City of Sugar Land Hazard Mitigation Plan*.
- Identified and reviewed those natural and non-natural hazards that are of greatest concern to the community (hazards of concern) to be included in the plan.
- Profiled the relevant hazards.
- Estimated the inventory at risk and potential losses associated with the relevant hazards.
- Reviewed and updated the hazard mitigation goals and added new objectives.
- Reviewed mitigation strategies identified in the 2015 City of Sugar Land HMP.
- Developed new mitigation actions to address reduction of vulnerability of hazards of concern.
- Involved a wide range of stakeholders and the public in the plan process.
- Developed mitigation plan maintenance procedures to be executed after obtaining approval of the plan from TDEM and FEMA.

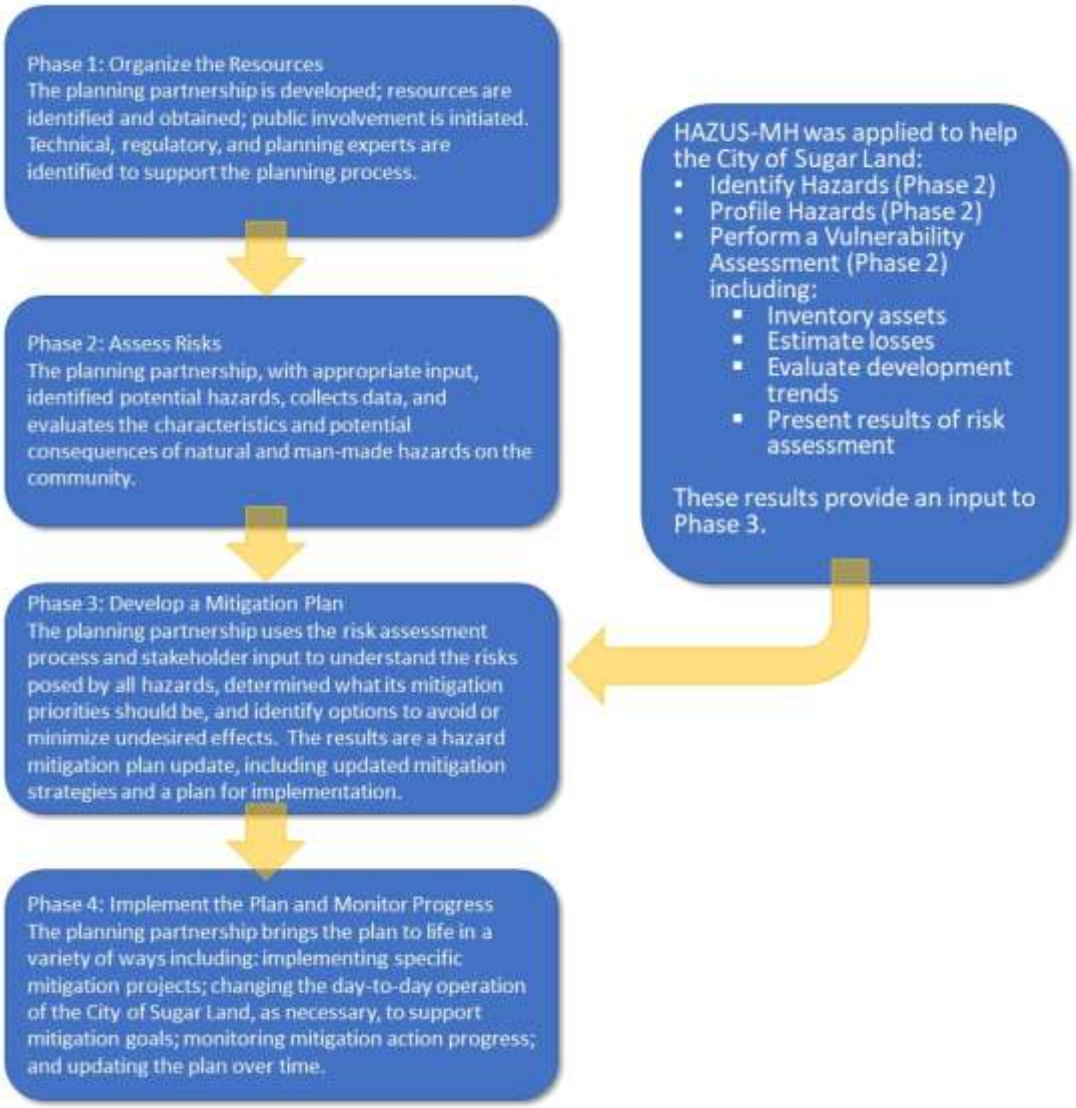
As required by the DMA 2000, the City of Sugar Land has informed the public and provided opportunities for public comment and input. Numerous agencies and stakeholders have participated as core or support members by providing input and expertise throughout the planning process. Refer to Appendix D (Public and Stakeholder Outreach) for copies of public service announcements, newspaper articles, and social media posts.

This HMP update documents the process and outcomes of the City of Sugar Land's efforts. Section 6 (Mitigation Strategy) includes documentation that the prerequisites for plan approval have been met. Section 2 (Planning Process) includes additional information on the process to develop this plan.

1.1.7 Organization of This Mitigation Plan

This HMP is organized in accordance with FEMA and TDEM guidance. The structure of this HMP follows the four-phase planning process recommended by FEMA and summarized in Figure 1-1.

Figure 1-1. City of Sugar Land Hazard Mitigation Planning Process



This HMP update includes the following sections:

Section 1: Introduction: Overview of participants and planning process.

Section 2: Planning Process: A description of the HMP methodology and development process; Steering Committee, Core Planning Team and stakeholder involvement efforts; and a description of how this HMP will be incorporated into existing programs.

Section 3: City Profile: An overview of the City of Sugar Land, including: (1) general information, (2) economy, (3) land use trends, (4) population and demographics, (5) general building stock inventory, and (6) critical facilities.

Section 4: Risk Assessment: Documentation of the hazard identification and hazard risk ranking process, hazard profiles, and findings of the vulnerability assessment (estimates of the impact of hazard events on life, safety and health; general building stock; critical facilities and the economy);

description of the status of local data; and planned steps to improve local data to support mitigation planning.

Section 6: Mitigation Strategies: Information regarding the mitigation goals and objectives identified by the Steering Committee in response to priority hazards of concern and the process by which local mitigation strategies have been developed or updated.

Section 7: Plan Maintenance Procedures: System established by the Steering Committee to continue to monitor, evaluate, maintain, and update the HMP.

Appendix A: Resolution of Plan Adoption: Resolutions from the City will be included as they formally adopt the HMP update.

Appendix B: Participation Matrix: A matrix is presented to give a broad overview of who attended meetings and when input was provided to the HMP update. Letters of Intent to Participate as described in Section 2 are also included in this appendix.

Appendix C: Meeting Documentation: Agendas, attendance sheets, minutes, and other documentation (as available and applicable) of planning meetings convened during the development of the plan.

Appendix D: Public and Stakeholder Outreach Documentation: Documentation of the public and stakeholder outreach effort including webpages, informational materials, public and stakeholder meetings and presentations, surveys, and other methods used to receive and incorporate public and stakeholder comment and input to the plan process. Survey results for both citizens and stakeholders are summarized as well.

Appendix E: FEMA Plan Review Tools: Examples of plan review templates available to support annual plan review.

1.2 THE PLAN UPDATE – WHAT IS DIFFERENT?

The City of Sugar Land's initial HMP was initially approved by FEMA and adopted by the City in 2015. The 2021 Update builds on the 2015 plan and specifically includes the following changes or enhancements. This plan differed from its predecessor for a variety of reasons:

- Updated data and tools provided for a more detailed and accurate risk assessment. Building footprint data was now available to provide a more accurate flood vulnerability assessment. The risk assessment was prepared to better support future grant applications by providing risk and vulnerability information that would directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- The plan identified implementable actions rather than strategies, with enough information to serve as the basis for policy and funding decisions and represent measurable impacts on resiliency and mitigation progress. Strategies provide direction, but actions are fundable under grant programs.

Table 1-2. Plan Changes Crosswalk

44 CFR Requirement	2015 Plan	2021 Updated Plan
Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: *(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;* *(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and* *(3) Review and incorporation, if appropriate, of existing plans, studies, reports and technical information.*	The 2015 plan followed an outreach strategy utilizing multiple media developed and approved by the Steering Committee. This strategy involved the following: • Public participation on an oversight Steering Committee. • Public meetings between City employees and citizens. • Establishment of a plan informational website. • Press releases. • Use of a public mitigation survey. Stakeholders were identified and coordinated with throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.	Building upon the success of the 2015 plan, the 2020 planning effort deployed the same public engagement methodology. The plan included the following enhancements: • Using social media. • Web-deployed survey. As with the 2015 plan, the 2020 planning process identified key stakeholders and coordinated with them throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The 2015 plan included a risk assessment of hazards of concern. It looked at assets exposed to the hazard, vulnerability, frequency of occurrence, warning time, geographic extent, potential impact, land use and development trends, and hazard summary.	Similar methodology, using new, updated data, was deployed for the 2020 plan update.
§201.6(c)(2)(i): [The risk assessment] shall include a] description of the … location and extent of all-natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	The 2015 plan presented a risk assessment of each hazard of concern. Each section included the following: • Hazard identification. • Hazard profile. • Probability of hazard affecting the City. • Assets exposed to hazard. • Vulnerability. • Land use and development trends. • Hazard summary.	The same format, using new and updated data, was used for the 2020 plan update. Each section of the risk assessment includes the following: • Hazard profile, including maps of extent and location, previous occurrences, and probability of future events. • Climate change impacts on future probability. • Vulnerability assessment including: impact on life, safety, and health, general building stock, critical facilities, and the economy, as well as future changes that could impact vulnerability. • The vulnerability assessment also includes changes in vulnerability since the 2015 plan. • Identified issues have been documented in each hazard profile.
§201.6(c)(2)(ii): [The risk assessment] shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall	Vulnerability was assessed for all hazards of concern. Each hazard of concern included a summary of assets exposed to the hazard (property risk/vulnerability, people	The same methodology was deployed for the 2020 plan update, using new and updated data. The 2020 plan update included the use of HAZUS computer model was used for the

44 CFR Requirement	2015 Plan	2021 Updated Plan
summary of each hazard and its impact on the community.	risk/vulnerability, and environment risk/vulnerability).	earthquake, flood, and hurricane hazards. These were Level 2 analyses using City data. Site-specific data on City-identified critical facilities were entered into the HAZUS model. HAZUS outputs were generated for other hazards by applying an estimated damage function to an asset inventory extracted from HAZUS-MH.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods.	A summary of NFIP insured properties including an analysis of repetitive loss property locations was included in the plan.	The same methodology was deployed for the 2020 plan update using new and updated data.
Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure and critical facilities located in the identified hazard area.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined "critical facilities" for the planning area, and these were inventoried by exposure. Each hazard profile provides a discussion on future development trends.	The same methodology was deployed for the 2020 plan update using new and updated data.
Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Loss estimates were generated for all hazards of concern by using readily available information.	Loss estimates were generated for all hazards of concern. These were generated by HAZUS for the earthquake, flood, and hurricane hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in HAZUS.
Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	There is a summary of anticipated development in the Community profile.	The same methodology was deployed for the 2020 plan update using new and updated data.
§201.6(c)(3):[The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.]	The 2015 plan contained goals, objectives, and actions. The identified actions covered multiple hazards, goals, and objectives.	The same methodology for setting goals, objectives, and actions was applied to the 2020 plan update. The Steering Committee reviewed and reconfirmed the goals and objectives for the plan. The City used the progress reporting from the plan maintenance and evaluated the status of actions identified in the 2015 plan. Actions that were completed or no longer considered to be feasible were removed. The balance of the actions was carried over to the 2020 plan, and in some cases, new actions were added to the action plan.
Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The Steering Committee identified goals and objectives targeted specifically for this hazard mitigation plan. These planning components	The same methodology for setting goals, objectives, and actions was applied to the 2020 plan update. The Steering Committee reviewed and updated the mission statement, goals,

44 CFR Requirement	2015 Plan	2021 Updated Plan
	supported the actions identified in the plan.	and objectives for the plan to include a focus on increased resiliency. This resulted in the finalization of eight goals and 26 objectives to frame the plan.
Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	For each identified hazard, goals and objectives were provided as part of the mitigation strategy for the City. The strategies were compiled into categories depending on the hazard they are related to. The strategies were then ranked.	The actions identified during the 2015 planning process were reviewed by the Core Planning Team and updated as necessary. This table was used to identified additional actions to include in the 2020 planning process.
Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	The City identified an action stating their commitment to maintain compliance and good standing under the program.	Ongoing participation in the NFIP for the City was included in ongoing capabilities.
Requirement: §201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Each recommended action was prioritized using a qualitative methodology based on the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project, and the costs of the project.	A revised methodology based on the STAPLEE criteria, incorporating new and updated data, was used for the 2020 plan update.
Requirement §201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	The 2015 plan details a plan maintenance strategy stating that the plan will be revised and maintained as required and formally adopted by the City Council after each revision.	The 2020 plan details a plan maintenance strategy similar to that of the initial plan.
Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	The 2015 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2020 plan details recommendations for incorporating the plan into other planning mechanisms such as the following: • Comprehensive Plan. • Emergency Response Plan. • Capital Improvement Programs. • Municipal Code.
Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The 2015 plan details a strategy for continuing public involvement.	The 2015 plan maintenance strategy was carried over to the 2020 plan.
Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).	The City adopted the 2015 HMP.	The 2020 plan achieves DMA compliance for the City of Sugar Land.

SECTION 2. PLANNING PROCESS

2.1 INTRODUCTION

This section includes a description of the planning process used to update the 2015 *City of Sugar Land, Texas Hazard Mitigation Plan* (HMP, also referred herein as the *Hazard Mitigation Plan* or *the plan*), including how it was prepared, who was involved in the process, and how the public was involved.

To ensure that the plan meets requirements of the DMA 2000 and that the planning process would have the broad and effective support of the City, regional and local stakeholders, and the public, an approach to the planning process and plan documentation was developed to achieve the following:

- The plan will be a single-jurisdiction plan, covering the entire City of Sugar Land.
- The plan will consider natural and non-natural hazards of concern facing the area, thereby satisfying the natural hazards mitigation planning requirements specified in DMA 2000.
- The plan will be developed following the process outlined by the DMA 2000 and FEMA regulations. Following this process ensures that all the requirements are met and support HMP review.

The City of Sugar Land HMP update was written using the best available information obtained from a wide variety of sources. Throughout the HMP update process, a concerted effort was made to gather information from municipal and regional agencies and staff, as well as stakeholders, federal and state agencies, and the residents of the City. The Steering Committee solicited information from local agencies and individuals with specific knowledge of certain hazards and past historical events. In addition, the Steering Committee took into consideration planning and zoning codes, ordinances, and recent land use planning decisions. The hazard mitigation strategies identified in this HMP update were developed through an extensive planning process involving local, county and regional agencies, residents, and stakeholders.

This section of the plan describes the mitigation planning process, including (1) Organization of the Planning Process; (2) Stakeholder Outreach and Involvement; (3) Integration of Existing Data, Plans, and Technical Information; (4) Integration with Existing Planning Mechanisms and Programs; and (5) Continued Public Involvement.

2.2 ORGANIZATION OF THE PLANNING PROCESS

This section of the plan identifies how the planning process was organized with the many planning partners involved and outlines the major activities that were conducted in the development of this HMP update.

2.2.1 Organization of Steering Committee

The City of Sugar Land applied for and was awarded a single-jurisdictional planning grant under the FEMA Hazard Mitigation Grant Program (HMGP) (DR-4332-0010), which supported the development of this update of this single-jurisdictional HMP. Project management and grant administration has been the responsibility of the City of Sugar Land Department of Fire-EMS/Emergency Management.

A contract planning consultant (Tetra Tech, Inc. referred herein as *Tetra Tech*) was selected to guide the City through the HMP update process. A contract between Tetra Tech and the City of Sugar Land was executed in July 2019 Specifically, Tetra Tech, the *contract consultant*, was tasked with the following:

- Assisting with the organization of the Core Planning Team and Steering Committee.
- Assisting with the development and implementation of a public and stakeholder outreach program.
- Data collection.
- Facilitation and attendance at meetings (Core Planning Team, Steering Committee, stakeholder, public and other).
- Review and update of the hazards of concern, hazard profiling and risk assessment.
- Assistance with the review and update of mitigation planning goals and objectives.
- Assistance with the review of past mitigation strategies progress.
- Assistance with the screening of mitigation actions and the identification of appropriate actions.
- Assistance with the prioritization of mitigation actions.
- Authoring of the draft and final plan documents.

*The goal of the **PDM** program is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. Mitigation planning is a key process used to break the cycle of disaster damage, reconstruction, and repeated damage. PDM grants are funded annually by Congressional appropriations and are awarded on a nationally competitive basis.*

Source: FEMA, 2019

To facilitate plan development, the City of Sugar Land developed a Steering Committee to provide guidance and direction to the HMP update effort and to ensure the resulting document will be embraced both politically and by the constituency within the planning area (refer to Table 2-1). Specifically, the Steering Committee was charged with the following:

- Attending and participating in Steering Committee meetings.
- Assisting with the development and completion of certain planning elements, including:
  - Reviewing and updating the hazards of concern.
  - Developing a public and stakeholder outreach program.
  - Assuring that the data and information used in the plan update process are the best available.
  - Reviewing and updating the hazard mitigation goals.
  - Identifying and screening of appropriate mitigation strategies and activities.
- Reviewing and commenting on plan documents prior to submission to TDEM and FEMA.

Table 2-1. Steering Committee Members

Name	Title	Organization	Steering Committee Member	Core Planning Team Member
Pat Hughes	Assistant Fire Chief / EMC	City of Sugar Land	X	X
Rob Valenzuela	Public Works Director	Public Works	X	X
Jessie Li	City Engineer	Engineering	X	X
Andrea Broughton	Assistant City Engineer	Engineering	X	X
Frank Garza	OEM Specialist	City of Sugar Emergency Management	X	X
Jorge Alba	Flood Mgmt. Engineer	Engineering	X	X
Sharon Shapiro	Grants Officer	City of Sugar Land	X	X
Ed Coleman	Safety Manager	Accredo Packaging Inc.	X	
Stacey Henderson	ENS Director	Animal Services	X	
Scott Schultz	Assistant Police Chief	City of Sugar Land	X	

Name	Title	Organization	Steering Committee Member	Core Planning Team Member
Danica Mueller	Facility Ops Mgr.	City of Sugar Land	X	
James Turner	Traffic Engineer	City of Sugar Land	X	
David Gornet	President	Fort Bend County Levee Improvement District #17	X	
Ng Fook "Francis" Ming	Secretary	Fort Bend County Levee Improvement District #17	X	
Keri Schmidt	President	Ft. Bend Chamber of Commerce	X	
Judy Lefevers	EMC	Ft. Bend Independent School District	X	
Sean Sevy	Director of Facilities and Security	Houston Methodist Hospital	X	
Pete Munoz	Manager	Houston Methodist Hospital	X	
Craig Kalkomey	Engineer	LJA Engineering	X	
Kord Quintero	Operations Manager	Memorial Herman Hospital Sugar Land	X	
Scott Schwalader	Plant Manager	Nalco / Champion	X	
Jason Jetton	Facilities Manager	Saint Luke's Hospital Sugar Land	X	
Ed Norman	District Coordinator 16D	Texas Division of Emergency Management	X	
Nathan Green	Assistant Fire Chief / EMC	University of Houston	X	

Appendix B (Participation Matrix), identifies those individuals who represented the municipalities during this planning effort and indicates how they contributed to the planning process.

2.2.2 Planning Activities

The Steering Committee, as well as key stakeholders, convened and/or communicated regularly to share information and participate in workshops to identify hazards; assess risks; review existing inventories of and identify new critical facilities; assist in updating and developing new mitigation goals and strategies; and provide continuity through the process to ensure that natural hazards vulnerability information and appropriate mitigation strategies were incorporated. All members of the Steering Committee had the opportunity to review the draft plan and supported interaction with other stakeholders and assisted with public involvement efforts.

A summary of Steering Committee meetings held, and key milestones met during the development of the HMP update is included in Table 2-2 that also identifies which DMA 2000 requirements the activities satisfy. Documentation of meetings (agendas, sign-in sheets, minutes, etc.) are in Appendix C (Meeting Documentation). Table 2-2 identifies only the formal meetings held during plan development and does not reflect the planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings, there was a great deal of communication between the City, committee members, and the contract consultant through individual local meetings, electronic mail (email), and by phone.

After completion of the HMP update, implementation and ongoing maintenance will become a function of the Steering Committee as described in Section 7. The Steering Committee is responsible for reviewing the HMP and soliciting and considering public comment as part of the five-year mitigation plan update.

This table summarizes a list of mitigation planning activities and meetings and their respective participants. A more detailed list of participants for each meeting is provided in Appendix C. Refer to DMA 2000 (Public Law 106-390) for details on each of the planning requirements (https://www.fema.gov/media-library-data/20130726-1524-20490-1790/dma2000.pdf).

Table 2-2. Summary of Mitigation Planning Activities / Efforts

Date	DMA 2000 Requirement	Description of Activity	Participants
October 17, 2019	2	Steering Committee Meeting #1: established Steering Committee Role/Ground rules and schedule; reviewed hazard mitigation planning and update process; defined the Planning Area for the update; defined and identified critical facilities/infrastructure; confirmed hazards of concern, reviewed data collection status/ confirmed public involvement strategy and tracking of efforts; and confirmed mission statement for the Plan	OEM, Public Works, Animal Services, Communications, Planning, Finance, Environmental, Engineering, Traffic Engineering, Dispatch, Nalco/Champion, Sugar Land Regional Airport, Sugar Land Methodist Hospital, Saint Luke's Hospital, Pages Southernland, Tetra Tech
January 16, 2020	2, 4a	Steering Committee Meeting #2: reviewed the Risk Assessment; confirmed Plan goals; conducted a capability exercise to identify strengths, weakness, obstacles and opportunities; and identified potential objectives for the Plan	Public Works, Tetra Tech
February 26, 2020	1b, 2, 3a, 3b, 3c, 3d, 3e	Risk Assessment - Public Workshop	
June 17, 2020	2, 4b	Steering Committee Meeting #3: confirmed Risk Ranking of hazards; confirmed Plan objectives; and developed mitigation actions for the Plan..	
July 29, 2020	2	Steering Committee Meeting #4: Presentation of Draft Plan to Steering Committee and provided instructions on how to submit edits and comments.	
August 21, 2020	1b, 2	Solicit Public Comment on Draft Plan – Public Workshop	

Note: All activities/efforts were conducted during the National Emergency response to the COVID-19 pandemic.
TBD = to be determined.
Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1a – Prerequisite – Adoption by the Local Governing Body
1b – Public Participation
2 – Planning Process – Documentation of the Planning Process
3a – Risk Assessment – Identifying Hazards
3b – Risk Assessment – Profiling Hazard Events
3c – Risk Assessment – Assessing Vulnerability: Identifying Assets
3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses
3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends
4a – Mitigation Strategy – Local Hazard Mitigation Goals
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures
4c – Mitigation Strategy – Implementation of Mitigation Measures
5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan
5b – Plan Maintenance Procedures – Implementation through Existing Programs
5c – Plan Maintenance Procedures – Continued Public Involvement

2.3 STAKEHOLDER OUTREACH AND INVOLVEMENT

This section details the outreach to and involvement of the many agencies, departments, organizations, non-profits, districts, authorities, and other entities that have a stake in managing hazard risk and mitigation, commonly referred to as *stakeholders*.

Diligent efforts were made to assure broad regional, county, and local representation in this planning process. To that end, a comprehensive list of stakeholders was developed with the support of the Steering Committee. Stakeholder outreach was performed early and throughout the planning process. This HMP update includes information and input provided by these stakeholders where appropriate, as identified in the references.

The following is a list of the various stakeholders that were invited to participate in the development of this plan, along with a summary of how these stakeholders participated and contributed. This summary discusses the various stakeholders that were invited to participate in the development of this HMP update and how they participated and contributed to the HMP. It should be noted that this summary listing cannot represent the sum total of stakeholders that were aware of and contributed to this HMP update, as outreach efforts were being made, both formally and informally, throughout the process by the many planning partners involved in the effort, and documentation of all such efforts is impossible. Instead, this summary is intended to demonstrate the scope and breadth of the stakeholder outreach efforts made during the plan update process.

Regional and Local Stakeholders

Appendix B (Participation Matrix) provides further details regarding regional and local stakeholder agencies. The stakeholders listed below were directly contacted by the City of Sugar Land to attend and provide public comment at the steering committee meetings, participate in the public survey, and to review and provide comments on the draft HMP. Results of the surveys are in Appendix D (Public and Stakeholder Outreach). Feedback was reviewed by the Steering Committee and integrated where appropriate in the plan.

Steering Committee

All members of the Steering Committee were notified of the HMP update process, were invited via email correspondence and meetings to provide input and notified of the draft HMP review period. Refer to Appendix D (Public and Stakeholder Outreach) for copies of the meeting minutes.

Academia

The Fort Bend Independent School District, and University of Houston Sugarland participated as a member of the Steering Committee and provided regular input at the Steering Committee meetings, and was notified and invited to review and provide comments on the draft HMP review period. The following have provided input in person or virtually at Steering Committee meetings, as well as through the City's online stakeholder survey:

- Ft. Bend Independent School District
- University of Houston – Sugarland
- Wharton County Junior College

Hospitals and Healthcare Facilities

All hospitals and healthcare facilities located in City were invited to take the stakeholder survey and provide input to the planning process. All three of the following hospitals participated as a member of the SC and provided regular input at the SC meetings, and were notified and invited to review and provide comments on the draft HMP review period:

- Saint Luke's Hospital Sugar Land
- Houston Methodist Hospital
- Memorial Herman Hospital Sugar Land

Highway and Public Works

All state, county, and local highway and public works departments were notified of the Highway and Public Work's stakeholder survey and invited to provide input on the draft HMP. In addition, many of the participating municipalities had representatives from their highway and public works departments representing them on the planning partnership. The following provided input to the planning process via the City's online stakeholder survey:

- City of Sugar Land Environmental and Neighborhood Services
- City of Sugar Land Facility Operations
- City of Sugar Land Traffic Engineering
- City of Sugar Land Public Works
- City of Sugar Land Flood Management

Emergency Services

All state, county and local emergency service providers (police, fire, and EMS) were notified of the Emergency Services stakeholder survey and invited to provide input on the draft HMP. The City of Sugar Land Emergency Management, Fire and Police Departments participated as members of the SC and provided regular input at the SC meetings, and was notified and invited to review and provide comments on the draft HMP review period. The following have provided input in person or virtually at SC meetings, as well as through the City's online stakeholder survey:

- Fort Bend County Emergency Management
- City of Sugarland Emergency Management
- City of Sugar Land Police Department
- City of Sugar Land Fire Department
- Texas State Guard
- Texas Department of Public Safety
- Texas Division of Emergency Management – District Coordinator

Utilities

Utility providers in the City were notified of the Utility Stakeholder survey and invited to provide input on the draft HMP.

- Comcast – Telecommunications

Business and Commercial Interests

Businesses and commercial industries in the City were notified of the stakeholder survey and invited to provide input on the draft HMP. Accredo Packaging Inc., Fort Bend Chamber of Commerce, LJA Engineering, and Nalco/Champion participated as members of the SC and provided regular input at the SC meetings, and was notified and invited to review and provide comments on the draft HMP review period. The following have provided input in person or virtually at SC meetings, as well as through the City's online stakeholder survey:

- Ft. Bend Chamber of Commerce

- Accredo Packaging Inc.
- Nalco / Champion
- LJA Engineering
- Texas Instruments
- Ecolab

Additional Stakeholders

The Fort Bend County Levee Improvement District #17 participated as members of the SC and provided regular input at the SC meetings, and was notified and invited to review and provide comments on the draft HMP review period. The following have provided input in person or virtually at SC meetings, as well as through the City's online stakeholder survey:

- Fort Bend County Levee Improvement District #17
- NOAA
- RedCross
- USACE
- Brazos River Authority

2.3.1 Public Outreach

The Core Planning Team and Steering Committee have made the following efforts toward public participation in the development and review of the HMP:

- A public project website was developed and is being maintained to facilitate communication between the Core Planning Team, Steering Committee, public and stakeholders (https://www.sugarlandtx.gov/1852/Hazard-Mitigation-Plan-Update). The public website contains a project overview, contact information, access to the citizen's survey and various stakeholder surveys, and sections of the HMP for public review and comment (see Figure 2-1)

Figure 2-1. City of Sugar Land HMP Webpage

- All hazard mitigation planning meetings that were open to the public were advertised on the City of Sugar Land's website.
- An on-line natural hazards preparedness citizen survey was developed to gauge household preparedness relevant to hazards in the City of Sugar Land and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards. The questionnaire asks quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs. The questionnaire also asks several demographic questions to help analyze trends. The questionnaire was posted on the City's public website on February 25, 2020 and available for over five months to facilitate public input garnering 112 responses. The survey results were provided to the Steering Committee to use to identify vulnerabilities and develop mitigation strategies. A summary of survey results is provided in Appendix D (Public and Stakeholder Outreach) of this plan.

> Over 110 responses provided feedback and input via the citizen survey.

- Starting in May 2021, draft sections of the plan (as available) were posted on the project website for public review and comment.

- Once approved by TDEM/FEMA, the final HMP will be available on the City website.

2.4 INTEGRATION WITH EXISTING PLANNING MECHANISMS AND PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the City of Sugar Land, there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate, coordinate with, and complement, those existing plans and programs.

The *Capability Assessment* section of Section 6 (Mitigation Strategy) provides a summary and description of the existing plans, programs and regulatory mechanisms in the City that support hazard mitigation. A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7 (Plan Maintenance).

2.5 CONTINUED PUBLIC INVOLVEMENT

The City of Sugar Land is committed to the continued involvement of the public in the hazard mitigation process. This HMP update will be posted online at https://www.sugarlandtx.gov/HMP . Due to COVID-19 and efforts to limit physical contact, electronic copies of the plan are available for download from the website and upon request at EMC@sugarlandtx.gov.

A notice regarding annual updates of the plan and the location of plan copies will be publicized annually after the Steering Committee's annual evaluation and posted on the public website at https://www.sugarlandtx.gov/HMP

The public will have an opportunity to comment on the plan as a part of the annual mitigation planning evaluation process and the next five-year mitigation plan update. The HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the plan.

Further details regarding continued public involvement are provided in Section 7 (Plan Maintenance).

After completion of this plan, implementation and ongoing maintenance will continue to be a function of the Steering Committee. The Steering Committee will review the plan and accept public comment as part of an annual review and as part of five-year mitigation plan updates.

A notice regarding annual updates of the plan and the location of plan copies will be publicized annually after the Steering Committee's annual evaluation and posted on the public web site.

Pat Hughes, City of Sugar Land Assistant Fire Chief, is identified as the City of Sugar Land HMP Coordinator in Section 7 (Plan Maintenance), and is responsible for receiving, tracking, and filing public comments regarding this plan. Contact information is: EMC@sugarlandtx.gov

SECTION 3. CITY PROFILE

This profile provides general information for the City of Sugar Land and critical facilities located within the City. Examining the City's physical setting, population and demographics, general building stock, and land use and population trends leads to a better understanding of the study area, including economic, structural, and population assets at risk, and concerns that could be related to hazards analyzed later in this plan.

3.1 GENERAL INFORMATION

This urban area originated as the Oakland Plantation. The earliest settlers arrived in the 1820's to plant the area with cotton, corn, and sugar cane. By 1843, the City of Sugar Land had its own sugar mill and Benjamin Franklin Terry, famous for leading Terry's Texas Rangers, and William Jefferson Kyle purchase the Plantation in 1852. In 1853, the pair of pioneers renamed the plantation Sugar Land. Following the Civil War, a Confederate veteran by the name of Colonel Edward H. Cunningham purchased the property and built the first sugar refinery as well as the first railroad. His leadership grew the area from a fledgling town to a booming industrial city that included a store, post office, paper mill, acid plant, meat market, boarding house, and depot.

The City of Sugar Land was incorporated in 1959 as a "General Law" city and remained such until January 17, 1981, at which time a special city election was held to establish a municipal government. Voters approved the adoption of a home rule charter in accordance with the constitution and statutes of the state of Texas. The type of municipal government provided by this Charter was known as "mayor-council" government and all powers of the City were invested in a Council composed of a mayor and five councilmen. An amendment on May 5, 1990, changed the composition of the City Council to a mayor, four council members to be elected by single-member districts, and two council members by at-large position. This composition remains in effect, with term limits of eight consecutive years.

3.2 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. No specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts operationalizes federal recovery programs to assist disaster victims, businesses and public entities. Programs can be matched by state programs. Review of presidential disaster declarations helps establish the probability of reoccurrence for each hazard and identify targets for risk reduction. Table 3-1 shows FEMA disaster declarations that have included Fort Bend County (including the City of Sugar Land) through 2020 (records date back to 1983).

Table 3-1. History of Hazard Events in Fort Bend County, Texas

Disaster Number	Declaration Date	Event Date	Incident Type	Title
DR-689	August 19, 1983	August 18-20, 1983	Hurricane	Hurricane Alicia
DR-930	December 26, 1991	December 20, 1991-January 14, 1992	Flood	Severe Thunderstorms
DR-1239	August 26, 1998	August 22-31, 1998	Severe Storm(s)	Tropical Storm Charley
DR-1041	October 18, 1994	October 14-November 8, 1994	Flood	Severe Thunderstorms And Flooding
DR-1606	September 24, 2005	September 23-October 14, 2005	Hurricane	Hurricane Rita

Disaster Number	Declaration Date	Event Date	Incident Type	Title
DR-1379	June 9, 2001	June 5-20, 2001	Coastal Storm	Tx-Tropical Storm Allison-06-06-2001
DR-1439	November 5, 2002	October 24-November 15, 2002	Severe Storm(s)	Severe Storms, Tornadoes And Flooding
DR-1257	October 21, 1998	October 17-November 15, 1998	Flood	Tx-Flooding 10/18/98
FM-2639	May 26, 2006	May 26, 2006	Fire	Lake Olympia Fire
EM-3142	September 1, 1999	August 1-December 10, 1999	Fire	Extreme Fire Hazards
EM-3294	September 10, 2008	September 7-26, 2008	Hurricane	Hurricane Ike
DR-1624	January 11, 2006	November 27-May 14, 2005	Fire	Extreme Wildfire Threat
EM-3216	September 2, 2005	August 29-October 1, 2005	Hurricane	Hurricane Katrina Evacuation
EM-3277	August 18, 2007	August 17-September 5, 2007	Hurricane	Hurricane Dean
EM-3261	September 21, 2005	September 20-October 14, 2005	Hurricane	Hurricane Rita
EM-3290	August 29, 2008	August 27-September 7, 2008	Hurricane	Hurricane Gustav
DR-1791	September 13, 2008	September 7-October 2, 2008	Hurricane	Hurricane Ike
DR-4269	April 25, 2016	April 17-30, 2016	Flood	Severe Storms And Flooding
DR-4223	May 29, 2015	May 4-June 22, 2015	Severe Storm(s)	Severe Storms, Tornadoes, Straight-Line Winds And Flooding
DR-4272	June 11, 2016	May 22-June 24, 2016	Flood	Severe Storms And Flooding
DR-4332	August 25, 2017	August 23-September 15, 2017	Hurricane	Hurricane Harvey
EM-3458	March 13, 2020	January 20, 2020	Biological	COVID-19
DR-4485	March 25, 2020	January 20, 2020	Biological	COVID-19 Pandemic

3.3 PHYSICAL SETTING

This section presents the physical setting of the City, including land use/land cover, location, climate, hydrography and hydrology, topography and geology.

3.3.1 Location

The City of Sugar Land is located in southeast Texas. It is located southwest of Houston in Fort Bend County, where it borders the cities of Stafford and Missouri City. The City of Sugar Land has a total area of 24.9 square miles, with land accounting for 24.1 square miles of the area. This land is utilized mostly for residential development as well as commercial and industrial use. The urban area is 71.7 percent residential, 15.97 percent commercial, and 12.3 percent industrial.

3.3.2 Topography and Geology

Sugar Land is part of the Coastal Prairie physiographic province, underlaid by Deltaic sands and muds in a nearly flat strata. The topography consists of a nearly flat prairie, with slopes of less than one foot per mile towards the Gulf of Mexico. Sugar Land is located in the Gulf Coast Prairie and Marshes ecoregion of Texas, which is characterized by expansive rolling brushlands and prairies that transition to estuarine marshes and dune environments. Sugar Land and greater Fort Bend County are a small part of this ecosystem, which stretches from Louisiana to Mexico. The Brazos River, which runs through the southern portion of the City, is a major influence in this environment. Benchmark elevations in the City range from approximately 80 feet in the northern and eastern sections of the City to approximately 60-70 feet elsewhere (City of Sugar Land 2020).

3.3.3 Hydrography and Hydrology

The City of Sugar Land is located in both the Brazos River Basin and San Jacinto-Brazos Coastal Basin. In terms of local waterways, the City falls in the Austin/Oyster sub-basin and Oyster Creek sub-watershed of the San Jacinto-Brazos Coastal Basin and the Lower Brazos sub-basin of the Brazos River Basin. An overview of the basins has been provided via the City of Sugar Land Water Conservation Program.

Upper Oyster Creek

The City's future surface water supply comes directly from the Upper Oyster Creek, located within the San Jacinto-Brazos River Coastal Basin, southwest of Houston within the northern portion of Fort Bend County. However, the primary source of water for the Oyster Creek watershed will be pumpage from the Brazos River as surface water becomes a more dominant use in the watershed; therefore, water will be supplied indirectly from the Brazos River Basin as well. Over the years, Upper Oyster Creek has been significantly modified, and it currently serves as a segment of a water conveyance system operated by the Gulf Coast Water Authority. Seasonally, water is pumped into Upper Oyster Creek from the Brazos River to provide agricultural and industrial water resources to the region.

In the near future, additional water supplies will be pumped through Oyster Creek from the Brazos River to serve as the primary potable water source for the City of Sugar Land, adding municipal use to the category of uses served. Surface water traveling through the Oyster Creek watershed will supply approximately 60 percent of the potable water demand for the City and its Groundwater Reduction Plan participants by the year 2025. The City also leases water rights held on Oyster Creek by the Fort Bend County Water Control and Improvement District No. 1 for the future use of non-potable water supply projects for irrigation and lake filling.

The Upper Oyster Creek watershed occupies approximately 278 square kilometers and lies within a climatic region classified as subtropical humid with hot summers and dry winters. The watershed is quickly becoming urbanized and includes portions of several municipalities, including Fulshear, Missouri City, Stafford, and Sugar Land. With the numerous urbanized areas located within the Upper Oyster Creek watershed, the watershed is affected by a variety of sources ranging from municipal and industrial wastewater discharges to storm water runoff

In June 2001, the Texas Commission on Environmental Quality (TCEQ) initiated two Total Maximum Daily Load (TMDL) studies on Oyster Creek: a bacteria study and a dissolved oxygen study. The TCEQ has conducted these studies as an element of the TMDL program initiated by the Environmental Protection Agency. Oyster Creek was selected for this program due to its classification as a historically impaired water body and its listing on the Texas 303(d) List for high bacteria levels and low concentrations of dissolved oxygen.

The Upper Oyster Creek Bacteria TMDL was adopted by the TCEQ on August 8, 2007. During the Implementation Phase of the TMDL process, the stakeholders will coordinate with the TCEQ to formulate and implement a plan detailing reasonable best management practices (BMPs) that may help lower bacteria levels in Upper Oyster Creek. As the Implementation Phase progresses, the City will revise the Storm Water Master Plan to reflect TMDL requirements. In addition, the Upper Oyster Creek Dissolved Oxygen TMDL was similarly adopted. Upon completion and adoption of the TMDL study, the stakeholders will coordinate efforts to ensure proper implementation of the TMDL requirements.

Growth in and around this potable source watershed, in the City and its extraterritorial jurisdiction (ETJ); the growing scarcity of state water resources; the greater costs involved in treating and distributing surface water; and the ecological impact of greater water withdrawals all offer incentive to promote water conservation as one tool among many in a comprehensive water supply and quality solution for the City of Sugarland and the region.

Brazos River

The City of Sugarland's wastewater treatment plants discharge into the Brazos River (far downstream of the pumping station that feeds Oyster Creek to the northwest. The Brazos River also serves, as noted above, as the future potable water source for the City. The Brazos River is greatly affected by seasonal variation in water quality in great part due to the series of reservoirs operated by the Brazos River Authority. The releases from these reservoirs often include elevated levels of chlorides.

3.3.4 Climate

Sugar Land's temperatures range from an average low of 44 degrees in January to an average high of 94 degrees in July. The City receives approximately 45 inches of rainfall each year (FEMA FIS). The growing season lasts 296 days, with first freezes typically occurring on December 7 and the last freeze occurring on February 14. The City receives moderating climatic influences due to its proximity to the Gulf of Mexico (Fort Bend County 2020).

3.3.5 Land Use and Land Cover

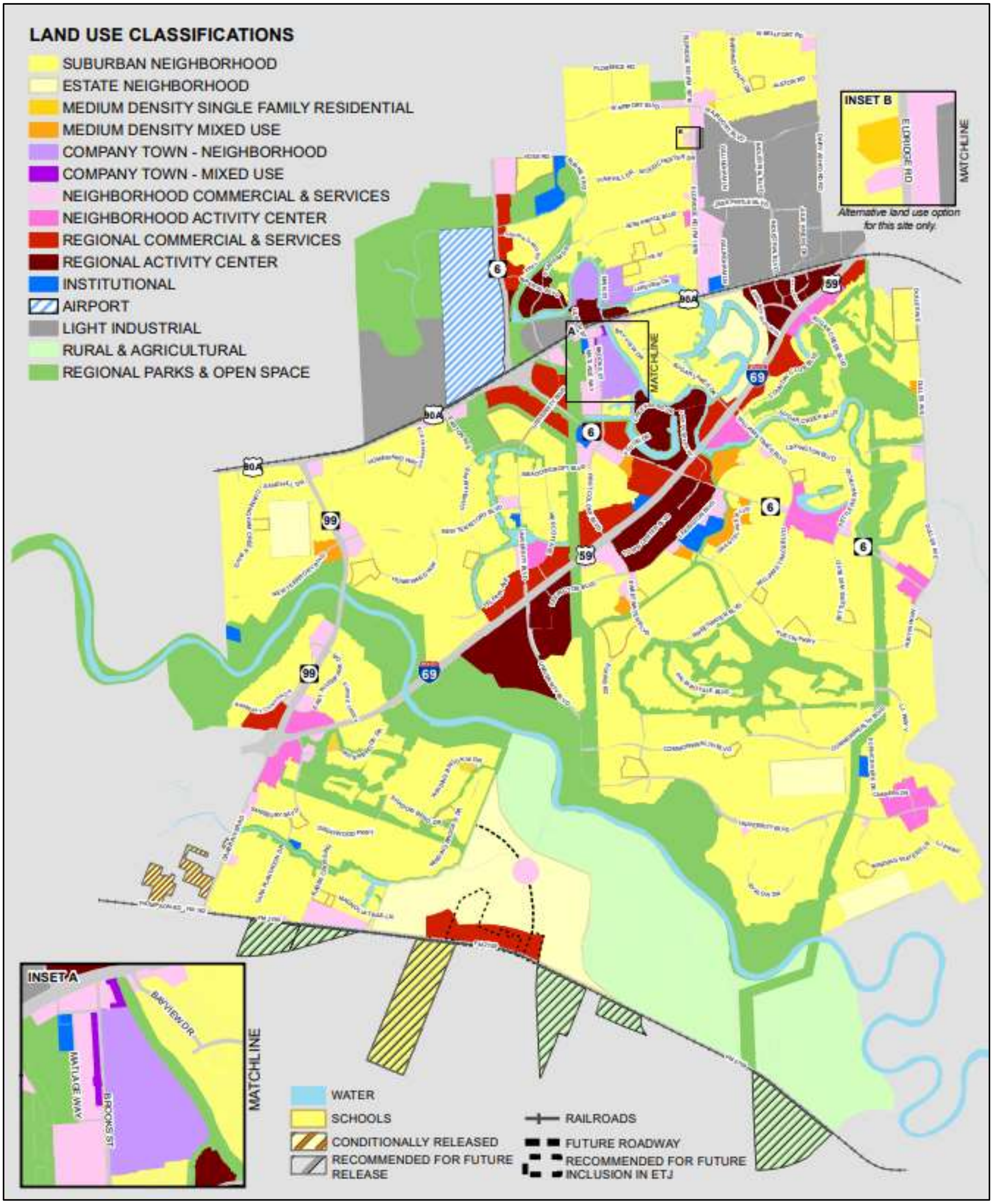
The prevailing land use type in Sugar Land is single-family residential, which comprises nearly one-quarter of land area. Vacant land accounts for only 6.9% of the City, whereas streets account for 14.09% of its area. Agriculture continues to account for a significant portion of the City's land area (10%), particularly in the southern section of the City. Table 3-2 summarizes the land use for Sugar Land. Figure 3-1 shows the distribution of land use throughout the City.

Table 3-2. Land Use Breakdown for City and ETJ, 2016

Land Use	Percent of City (%)	Land Use	Percent of City (%)
Single-Family Residential	24.97%	Commercial	3.28%
Street	14.09%	Office	1.5%
Open Space	12.47%	Rural Residential	1.47%
Agriculture	10.18%	Vacant Residential	0.9%
Vacant Nonresidential	6%	Utility	0.66%
Park	5.76%	Multifamily	0.54%
Civic	5.71%	Townhome	0.12%
Water Drainage	4.81%	Extended Residential	0.11%
Water	3.84%	Mixed Use - Nonresidential	0.07%
Industrial	3.51%		

Source: City of Sugar Land, 2016

Figure 3-1. 2016 Land Use in Sugar Land, Texas



3.4 POPULATION AND DEMOGRAPHICS

According to the 2018 American Community Survey, Sugar Land had a population of 118,812 people which represents a significant increase from the 2010 U.S. Census population of 78,817 people. HAZUS demographic data will be used in the loss estimation analyses in Section 4 of this plan. All demographic data in HAZUS corresponds to the 2010 U.S. Census data. Table 3-3 presents the population statistics for Sugar Land based on the 2000 and 2010 U.S. Census data. For the purposes of this plan, the 2010 Census was used where the data was available and supplemented with HAZUS data (representing 2010 data).

Table 3-3. Population Statistics in Sugar Land

Municipality	2000 Census	2010 Census	2018 ACS
Sugar Land	63,328	78,817	118,182

Population and Demographic Trends

This section discusses population trends to use as a basis for estimating future changes that could result from the seasonal character of the population and significantly change the character of the area. Population trends can provide a basis for making decisions on the type of mitigation approaches to consider and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

According to the U.S. Census Bureau, the 2010 population for Sugar Land was 78,817 persons, which is a 24.5% increase from the 2000 Census population of 63,328. Over the last 58 years, from 1960 to 2018, the City has seen notable population growth. The largest increase in absolute terms was between 2010 and 2018, whereas the largest increase in percentage came between 1980 and 1990.

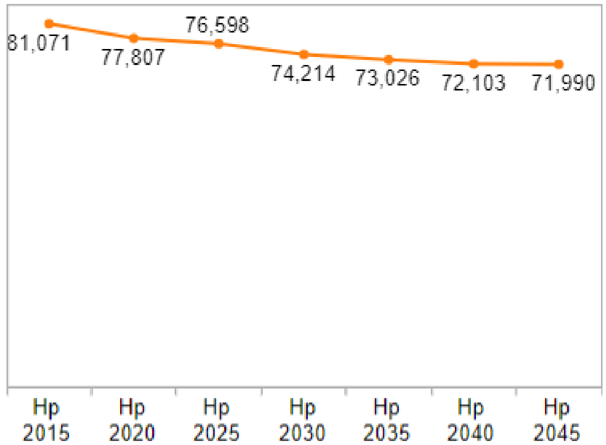
Table 3-4. Sugar Land Population Trends, 1960 to 2018

Year	Population	Change in Population	Percent (%) Population Change
1960	2,802	-	-
1970	3,318	516	18.4%
1980	8,826	5,508	166.0%
1990	24,529	15,703	177.9%
2000	63,328	38,799	158.2%
2010	78,817	15,489	24.5%
2018	118,812	39,995	50.7%

Source: Sugar Land Comprehensive Plan; U.S. American Community Survey 2018 (Five-Year)
Note: Change in population and percent in population change were calculated from available data.

The Houston-Galveston Area Council, the Metropolitan Planning Organization for Sugar Land and Fort Bend County, has produced population estimates for the region that were last updated in 2018 based on 2010 Census data (Houston-Galveston Area Council 2020). Contrary to what is estimated in the 2018 American Community Survey data, the H-GAC reports that the population in households will decline to 77,807 people by 2020 and continue declining through 2045. The H-GAC Regional Growth Forecast anticipates that job growth and household growth will increase slightly during through 2045.

Figure 3-2. Sugar Land Population Estimates and Projection, 2015 to 2045



Source: H-GAC 2018
Note: 2010 data is derived from the Decennial Census; 2011-2018 data is derived from five-year ACS population estimates

3.4.1 Vulnerable Populations

DMA 2000 requires that HMPs consider socially vulnerable populations. These populations can be more susceptible to hazard events, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. For the purposes of this study, vulnerable populations shall include (1) the elderly (persons aged 65 and over) and (2) those living in low-income households.

Table 3-5. Sugar Land Vulnerable Population Statistics

Municipality	ACS 2018			U.S. Census 2010				
	Total	Pop. 65+	% Pop. 65+	Total	Pop. 65+	Percent Pop. 65+	Low-Income Pop.*	% Low-Income Pop. of Total
Sugar Land	118,182	17,100	14.5%	78,817	8,162	10.2%	N/A	N/A

Source: American Community Survey (2019); Census 2010 (U.S. Census Bureau);
Note: Pop. = population;
** Individuals below poverty level (Census poverty threshold for a 3-person family unit is approximately $18,500)*

It is noted that the Census data for household income provided in HAZUS includes two ranges ($0-10,000 and $10,000-$20,000/year) that were totaled to provide the "low-income" data used in this study. This does not correspond exactly with the "poverty" thresholds established by the 2019 U.S. Census Bureau, which identifies households with three adults and no children with an annual household income below $19,998 per year, or households with one adult and two children with an annual household income below $20,598 per year as "low income" for this region. This difference is not believed to be significant for the purposes of this planning effort.

The 2018 American Community Survey data identified approximately 5,873 people in Sugar Land living below the poverty line. This represents approximately five percent of the population. Though this is an absolute increase from 2012, the proportion of individuals in poverty has declined by 4.4% since 2012.

Income

The 2018 American Community Survey 5-Year Estimates provides that the median household income in Sugar Land was $122,233. The U.S. Census Bureau identifies households with two adults and two children with an annual household income below $25,465 per year as *low income* (U.S. Census 2018). The 2018 American Community Survey 5-Year Estimates indicates that a total of five percent of persons are below the poverty level within the City.

The spatial U.S. Census data for household income provided in HAZUS includes two ranges (less than $10,000 and $10,000-$20,000/year) that were totaled to provide the *low-income* data used in this study. This does not correspond exactly with the *poverty* thresholds established by the 2016 U.S. Census Bureau data. This difference is not believed to be significant for the purposes of this planning effort; therefore, for the exposure and loss estimations in the risk assessment, the 2010 U.S. Census data in HAZUS is reported.

Physically or Mentally Disabled

According to the Centers for Disease Control, "Persons with a disability include those who have physical, sensory, or cognitive impairment that might limit a major life activity (Centers for Disease Control 2015)." Cognitive impairments can increase the level of difficulty that individuals might face during an emergency and reduce an individual's capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability can face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2018 American Community Survey, 7.3 percent of residents in Sugar Land are living with a disability.

Non-English Speakers

Individuals who are not fluent or working proficiency in English are vulnerable because they can have difficulty with understanding information being conveyed to them. Cultural differences also can add complexity to how information is being conveyed to populations with limited proficiency of English (Centers for Disease Control 2015). According to the 2018 American Community Survey, nearly 43.6% of the City's population over the age of 5 primarily speaks a language other than English at home. Approximately, 2,354 households (or 6.1%) speak limited English.

3.4.2 General Building Stock

For this Plan, the default general building stock in Hazus was updated and replaced with a custom building inventory for Sugar Land both at the aggregate and structure level. The building stock update was performed using 2019 certified assessor data from the Fort Bend Central Appraisal District (FBCAD). The replacement cost value was calculated using the square footage value of each building and RS Means 2019 data.

For the purposes of this plan, there are approximately 39,824 structures identified through data provided by the FBCAD. These structures account for a replacement cost value of approximately $49.4 billion (structure and contents). Estimated content value was calculated by using 50-percent of the residential replacement cost value, and 100-percent of the non-residential replacement values. Using this methodology, there is approximately $22.3 billion in contents within these structures. Approximately 97% of the total buildings in the City are residential, which make up approximately 41.3% of the building stock structural value associated with residential housing. Table 3-6 presents building stock statistics by occupancy class for the City.

Table 3-6. Number of Buildings and Improvement Value in Sugar Land

		All Occupancies		
Municipality	Count	Estimated Structure RCV	Estimated Contents RCV	Total (Structure + Contents)
City Limits	37,060	$25,815,078,015	$21,589,683,642	$47,404,761,657
ETJ – Riverstone/LID 15	2,764	$1,302,976,458	$735,988,790	$2,038,965,248

Source: Fort Bend Central Appraisal District (FBCAD)
Notes: RCV = Replacement cost value.

3.5 LAND USE AND POPULATION TRENDS

Texas exhibits a limited type of home rule for municipalities that meet population thresholds. Pursuant to Title 7, Section 211 of Local Government Code, a home-rule municipality can regulate the bulk of buildings as well as land use. Zoning regulations are required to be consistent with a comprehensive plan per Section 211.004. The City of Sugar Land has increased in size as it has annexed master planned communities from unincorporated portions of Fort Bend County. To promote orderly development and make recommendations to City Council about land use, the City established a Planning and Zoning Commission in 1981.

This Hazard Mitigation Plan provides a general overview of population, land use, and types of development occurring within the study area. An understanding of these development trends can assist in planning for further development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

3.5.1 Land Use Trends

According to the Sugar Land Comprehensive Plan, the City has a development pattern that derives from its history as a sugar manufacturing town to a more suburban community with employment from service occupations and management, business, science, and arts compromising the majority of the City's workforce by 2010. The City's Land Use Plan Update notes a number of trends impacting the City, including an aging population (with the median age rising from 30.4 years in 1980 to 41.2 years in 2010), aging housing stock due to the majority of units being constructed in the 1980s and 1990s, a decrease in average household sizes, and a diminishing amount of vacant land. Additionally, an increasing amount of the City's workforce lives outside the City.

Economy

The U.S. Census Bureau's Economic Census provides an annual series of sub-national economic data by industry covering the majority of the country's economic activity. According to the 2017 Sugar Land Economic Census, the healthcare and social assistance sector provides the plurality of jobs and establishments, comprising more than $581 million in payrolls. The professional services industry comprises the highest payroll (more than $1 billion) and the second-highest number of jobs.

Table 3-7. 2017 Economic Census for Sugar Land, Texas

Sector	# of Establishments	# of employees	Annual payroll ($1,000)
Utilities	11	204	$20,281
Wholesale trade	203	2,947	$171,080
Retail trade	546	8,629	$219,430
Transportation and warehousing	61	815	$47,084
Information	58	1,174	$ 76,854
Finance and insurance	294	3,895	$300,966
Real estate and rental and leasing	212	516	$23,930
Professional, scientific, and technical services	643	9,908	$1,037,874
Administrative and support and waste management and remediation services	145	4,148	$165,925
Educational services	79	679	$14,702
Health care and social assistance	740	12,100	$581,812
Arts, entertainment, and recreation	45	g	D

Sector	# of Establishments	# of employees	Annual payroll ($1,000)
Accommodation and food services	377	8,118	$145,447
Other services (except public administration)	190	1,559	$39,588
Total	**3,604**	**54,692**	**$2,844,973**

Source: U.S. Census, Economic Census 2017
G= 1,000-2,499
D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals.

Agriculture

Though the amount of farmland in Sugar Land has declined as the City has developed, farmland continues to play an important role in the City and Fort Bend County. The US Department of Agriculture produces a Census of Agriculture that tracks agricultural data on the County level. In Fort Bend County, the number of farms has decreased by 10% since 2012 and the acreage of farms has decreased 18% in the same time. Though crops account for a significantly larger share of sales (83%) than livestock and poultry (17%), nearly half (43%) of the County's farm acreage is pastureland. Fort Bend County 's agriculture products generate $85 million in sales each year (a decline of 18%), with grains, oilseeds, dry beans, dry peas; cotton and cottonseed; and nursery products generating the vast majority of farm sales (USDA 2020).

Corridors and Gateways

As a suburb of Houston and significant portion of the Greater Houston metropolitan area, Sugar Land's access to Houston and the rest of the region is a significant contributor to its growth and desirability as a residential and commercial community. Interstate 69, which stretches from nearby Rosenberg through Houston and north to Cleveland, Texas, stretches for eight miles through the City of Sugar Land. State Highway 99, known as the Grand Parkway, passes through the western section of the City and will eventually be a 180-mile circumferential highway that connects seven counties in the greater Houston Area (Texas Department of Transportation 2017). The intersection of State Highway 6 and Interstate 69 is a major crossroads in the City and the site of major commercial developments. State Highway 6 continues east to Bayou Vista and Interstate 45 into Galveston, and also continues north through to US 290 in Wortham Grove. Finally US-90 Alt passes through the northern section of the City, connecting Port Houston and areas south of I-10 before re-joining the Interstate near Seguin, Texas.

3.5.2 Population Trends

Sugar Land, like the rest of the greater Houston metropolitan area, has grown significantly in recent years. Between 2010 and 2018 alone, the estimated population has increased from 76,080 residents to 118,182 residents- a 55% increase. The City has grown steadily since 1970. By 1980, the City's population had more than doubled to 8,826 residents. By 1990, it increased to 24,529 residents. Between 1990 and 2000, the City added nearly 40,000 residents- more than doubling in size. During this time, the City's median age increased from 30.4 years in 1980 to 41.2 years in 2010. The number of persons per household fell from 3.18 to 2.9, and median household income rose from $27,992 to $101,611.

As the City has grown, it has also aged and change composition. Between 1980 and 2000, those between the ages of 25 and 44 years old represented the plurality of residents. As of 2010, those between the ages of 45 and 64 years of age represent the plurality. Whereas the population share of those between the ages of 15 and 24 years has remained relatively constant, the share of residents between the ages of 0 and 14 years has declined from 28.5% to 19.4% in the same time. The City has also diversified racially and ethnically, with the share of Black residents increasing by 2.4% and the share of Asian residents increased from 1% in 1980 to 35.1% in 2010. In comparison to Fort Bend County, and the City of Houston, Sugar Land has a higher percentage of White residents and a significantly higher percent of Asian residents, yet a smaller proportion of Black and Hispanic residents.

3.5.3 Future Growth and Development

In 2012, the City of Sugar Land updated the majority of its City of Sugar Land Comprehensive Plan. This includes chapter 1-5, which covers the history of comprehensive planning in Sugar Land, provides a community profile, and details development trends. The Land Use Plan, which is Chapter 6 of the City of Sugar Land Comprehensive Plan, is undergoing an update and is not complete as of the completion of the City of Sugar Land Hazard Mitigation Plan.

Future development in Sugar Land is influenced by the following factors:

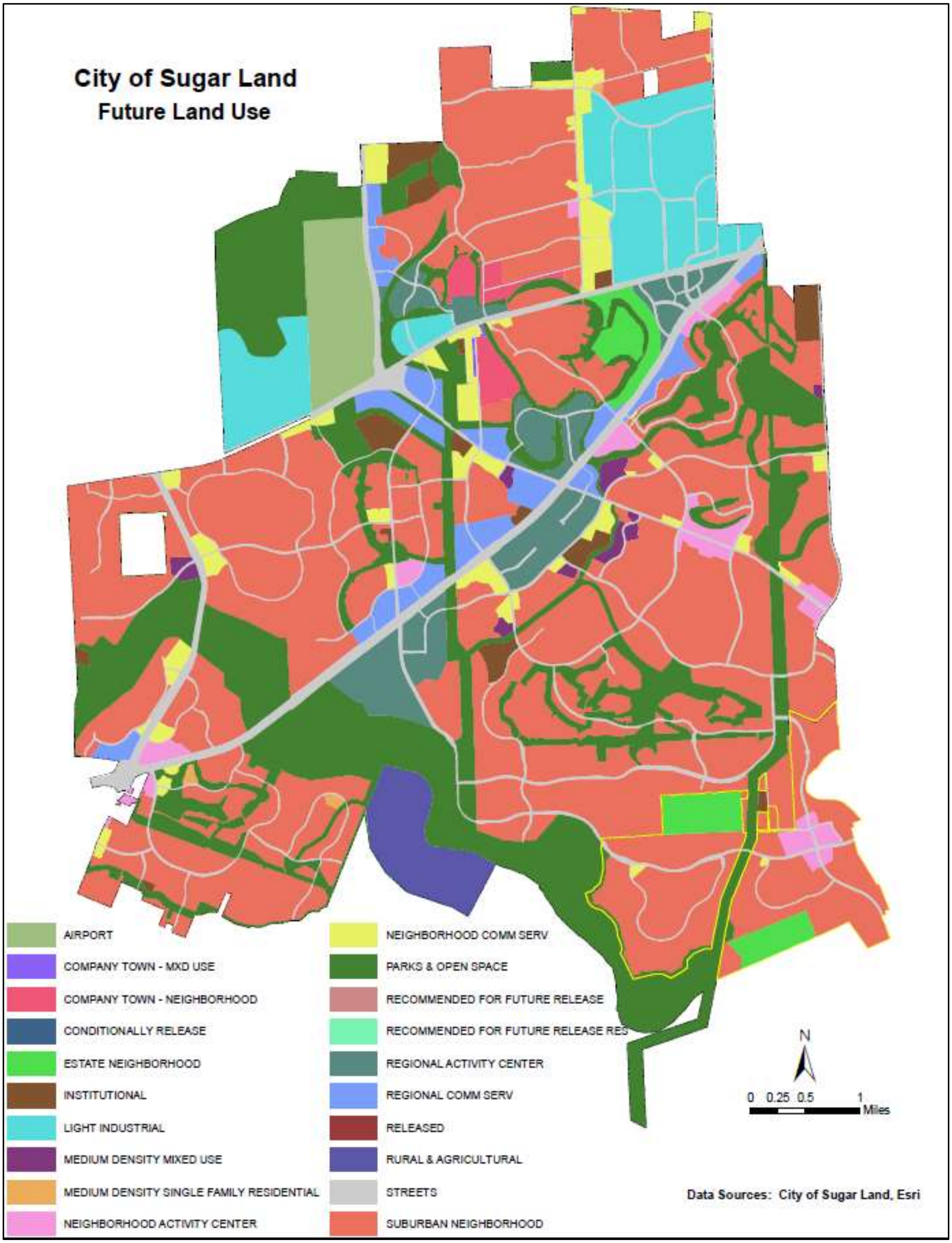
- Development of vacant residential land within the City limits and annexation of existing residential neighborhoods in the extraterritorial jurisdiction (ETJ) will increase the population to 95,313 people by 2020.
- Full build out of residential land within the January 2012 City limits will likely occur by 2025. At full build out, population increases may require new development patterns to accommodate a larger variety of housing opportunities.
- Redevelopment may become more commonplace as the region becomes more densely developed. The economics of such redevelopment may drive commercial redevelopment to occur at a higher density with a mix of uses.
- Areas south of the Brazos River will likely experience increased development pressures because of limited development opportunities north of the River. The City's Future Land Use Plan (2012) designates this area primarily as large residential estate lots. The relatively limited access via F.M. 2759 will limit the speed and types of development feasible in this area.

According to the Comprehensive Plan, development in the City is guided by the City's Development Code and Subdivision regulations. Developments over 50 acres in size proposed for residential use or over 30 acres for non-residential use must follow an approved general plan. This process for larger developments has allowed the City to plan future growth. The general plan outlines the land use, circulation, and building phases of the proposed project. The general plan process also allows for the coordination with City master plans like the Thoroughfare Master Plan, Pedestrian and Bicycle Master Plan, and the utility master plans for Water and Wastewater. The City Council and Planning and Zoning Commission must approve the general plan before the development occurs, and the general plan serves as a guide throughout the development process.

There are two major developments currently underway in the City of Sugar Land. Lake Point Towne Center is largely developed and is a custom-zoned, planned development of nearly 200 acres that includes residential, office, retail, medical, and recreational uses. It will be a waterfront urban village with portions of the property being gated communities with access to nearly any type of service needed. Another major development is Telfair, formerly State Prison Farm Tracts 4 and 5. Development includes a mix of residential living units as well as including a civic center, elementary school, extensive trail and lake system, retail and commercial space, the Houston Museum of Natural Science at Sugar Land, and a city fire station.

Additionally, the Imperial redevelopment project is going through development and zoning approval process; the Central Prison Unit is now zoned for M-1 Restricted Industrial land use, providing large-scale commercial and industrial development opportunities; and the redevelopment of Riverstone in the City ETJ is currently underway. The first residential development is underway, a stadium was built in 2012, and all of the major streets are constructed. Figure 3-3 is the map of future land use planned for City of Sugar Land.

Figure 3-3. Future Land Use Map of Sugar Land, Texas



3.6 CRITICAL FACILITIES

Critical infrastructure and facilities are those that are essential to the health and welfare of the population. These facilities are especially important after any hazard event. Critical facilities are those that maintain essential and emergency functions and are typically defined to include police and fire stations, schools, and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need and the utilities that provide water, electricity, and communication services to the community. Also included are Tier II facilities (hazardous materials) and rail yards; rail lines hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event.

> ***Critical Facilities*** are those facilities considered critical to the health and welfare of the population and that are especially important following a hazard. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities, and hazardous material facilities.
>
> ***Essential facilities*** are a subset of critical facilities that include those facilities that are important to ensure a full recovery following the occurrence of a hazard event. For the City risk assessment, this category was defined to include emergency (police, fire, EMS), hospitals and health care, schools, and government facilities.

A comprehensive inventory of critical facilities in Sugar Land was developed from various sources including input from the Steering Committee. The inventory of critical facilities presented in this section represents the current state of this effort at the time of publication of the HMP and was used for the risk assessment in Section 4.

3.6.1 Essential Facilities

This section provides information on emergency facilities, hospital and medical facilities, schools, shelters and senior care and living facilities. For the purposes of this plan, emergency facilities include police, fire, emergency medical services (EMS), and emergency operations center.

Emergency Facilities

For the purposes of this Plan, emergency facilities include police, fire, emergency medical services (EMS) and emergency operations centers (EOC). Table 3-8 identifies these facilities within Sugar Land.

Table 3-8. Emergency Facilities in Sugar Land

Name	Type	Address	Backup Power
Police and Courts Facility	Police Station	1200 SH 6 S	-
Fort Bend County EMS Medic	EMS	1514 SOUTH PARKWAY BLVD	-
FIRE STATION #1	Fire Station	555 MATTLAGE WAY	-
FIRE STATION #2	Fire Station	1040 INDUSTRIAL BLVD	-
FIRE STATION #3	Fire Station	2255 SETTLER'S WAY BLVD	-
FIRE STATION #4	Fire Station	2100 AUSTIN PKWY	-
FIRE STATION #5	Fire Station	5735 COMMONWEALTH BLVD	-
FIRE STATION #6	Fire Station	6255 SANSBURY	-
FIRE STATION #7	Fire Station	1301 Chatham Ave	-

Source: *City of Sugar Land*
\- *Unknown/not available*

Figure 3-4. Planning Area Critical Facilities in Sugar Land, Texas – Map 1

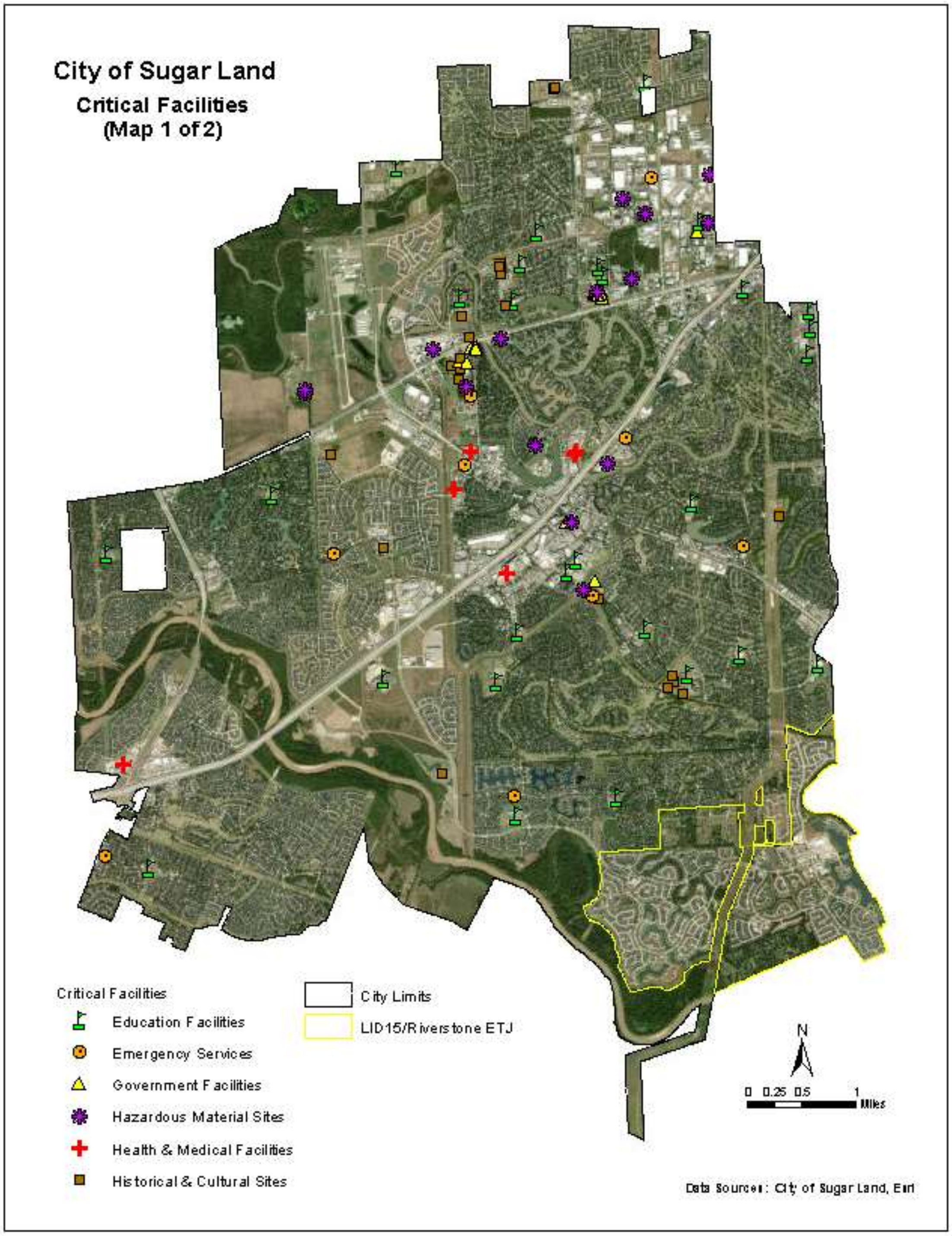
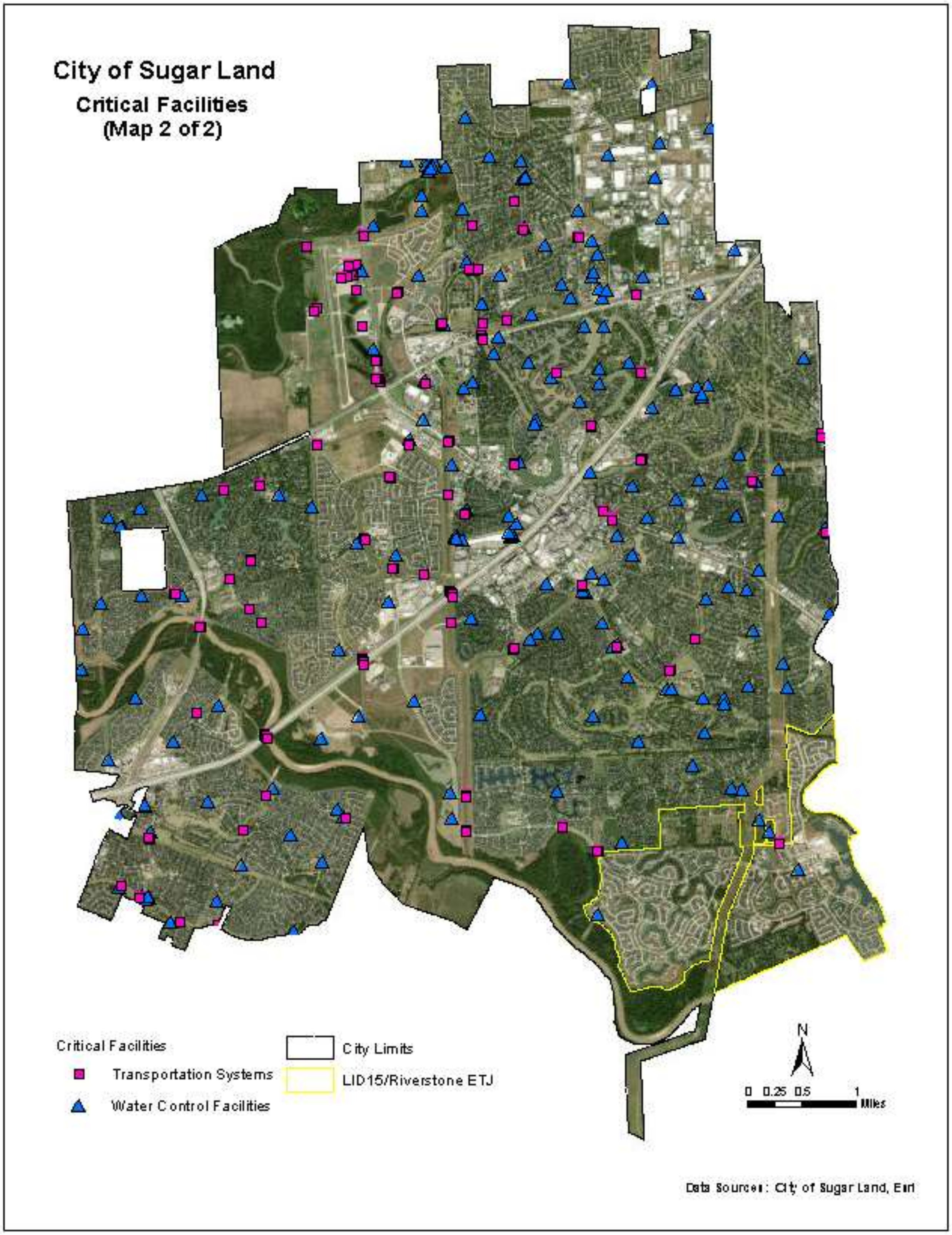


Figure 3-5. Planning Area Critical Facilities in Sugar Land, Texas – Map 2



Hospitals and Medical Facilities

Table 3-9 identifies hospitals and medical facilities in Sugar Land.

Table 3-9. Hospital and Medical Facilities in Sugar Land

Name	Type	Address	Backup Power
KINDRED HOSPITAL	Hospital	1550 FIRST COLONY BLVD	-
MD ANDERSON	Hospital	1327 LAKE POINTE PKWY	-
MEMORIAL HERMANN MEDICAL FACILITY	Hospital	1111 SOUTH SH 6	-
MEMORIAL HERMANN SUGAR LAND	Hospital	17500 W GRAND PKWY S	-
ST. LUKES HOSPITAL	Hospital	1317 LAKE POINTE PKWY	-
SUGAR LAND METHODIST HOSPITAL	Hospital	16655 SOUTHWEST FWY N	-

Source: City of Sugar Land
- *Unknown/not available*

Schools

Table 3-10 identifies educational facilities in Sugar Land.

Table 3-10. Schools in Sugar Land

Name	Type	Address	Backup Power
UNIVERSITY OF HOUSTON - SUGAR LAND	College/university	14000 UNIVERSITY BLVD	-
WHARTON COUNTY JUNIOR COLLEGE	College/university	550 JULIE RIVERS DR	-
FORT BEND ISD - SOUTH - ATHLETIC FAC	Education Facility	16403 LEXINGTON BLVD	-
FORT BEND ISD - SOUTH - SUPPORT SERVICES	Education Facility	16431 LEXINGTON BLVD	-
KIDS DAY OUT-SUGAR CREEK BAPTIST CHURCH	Education Facility	13213 SOUTHWEST FWY N	-
M R WOOD ALTERNATIVE EDUCATION CENTER	Education Facility	139 AVENUE E	-
AUSTIN PARKWAY ELEMENTARY	Elementary School	4400 AUSTIN PKWY	-
BARRINGTON PLACE ELEMENTARY	Elementary School	2100 SQUIRE DOBBINS DR	-
BRAZOS BEND ELEMENTARY SCHOOL	Elementary School	621 CUNNINGHAM CREEK BLVD	-
COLONY BEND ELEMENTARY	Elementary School	2720 PLANTERS ST	-
COLONY MEADOWS ELEMENTARY	Elementary School	4510 SWEETWATER BLVD	-
COMMONWEALTH ELEMENTARY SCHOOL	Elementary School	4909 COMMONWEALTH BLVD	-
DICKINSON ELEMENTARY SCHOOL	Elementary School	7110 GREATWOOD PKWY	-
DULLES ELEMENTARY SCHOOL	Elementary School	630 DULLES AVE	-
FORT BEND BAPTIST ACADEMY - ELEMENTARY	Elementary School	1201 LAKEVIEW DR	-
FORT BEND BAPTIST ACADEMY - GYMNASIUM	Elementary School	1250 SEVENTH ST	-
HIGHLANDS ELEMENTARY SCHOOL	Elementary School	2022 COLONISTS PARK DR	-

Name	Type	Address	Backup Power
LAKEVIEW ELEMENTARY SCHOOL	Elementary School	314 LAKEVIEW DR	-
SETTLERS WAY ELEMENTARY	Elementary School	3015 SETTLERS WAY BLVD	-
SUGAR MILL ELEMENTARY SCHOOL	Elementary School	13707 JESS PIRTLE BLVD	-
WALKER STATION ELEMENTARY	Elementary School	6200 HOMEWARD WAY	-
CLEMENTS HIGH SCHOOL	High School	4200 ELKINS RD	-
DULLES HIGH SCHOOL	High School	550 DULLES AVE	-
KEMPNER HIGH SCHOOL	High School	14777 VOSS RD	-
DULLES MIDDLE SCHOOL	Middle School	500 DULLES AVE	-
FIRST COLONY MIDDLE SCHOOL	Middle School	3225 AUSTIN PKWY	-
FORT SETTLEMENT MIDDLE SCHOOL	Middle School	5440 ELKINS RD	-
SUGAR LAND MIDDLE SCHOOL	Middle School	321 SEVENTH ST	-

Source: City of Sugar Land
- *Unknown/not available*

Government Facilities

Table 3-11 identifies government facilities in Sugar Land.

Table 3-11. Government Facilities in Sugar Land

Name	Type	Address	Backup Power
ANIMAL SERVICES	Government Building	101 GILLINGHAM LN	-
BUILDING A / OLD ARCHIVES BUILDING	Government Building	111 BROOKS ST	-
BUILDING B / KSLB	Government Building	115 BROOKS ST	-
BUILDING C / ARC	Government Building	123 BROOKS ST	-
CITY HALL	Government Building	2700 TOWN CENTER BLVD N	-
FIRE ADMINISTRATION AND ANNEX	Government Building	10405 CORPORATE DR	-
PARKS ADMINISTRATION	Government Building	10405 Corporate Dr.	-
PUBLIC WORKS ADMINISTRATION 1	Government Building	111 GILLINGHAM	Yes
PUBLIC WORKS ADMINISTRATION 2	Government Building	111 GILLINGHAM	Yes
PUBLIC WORKS CAR WASH AND EQUIPMENT SHED	Government Building	111 GILLINGHAM	Yes
PUBLIC WORKS FUEL FACILITY	Government Building	111 GILLINGHAM	Yes
PUBLIC WORKS SIGN SHOP	Government Building	111 GILLINGHAM	Yes
PUBLIC WORKS WAREHOUSE AND GARAGE	Government Building	111 GILLINGHAM	Yes
U S POST OFFICE	Post Office	3130 GRANTS LAKE BLVD	-
US POST OFFICE	Post Office	225 MATLAGE WAY	-

Source: City of Sugar Land
- *Unknown/not available*

3.6.2 Transportation Systems

The transportation system of the City of Sugar Land is a network of roadways, highways, and rail lines that provide for travel within Fort Bend County and the City and to major centers in surrounding counties and states. Table 3-12 through Table 3-13 identify the transportation systems found in the City of Sugar Land.

Airport Facilities

Sugar Land is home to the Sugar Land Regional Airport, an executive airport located in the northwestern section of the City. Table 3-12 below shows airport facilities in the City.

Table 3-12. Airport Facilities in Sugar Land

Name	Address	Back Up Power
AIRPORT - OLD TERMINAL BUILDING	224 TERMINAL LN	-
AIRPORT - AIR TRAFFIC CONTROL TOWER	1509 ELLIS RD	-
AIRPORT LEASE - CORPORATE II HANGAR	550-A JIM DAVIDSON	-
AIRPORT LEASE - HOUSTON AVIATION HANGAR	1288 SH 6 S	-
AIRPORT - NEW T-HANGERS	12892 S SH 6	-
AIRPORT LEASE - FRANK'S CASSING HANGAR	12718 DIAMOND DR	-
AIRPORT LEASE - NOBLE DRILLING HANGAR	12800 DIAMOND DR	-
AIRPORT LEASE - NORTHWEST HANGAR COMPLEX	400, 400-A, 415 HULL RD	-
AIRPORT LEASE - SOLAPP AVIATION HANGAR	1511 ELLIS RD	-
AIRPORT TERMINAL - NEW BUILDING	12888 SH 6 S	Yes

Source: City of Sugar Land
\- *Unknown/not available*

Bridges

Of the roadway bridges in the City, those identified in Table 3-13 are listed as critical.

Table 3-13. Critical Roadway Bridges in Sugar Land

Name	Name	Name	Name	Name
Austin Pkwy N at Ditch (FC Middle Sch)	Flour Daniel N at Brooks Lake	Lexington Blvd N at SH 6	SH 6 N at Smithville	University Blvd N at Ditch "H"
Austin Pkwy N at Ditch (FS #4)	Flour Daniel S at Brooks Lake	Lexington Blvd S at SH 6	SH 6 S Oyster Creek north of airport	University Blvd N at Old River
Austin Pkwy S at Ditch (FC Middle Sch)	Grand Pkwy N at Brazos River	Lexington Blvd at Ditch "H"	SH 6 S at Ditch	University Blvd N at Telfair Lake south
Austin Pkwy S at Ditch (FS #4)	Grand Pkwy S at Brazos River	Lexington Blvd E at Oyster Creek	SH 6 S at Ditch "H"	University Blvd N/S at 90A
Burnet RD at Ditch	Greatwood PKWY at Ditch	Lexington Blvd W at Oyster Creek	SH 6 S at Oyster Creek	University Blvd S at Ditch
Cabrera DR	Greatwood PKWY at Ditch NB	Lombardy DR at Eldridge Lake	SH 6 S at Smithville	University Blvd S at Ditch "H"
Commonwealth Blvd E at Ditch "H"	Greatwood PKWY at Ditch sb	Macek RD at Rabbs Bayou	SH 6 S at Smithville to 90A	University Blvd S at Old River
Commonwealth Blvd W at Ditch "H"	Green Fields DR	Main ST	Shadow Bend DR at Ditch	University Blvd S at Telfair Lake south
Creek Bend DR E at Oyster Creek	Harmon St at Oyster Creek	Meadowcroft at Ditch	SW Fwy N at Brazos River	University Blvd W near Ravenwood
Creek Bend DR W at Oyster Creek	Hidden Lake LN	New Territory Blvd at Ditch EB	SW Fwy N at Ditch "H"	US 59 N at Brazos River
Crisfield DR at detention Lake	Homeward Way at Detention Lake	New Territory Blvd at Ditch WB	SW Fwy N at UH Ditch	US 59 N at Ditch "H"
Dulles Ave N at American Water Canal	Homeward Way at Ditch	New Territory Blvd E at Ditch	SW Fwy S at Brazos River	US 59 N at UH Ditch

Name	Name	Name	Name	Name
Dulles Ave N at Ditch	Homeward Way at Ditch	New Territory Blvd E at Telfair Lake	SW Fwy S at Ditch "H"	US 59 S at Brazos River
Dulles Ave N at Oyster Creek	Homeward Way at Gateway Blvd	New Territory Blvd W at Ditch	SW Fwy S at UH Ditch	US 59 S at Ditch "H"
Dulles Ave S at American Water Canal	Imperial Blvd E at Oyster Creek	New Territory Blvd W at Telfair Lake	Sweetwater Blvd E at Ditch	US 59 S at UH Ditch
Dulles Ave S at Ditch	Imperial Blvd E at Oyster Creek (Ulrich)	Rabbs Crossing at Rabbs Bayou	Sweetwater Blvd S at Ditch	US 90 A E at Oyster Creek
Dulles Ave S at Oyster Creek	Imperial Blvd W at Oyster Creek	Schlumberger DR N at Cleveland Lk Ditch	Sweetwater Blvd S at Ditch	US 90 A W at Oyster Creek
East Riverpark DR at Ditch	Imperial Blvd W at Oyster Creek (Ulrich)	Schlumberger DR S at Cleveland Lk Ditch	Sweetwater Blvd W at Ditch	Wescott Ave at Telfair Lake
Eaton AVE at Ditch	Jess Pirtle E at Ditch	SH 6 N Oyster Creek north of airport	Tara Blvd at Rabbs Bayou	West Alkire Lake DR at Alkire Lake
Eldridge RD N at Ditch	Jess Pirtle W at Ditch	SH 6 N Access at Smithville	University Blvd N at Ditch	Williams Trace Blvd N at Oyster Creek
Eldridge RD S at Ditch	Kempner at Oyster Creek	SH 6 N at Ditch	University Blvd N at Telfair Lake north	Williams Trace Blvd S at Oyster Creek
First Colony Blvd N at MDE Lakes	Knoll Forest DR at Rabbs Bayou	SH 6 N at Ditch "H"	University Blvd S at Telfair Lake north	Winding Brook East DR at Ditch
First Colony Blvd S at MDE Lakes	Lakeway DR	SH 6 N at Oyster Creek	University Blvd E near Ravenwood	Wood ST

Source: City of Sugar Land

3.6.3 Lifeline Utility Systems

This section presents potable water, wastewater, energy resource, and communication utility system data. Due to heightened security concerns, local utility lifeline data sufficient to complete the analysis have only partially been obtained. The City of Sugar Land's Water Utilities Department operates and maintains City water plants, water wells, ground storage tanks, elevated storage tanks, and high service booster pumps, sanitary sewer lift stations, and wastewater treatment facilities.

Potable Water

Potable water facilities are identified in Table 3-14.

Table 3-14. Potable Water Facilities in Sugar Land

Name	Type	Address	Back Up Power
GREATWOOD EAST GROUNDWATER PLANT	Groundwater Facility	8915 PARK RIVER DR	-
GREATWOOD WEST GROUNDWATER PLANT	Groundwater Facility	6660 GREATWOOD PKWY	-
HOMEWARD WAY GROUNDWATER PLANT-ELEC/PUMP	Groundwater Facility	5505 HOMEWARD WAY	-
NEW TERRITORY GROUNDWATER PLANT	Groundwater Facility	4421 NEW TERRITORY	-
THOMPSON CHAPEL GROUNDWATER PLANT	Groundwater Facility	4603 THOMPSON CHAPEL	-
WOODCHESTER GROUND WTR PLANT - CHEM BLDG	Groundwater Facility	13743 WOODCHESTER DR	-
WOODCHESTER GROUNDWATER PLANT-OFFICE BLDG	Groundwater Facility	13743 WOODCHESTER DR	-
WOODCHESTER GROUNDWATER PLANT-PUMP/ELEC	Groundwater Facility	13743 WOODCHESTER DR	-
AUSTIN PKWY WATER PLANT	Potable Water Facility	1402 AUSTIN PKWY	-

Name	Type	Address	Back Up Power
FIRST COLONY BLVD WATER PLANT	Potable Water Facility	1950 FIRST COLONY BLVD	-
INDUSTRIAL ELEVATED WATER TANK	Potable Water Facility	1040 INDUSTRIAL BLVD	-
LAKEVIEW WATER PLANT	Potable Water Facility	1101 LAKEVIEW DR	-
MASON RD ELEVATED WATER TANK	Potable Water Facility	13944 OAKWOOD LN	-
MERRICK ELEVATED WATER TANK	Potable Water Facility	722 MERRICK DR	-
RIVERSTONE WATER PLANT	Potable Water Facility	5200 ROSEWOOD MANOR LN	-
SETTLERS WAY WATER STORAGE FACILITY	Potable Water Facility	2216 SCENIC RIVERS DR	-
SUGAR CREEK WATER PLANT - CHEMICAL BLDG	Potable Water Facility	2330 COUNTRY CLUB BLVD	-
SUGAR CREEK WATER PLANT - OFFICE/PUMP RM	Potable Water Facility	2330 COUNTRY CLUB BLVD	-
SURF WTR TREAT PLANT-MAIN/MEMBRANE BLDG	Surface Water Facility	14601 VOSS RD	-
SURFACE WRE TREATMENT PLANT-SLUDGE BLDG	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREAT PLANT-LOW LIFT PMP STA	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREAT PLANT-RAW WTR PUMP STA	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREATMENT PLANT - CHEM BLDG	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREATMENT PLANT - ELEC BLDG	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREATMENT PLANT - FLOC BLDG	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREATMENT PLANT - GAC BLDG	Surface Water Facility	14601 VOSS RD	-
SURFACE WTR TREATMENT PLANT - MAINT BLDG	Surface Water Facility	14601 VOSS RD	-
ELDRIDGE RD OFF SITE WELL	Well	1106 ELDRIDGE RD	-
FIRST COLONY OFF-SITE WELL	Well	4226 WILLOW BANK	-
FIRST COLONY OFF-SITE WELL	Well	1112 SOLDIERS FIELD DR	-
FORT BEND COUNTY MUD #106 WATER WELL	Well	6660 GREATWOOD PKWY	-
FORT BEND COUNTY MUD WATER WELL #1	Well	4603 THOMPSTON CHAPEL	-
LAKEVIEW #2 WELL	Well	1106 ELDRIDGE	-
LAURA RD OFF SITE WELL	Well	13330 LAURA MORRIS DR	-
SUGAR CREEK OFF SITE WELL	Well	2331 COUNTRY CLUB BLVD	-
SUGAR LAND WATER WELL #2	Well	2628 GRANTS LAKE BLVD	-
SUGAR LAND WATER WELL #3	Well	2120 FIRST COLONY BLVD	-
SUGAR LAND WATER WELL #4	Well	5206 WILLOW BANKS	-
SUGAR LAND WATER WELL #5	Well	1600 SOLDIERS FIELD DR	-

Source: City of Sugar Land
- *Unknown/not available*

Wastewater Facilities

Wastewater facilities in Sugar Land are identified in Table 3-15.

Table 3-15. Sugar Land Wastewater Treatment Facilities and Pump Stations

Name	Type	Address	Back Up Power
AIRPORT HANGAR LIFT STATION	Lift Station	101 JIM DAVIDSON DR	-
AIRPORT LIFT STATION	Lift Station	151 JIM DAVIDSON DR	-
ALSTON LIFT STATION	Lift Station	12702 ALSTON RD	-
ANIMAL SERVICES LIFT STATION	Lift Station	101 GILLINGHAM LN	-
AUBURN TRAIL LIFT STATION (MUD 68 LS 2)	Lift Station	1012 Cunningham Creek BLVD	-
AUSTIN PKWY GWP BATHROOM LIFT STATION	Lift Station	1402 AUSTIN PKWY	-
AUSTIN PKWY LIFT STATION	Lift Station	3802 AUSTIN PKWY	-
AVENUE A LIFT STATION	Lift Station	90 AVENUE A	-
AVONDALE LIFT STATION	Lift Station	5219 AVONDALE DR	-
BALL PARK LIFT STATION	Lift Station	201 SEVENTH ST	-
BAYBRIDGE LIFT STATION	Lift Station	775 SUGAR LAKES DR	-
BIG MESQUITE LIFT STATION	Lift Station	3552 MESQUITE DR	-
BIG SWEETWATER LIFT STATION	Lift Station	3130 SWEETWATER BLVD	-
BOURNEWOOD LIFT STATION	Lift Station	633 GREEN BELT DR	-
BRAZOS RIVER PARK LIFT STATION	Lift Station	18427 N SOUTHWEST FWY	-
CAMPBELL ELEM LIFT STA (MUD 117 LS 3)	Lift Station	1801 WINDING BROOK E DR	-
CENTRAL LIFT STATION	Lift Station	2108 COUNTRY CLUB BLVD	-
CHAR LAKE LIFT STATION	Lift Station	11425 UNIVERSITY	-
COLONIST PARK LIFT STATION	Lift Station	1910 COLONIST PARK DR	-
COMMONWEALTH LIFT STATION	Lift Station	5328 COMMONWEALTH BLVD	-
CORELLIS LIFT STATION	Lift Station	2370 WILLIAMS TRACE BLVD	-
CREEK BEND LIFT STATION	Lift Station	15906 CREEK BEND DR	-
DAIRY ASHFORD LIFT STATION	Lift Station	12010 DAIRY ASHFORD RD	-
DAIRYBROOK COVE LIFT STA (MUD 69 LS 1)	Lift Station	5605 DAIRYBROOK CV	-
DEER HOLLOW LIFT STATION (MUD 109 LS 2)	Lift Station	626 DEER HOLLOW DR	-
ELDRIDGE PARK LIFT STATION	Lift Station	2415 ELDRIDGE RD	-
ELKINS LIFT STATION	Lift Station	4428 ELKINS RD	-
ELLICOTT LIFT STATION	Lift Station	29 ELLICOTT WAY	-
ELLIS CREEK LIFT STATION (MUD 67 LS 1)	Lift Station	510 ELLIS CREEK BLVD	-
FC NORTH LIFT STATION	Lift Station	2002 FIRST COLONY BLVD	-
FERRY LANDING LIFT STATION	Lift Station	2745 FERRY LANDING	-
FESTIVAL SITE LIFT STATION	Lift Station	18355 N SOUTHWEST FWY	-

Table 3-15. Sugar Land Wastewater Treatment Facilities and Pump Stations

Name	Type	Address	Back Up Power
FIRST COLONY GWP BATHROOM LIFT STATION	Lift Station	2002 FIRST COLONY BLVD	-
FIRST COLONY PARK LIFT STATION	Lift Station	3232 AUSTIN PKWY	-
FIRST COLONY PARK SUMP LIFT STATION	Lift Station	3233 AUSTIN PKWY	-
FLUOR LIFT STATION	Lift Station	5 FLUOR DANIEL DR	-
FRONTIER LIFT STATION	Lift Station	3914 FRONTIER DR	-
GABLE MEADOWS LIFT STATION	Lift Station	5400 GABLE MEADOWS DR	-
GANNOWAY LIFT STATION	Lift Station	1711 BURNEY RD	-
GARDEN BROOK LIFT STATION (MUD 106 LS 2)	Lift Station	1210 GARDEN BROOK	-
GILLINGHAM LIFT STATION	Lift Station	1441 GILLINGHAM LN	-
GLEN LAUREL LIFT STATION	Lift Station	14355 W AIRPORT BLVD	-
GRANTS LAKE LIFT STATION	Lift Station	2932 GRANTS LAKE BLVD	-
GREAT LAKES (LAKEFIELD) LIFT STATION	Lift Station	3122 GREAT LAKES AVE	-
GREAT LAKES LIFT STATION	Lift Station	2920 GREAT LAKES AVE	-
GREATWOOD LAKE LIFT STA (MUD 106 LS 1)	Lift Station	6825 GREATWOOD PKWY	-
GREYWOOD LIFT STATION	Lift Station	13810 JESS PIRTLE BLVD	-
HARMAN LIFT STATION	Lift Station	14316 HARMAN ST	-
HOME DEPOT LIFT STATION	Lift Station	15595 N SOUTHWEST FWY	-
HORSESHOE LIFT STATION	Lift Station	410 W ALKIRE LAKE DR	-
IMPERIAL BLVD LIFT STATION	Lift Station	IMPERIAL BLVD	-
INDUSTRIAL LIFT STATION	Lift Station	520 INDUSTRIAL BLVD	-
INVERRARY LIFT STATION	Lift Station	87 INVERRARY	-
JURGENSON LIFT STATION	Lift Station	2225 JURGENSON LN	-
KANEB LIFT STATION	Lift Station	14250 CENTRAL DR	-
KEMPNER LIFT STATION	Lift Station	14801 VOSS RD	-
KINGFISHER LIFT STATION	Lift Station	535 KINGFISHER DR	-
KNIGHTS BRANCH LIFT STA (MUD 112 LS 2)	Lift Station	4715 KNIGHTS BRANCH DR	-
KNIGHTSBRIDGE LIFT STATION	Lift Station	4119 KNIGHTSBRIDGE BLVD	-
KNOLL FOREST LIFT STATION (MUD 109 LS 1)	Lift Station	923 KNOLL FOREST DR	-
LAKEVIEW LIFT STATION	Lift Station	801 LAKEVIEW DR	-
LAVENDER FIELD LIFT STA (MUD 117 LS 4)	Lift Station	2650 WINDING BROOK E DR	-
LEXINGTON - WALKING TRAIL LIFT STATION	Lift Station	14400 LEXINGTON BLVD	-
LEXINGTON AMC LIFT STATION	Lift Station	16631 LEXINGTON BLVD	-
LEXINGTON EASEMENT LIFT STATION	Lift Station	14243 LEXINGTON BLVD	-
LIFT STATION	Lift Station	422 BROOKS	-

Table 3-15. Sugar Land Wastewater Treatment Facilities and Pump Stations

Name	Type	Address	Back Up Power
LIFT STATION	Lift Station	2042 COUNTRY CLUB BLVD	-
LIFT STATION	Lift Station	3122 GRANTS LAKE BLVD	-
LIFT STATION	Lift Station	3441 MESQUITE DR	-
LIFT STATION	Lift Station	3441 SETTLERS WAY BLVD	-
LIFT STATION	Lift Station	16331 SETTLERS WAY	-
LIFT STATION	Lift Station	3744 ST. MICHAELS COURT	-
LITTLE MESQUITE LIFT STATION	Lift Station	2718 MESQUITE DR	-
LITTLE SWEETWATER LIFT STATION	Lift Station	3212 SWEETWATER BLVD	-
LOST CREEK PARK LIFT STATION	Lift Station	3703 LOST CREEK BLVD	-
LYNNWOOD LIFT STATION	Lift Station	1537 ALDERBROOK DR	-
MAIN STREET LIFT STATION	Lift Station	312 MAIN ST	-
MARKET PLACE LIFT STATION	Lift Station	13520 PARKLANE BLVD	-
MATLAGE LIFT STATION	Lift Station	422 BROOKS	-
MAYOR DUGGAN LIFT STATION	Lift Station	1204 HORSESHOE DR	-
MAZDA LIFT STATION	Lift Station	12910 EXECUTIVE DR	-
MEADOW LAKE LIFT STATION	Lift Station	1722 FIRST COLONY BLVD	-
MEADOWLARK LIFT STATION	Lift Station	1011 MEADOWLARK LN	-
MEMORIAL DOG PARK LIFT STATION	Lift Station	15300 UNIVERSITY BLVD	-
MEMORIAL PARK LIFT STATION	Lift Station	15300 UNIVERSITY BLVD	-
MILLROCK LIFT STATION	Lift Station	3935 MILLROCK CIR	-
MOODY RAMBIN LIFT STATION	Lift Station	14889 S PARKWAY BLVD	-
NEAL LIFT STATION	Lift Station	815 NEAL DR	-
NEW PUBLIC WORKS LIFT STATION	Lift Station	101 GILLINGHAM LN	-
NEW TERRITORY LIFT STATION	Lift Station	7120 NEW TERRITORY BLVD	-
NORTH DULLES - 2150 LIFT STATION	Lift Station	2114 DULLES AVE	-
OXBOW LIFT STATION	Lift Station	17430 LEXINGTON BLVD	-
OYSTER CREEK LIFT STATION	Lift Station	214 OYSTER CREEK DR	-
OYSTER CREEK PARK LIFT STATION	Lift Station	4333 S SH 6	-
OYSTER POINT LIFT STATION	Lift Station	1540 OYSTER POINT DR	-
PALM ROYALE LIFT STATION	Lift Station	4645 PALM ROYALE BLVD	-
PARADISE POINT LIFT STATION	Lift Station	11 PARADISE POINT DR	-
PINEHAVEN LIFT STATION	Lift Station	1211 SEVENTH ST	-
PLANTERS ROW LIFT STATION	Lift Station	2538 PLANTERS ROW	-
PUBLIC WORKS LIFT STATION	Lift Station	111 GILLINGHAM LN	-
RAGUS LIFT STATION	Lift Station	1280 BURNEY RD	-
REC CENTER LIFT STATION (MUD 68 LS 1)	Lift Station	222 Cunningham Creek BLVD	-

Table 3-15. Sugar Land Wastewater Treatment Facilities and Pump Stations

Name	Type	Address	Back Up Power
RIVER LODGE LIFT STATION	Lift Station	2205 RIVER LODGE LN	-
RIVERBROOK LIFT STATION (MUD 106 LS 4)	Lift Station	7505 RIVERBROOK DR	-
RIVERPARK HOTEL LIFT STATION	Lift Station	6310 EAST RIVERPARK CIR	-
RIVERSTONE MASTER LIFT STATION	Lift Station	4913 FAIRFORD DR	-
ROBINSON FERRY LIFT STATION	Lift Station	4110 AUSTIN PKWY	-
SAND HILL LIFT STATION (MUD 68 LS 3)	Lift Station	4615 SANDHILL DR	-
SARTARTIA WAY LIFT STA (MUD 112 LS 1)	Lift Station	1021 SARTARTIA WAY	-
SAVOY LIFT STATION	Lift Station	402 SAVOY ST	-
SCHLUMBERGER LIFT STATION	Lift Station	129 INDUSTRIAL BLVD	-
SCOTSMOOR LIFT STATION	Lift Station	34 SCOTSMOOR CT	-
SHADOW BEND LIFT STATION (MUD 106 LS 3)	Lift Station	8006 GREATWOOD PKWY	-
SHADOW LAKE LIFT STATION (MUD 117 LS 5)	Lift Station	2550 WINDING BROOK E DR	-
SOUTH DULLES - 2850 LIFT STATION	Lift Station	2850 DULLES AVE	-
ST MICHAELS LIFT STATION	Lift Station	8555 E COMMONWEALTH BLVD	-
STADIUM DR LIFT STATION	Lift Station	205 STADIUM DR	-
STURBRIDGE LIFT STATION	Lift Station	3200 STURBRIDGE LN	-
SURFACE WATER TREATMENT PLANT LIFT STA	Lift Station	14601 VOSS RD	-
TELEPHONE LIFT STATION	Lift Station	8302 E US 90A	-
TELFAIR LIFT STATION	Lift Station	7335 TELFAIR AVE	-
TERRACE VIEW LIFT STATION (MUD 117 LS 1)	Lift Station	1325 WINDING BROOK E DR	-
THE ORCHARD LIFT STATION	Lift Station	506 ORCHARD LN	-
TRUDEAU LIFT STATION	Lift Station	136 TRUDEAU LN	-
TRUSLOW LIFT STATION	Lift Station	1820 ENGLEWOOD DR	-
TXDOT LIFT STATION	Lift Station	STATE HWY 6 SOUTH	-
U-HAUL LIFT STATION (MUD 109 LS 3)	Lift Station	1702 FM 2759	-
UNIVERSITY CENTRAL MUSEUM LIFT STATION	Lift Station	13115 UNIVERSITY BLVD	-
UNIVERSITY NORTH HEB/HILTON LIFT STATION	Lift Station	11950 UNIVERSITY BLVD	-
UNIVERSITY UofH LIFT STATION	Lift Station	14231 UNIVERSITY BLVD	-
VENETIAN ESTATES LIFT STATION	Lift Station	193 LOMBARDY DR	-
VINCES BRIDGE LIFT STATION	Lift Station	14777 LEXINGTON BLVD	-
VISTA LAKE LIFT STATION	Lift Station	3227 VISTA LAKE DR	-
WALMART LIFT STATION	Lift Station	547 N STATE HWY 6 FRONTAGE RD	-
WEST AIRPORT LIFT STATION	Lift Station	12731 W AIRPORT BLVD	-

Table 3-15. Sugar Land Wastewater Treatment Facilities and Pump Stations

Name	Type	Address	Back Up Power
WHIMBREL LIFT STATION	Lift Station	100 WHIMBREL DR	-
WIMBERLY CANYON LIFT STATION	Lift Station	3215 WIMBERLY CANYON DR	-
WOOD DALE LIFT STATION (MUD 117 LS 2)	Lift Station	1650 WOOD DALE DR	-
WOODSTREAM LIFT STATION	Lift Station	3870 BAYOU CROSSING	-
GREATWOOD WASTEWTR TREAT PLANT - SLUDGE	Waste Water Facility	902 TARA BLVD	-
GREATWOOD WASTEWTR TREAT PLANT-ELEC BLDG	Waste Water Facility	902 TARA BLVD	-
GREATWOOD WASTEWTR TREAT PLANT-OFF BLDG	Waste Water Facility	902 TARA BLVD	-
GREATWOOD WASTEWTR TREAT PLANT-SM CHEM	Waste Water Facility	902 TARA BLVD	-
NEW TERRITORY WASTEWATER TREATMENT PLANT	Waste Water Facility	4050 US 90A	-
NORTH WASTEWTR TREAT PLANT - BLOWER BLDG	Waste Water Facility	15400 SOUTHWEST FWY	-
NORTH WASTEWTR TREAT PLANT - MAINT BLDG	Waste Water Facility	15400 SOUTHWEST FWY	-
NORTH WASTEWTR TREAT PLANT - OFFICE BLDG	Waste Water Facility	15400 SOUTHWEST FWY	-
NORTH WASTEWTR TREAT PLANT - OPS BLDG	Waste Water Facility	15400 SOUTHWEST FWY	-
NORTH WASTEWTR TREAT PLANT - SOLIDS BLDG	Waste Water Facility	15400 SOUTHWEST FWY	-
NORTH WASTEWTR TREAT PLANT-LIFTSTA ELEC	Waste Water Facility	15400 SOUTHWEST FWY	-
SOUTH WASTEWATER TREATMENT PLANT	Waste Water Facility	4802 SCENIC RIVER DR	-

Source: City of Sugar Land
- *Unknown/not available*

3.6.4 Other Facilities

Sugar Land identified additional critical facilities (hazardous material facilities and cultural/recreation facilities) that did not fit the previously discussed categories. Table 3-16 and Table 3-17 below identify these sites and their locations.

Table 3-16. Hazardous Material Facilities in Sugar Land

Name	Type	Address	Back Up Power
City of Sugar Land City Hall	Below Ground Fuel Tank	-	-
City of Sugar Land Public Works Ops	Below Ground Fuel Tank	-	-
CROWN CORK & SEAL	Hazardous Material Facility	12910 JESS PIRTLE BLVD	-
ENTEX	Hazardous Material Facility	422 BROOKS ST	-
ENTEX	Hazardous Material Facility	1 CIRCLE DR	-
NALCO CHEMICAL	Hazardous Material Facility	7701 US HWY 90A	-
SCHLUMBERGER	Hazardous Material Facility	121 INDUSTRIAL BLVD	-

Name	Type	Address	Back Up Power
TDC CENTRAL UNIT	Hazardous Material Facility	1 CIRCLE RD	-
THE HOME DEPOT	Hazardous Material Facility	15505 SW FREEWAY	-
UDL LABORATORIES INC	Hazardous Material Facility	12720 DAIRY ASHFORD	-
VWR SCIENTIFIC PRODUCTS	Hazardous Material Facility	12835 JESS PIRTLE BLVD	-
WINDSTREAM	Hazardous Material Facility	8306 HWY 90A	-
WINDSTREAM	Hazardous Material Facility	12626 DAIRY ASHFORD	-
WINDSTREAM	Hazardous Material Facility	1850 AUSTIN PKWY	-
WORLDCOM MCI	Hazardous Material Facility	1 FLUOR DANIEL DR	-

Source: City of Sugar Land
- *Unknown/not available*

Table 3-17. Historical and Cultural Sites in Sugar Land

Name	Type	Address	Back Up Power
Central Unit	Historical Marker		-
Sugar Land Auditorium	Historical Marker		-
Sugar Land Independent School Dist No 17	Historical Marker		-
Sugar Land Refinery	Historical Marker		-
HOUSTON MUSEUM OF NAT SCI OF SUGAR LAND	Museum	13016 UNIVERSITY BLVD	-
AUSTIN PKWY MAINTENANCE SHOP	Parks Facility	2100 AUSTIN PKWY	-
CITY PARK - BAKER CONCESSION	Parks Facility	225 SEVENTH ST	-
CITY PARK - POOL CONCESSION	Parks Facility	225 SEVENTH ST	-
CITY PARK - PRESS BOX	Parks Facility	225 SEVENTH ST	-
CITY PARK - SENIOR CONCESSION	Parks Facility	225 SEVENTH ST	-
CITY PARK - CONFERENCE BUILDING	Parks Facility	225 SEVENTH ST	-
CITY PARK - SWIMMING POOL BUILDING	Parks Facility	225 SEVENTH ST	-
ELDRIDGE PARK - CONCESSION & PICNIC PAV*	Parks Facility	2511 ELDRIDGE RD	-
ELDRIDGE PARK - MEETING ROOM & RESTROOM	Parks Facility	2511 ELDRIDGE RD	-
FIRST COLONY PARK - CONCESSION 1	Parks Facility	3232 AUSTIN PKWY	-
FIRST COLONY PARK - CONFERENCE CENTER	Parks Facility	3232 AUSTIN PKWY	-
FIRST COLONY PARK - JACKS CONF CTR	Parks Facility	3232 AUSTIN PKWY	-
FIRST COLONY PARK - PRESS BOX	Parks Facility	3232 AUSTIN PKWY	-
IMPERIAL PARK - CONCESSION 1	Parks Facility	234 MATLAGE WAY	-
IMPERIAL PARK - CONCESSION 2	Parks Facility	234 MATLAGE WAY	-
IMPERIAL PARK - PRESS BOX	Parks Facility	234 MATLAGE WAY	-

Name	Type	Address	Back Up Power
IMPERIAL PARK - RECREATION CENTER	Parks Facility	234 MATLAGE WAY	-
LOST CREEK PARK - CONCESSION	Parks Facility	3703 LOST CREEK BLVD	-
LOST CREEK PARK - CONFERENCE	Parks Facility	3703 LOST CREEK BLVD	-
MAYFIELD PARK YMCA	Parks Facility	112 AVE D	-
SUGAR LAND MEMORIAL PARK MEMORIAL	Parks Facility	15300 UNIVERSITY BLVD	-
TE HARMON CENTER	Parks Facility	226 MATLAGE WAY	-

Source: City of Sugar Land
- *Unknown/not available*

SECTION 4. RISK ASSESSMENT

4.1 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 this hazard mitigation plan 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.

4.1.1 Risk Assessment Tools

Mapping

National, state, and 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, 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.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan 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.

4.1.2 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 similar to those from Hazus were generated for other hazards, using data generated through GIS.

Earthquake, Flood and Hurricane

The following hazards were evaluated using Hazus:

- **Earthquake**—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for the 500-yr probabilistic event.
- **Flood**—A Level 2 user-defined analysis was performed for general building stock in flood zones and for critical facilities and infrastructure. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance, 0.2-

percent-annual-chance, and Hurricane Harvey flood events. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.

- **Hurricane**—A Level 2 analysis was performed to assess hurricane exposure and vulnerability for the 20-year, 100-year, and 500-year probabilistic events.

Drought

The risk assessment methodologies used for this plan focus on damage to structures. The risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern because drought does not affect structures.

All Other Assessed Hazards

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

4.1.3 Sources of Data Used in Hazus Modeling and Exposure Analyses

Building and Cost Data

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by the Fort Bend Central Appraisal District were loaded into Hazus. An updated inventory was used in place of the Hazus defaults for critical facilities and infrastructure.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RS Means Square Foot Costs* (RS Means, 2019). It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

Hazus Data Inputs

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

- **Earthquake**—Earthquake probabilistic data prepared by the U.S. Geological Survey (USGS) were used for the analysis of this hazard.
- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) and Hurricane Harvey inundation depth grids for the planning area was used to delineate flood hazard areas and estimate potential losses. Using the DFIRM floodplain boundaries and base flood elevation information, and the USGS 1-meter digital elevation model data, flood depth grids were generated and integrated into the Hazus model.
- **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:

- **Wildfire**—Wildland Urban Interface (WUI) data was acquired from the Texas Wildfire Risk Assessment Portal (TxWRAP).

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: erosion, expansive soils, extreme temperatures, hailstorms, land subsidence, lightening, severe thunderstorms, severe winter storms.

Data Source Summary

Table 4-1 summarizes the data sources used for the risk assessment for this plan.

4.1.4 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 have 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, the City of Sugar Land will collect additional data to assist in estimating potential losses associated with other hazards.

Table 4-1. Hazus Model Data Documentation

Data	Source	Date	Format
Fort Bend County 2019 Certified Parcel Data	Fort Bend Central Appraisal District	2019	Digital (GIS) format
Fort Bend County 2016 flooding project building footprints	Fort Bend County	2016	Digital (GIS) format
Building replacement cost	RS Means	2019	Paper format. Updated RS Means values
Population data	FEMA Hazus version 4.2 SP03	2010	Digital (GIS and tabular) format
Fort Bend County Effective DFIRM (December 21, 2017; latest LOMR August 8, 2019)	FEMA	2019	Digital (GIS) format
Depth Grid of Calculated Inundation Areas for Disaster Declared Counties, Texas, USA, DR-4332 (Hurricane Harvey)	FEMA	2017	Digital (GIS) format
Texas Wildfire Risk Assessment Portal (TxWRAP) Wildland Urban Interface (WUI)	Texas A&M Forest Service	Unknown	Digital (GIS) format

Data	Source	Date	Format
LiDAR Elevation Dataset - Bare Earth DEM - 1 Meter	U.S. Geological Survey	Unknown	Digital (GIS) format
Facilities	City of Sugar Land	Unknown	Digital (GIS) format
Hazmat vulnerable facilities	City of Sugar Land	Unknown	Digital (GIS) format
Hospitals	City of Sugar Land	Unknown	Digital (GIS) format
Bridges	City of Sugar Land	Unknown	Digital (GIS) format
Lift stations	City of Sugar Land	Unknown	Digital (GIS) format
Well sites	City of Sugar Land	Unknown	Digital (GIS) format
2018 Draft Tier II Report – City Wide Facilities (below ground fuel tanks)	City of Sugar Land	Unknown	Digital (document) format
Historical markers	City of Sugar Land	Unknown	Digital (document) format
Regulated hazmat facilities	City of Sugar Land	Unknown	Digital (GIS) format

4.2 IDENTIFICATION OF HAZARDS OF CONCERN

To provide a strong foundation for mitigation actions considered in Sections 6 (Mitigation Strategy), the City of Sugar Land focused on considering a full range of hazards that could impact the area and then identified and ranked those hazards that presented the greatest concern. The hazard of concern identification process incorporated input from the Steering Committee; review of the State of Texas Hazard Mitigation Plan (2019); review of the 2015 City of Sugar Land HMP; research and local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural (not manmade) hazards and the perceived vulnerability of the study area's assets to them. Table 4-1 documents the process of identifying the natural hazards of concern for further profiling and evaluation. Specific hazards not identified as a hazard of concern for the City of Sugar Land will not be further discussed in detail.

4.2.1 Changes from the 2015 Hazard Mitigation Plan

Since the development of the last plan, hazards and disasters not assessed in the prior plan have occurred in the City. These hazards were identified by stakeholders as areas to address in the plan.

The prior plan did not address disease outbreak as a hazard of concern. In 2020, Fort Bend County, including the City of Sugar Land, was hit with the COVID-19 pandemic. As of July 26, 2020, there were 6,530 confirmed cases in Fort Bend County and 90 deaths associated with the virus.

The 2020 City of Sugar Land Hazard Mitigation Plan Update includes best available data throughout the plan to present an updated understanding the City's risk.

4.2.2 Hazard Groupings

As per the 2015 City of Sugar Land HMP, the Steering Committee maintained the grouping of hazards based on the similarity of hazard events, typical concurrence or impacts, consideration of how hazards have been grouped in FEMA guidance documents (*FEMA 386-2 Understanding Your Risks, Identifying Hazards and Estimating Losses*; *Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy*; *Local Mitigation Planning Handbook*), and consideration of hazard grouping in the State of Texas HMP.

The *Severe Winter Storm* profile includes heavy snow, blizzards, and ice storms. This grouping is consistent with the State of Texas HMP.

The *Thunderstorm Wind* hazard profile specifically addresses thunderstorm events that occurred in or impacted the City of Sugar Land.

The *Tornado* hazard profile specifically addresses tornado events that occurred in or impacted the City of Sugar Land.

The *Lightning* hazard profile specifically addresses lightning events that occurred in or impacted the City of Sugar Land.

The *Extreme Temperature* hazard profile specifically addresses periods of extreme temperature (heat and cold) that occurred in the City or had considerable impact on the City.

The *Hail* hazard profile specifically addresses hail events that occurred in or impacted the City of Sugar Land.

The *Flood* hazard includes riverine, flash flooding, and stormwater flooding. Inclusion of the various forms of flooding is consistent with that used in FEMA's *Multi-Hazard Identification and Risk Assessment* guidance.

The *Drought* hazard profile specifically addresses drought events that occurred in or impacted the City of Sugar Land.

The *Hurricane and Tropical Storm* profile addresses hurricanes and tropical storms that occurred in or impacted the City of Sugar Land.

The *Dam and Levee Failure* profile addresses dam/levee failures that occurred in or impacted the City of Sugar Land.

The *Erosion* profile addresses inland erosion associated with water in the City of Sugar Land.

The *Land Subsidence* profile addresses land subsidence events occurring in the City of Sugar Land or having impacts on the City.

The *Earthquake* hazard profile specifically addresses earthquakes that occurred in the City of Sugar Land or had a considerable impact on the City.

The *Expansive Soils* profile addresses expansive soil-related events that occurred in the City of Sugar Land or had impacts on the City.

The *Wildfire* profile addresses wildfire events that occurred in the City of Sugar Land or events that had impacts on the City.

The *Terrorism* profile includes terrorism-related events that occurred in the City or had impacts on the City.

The *Hazardous Materials Spills* profile includes events (in-transit or on-site) that occurred in the City or had impacts on the City.

The *Energy and Fuel Shortages* profile includes events related to energy and fuel shortages in or around the City of Sugar Land.

The *Transportation Accident* profile includes events associated with aircraft crashes and motor vehicle incidents.

The *Pandemic* hazard profile addresses diseases with the potential to impact the City, including the novel coronavirus (COVID-19), West Nile Virus, and Influenza.

Table 4-2. Identification of Hazards of Concern for the City of Sugar Land

Hazard	Description
Natural Hazards	
Dam/Levee Failure	• There are 19 dams in Fort Bend County, with four located in Sugar Land. The dams are not identified as high hazard dams. • Identified dams are for irrigation purposes and were built in 1948. • There is a levee system located in the City, inclusive of nine Levee Improvement Districts. • There have been no reported dam or levee incidents in the City. • Due to the low-risk dams in the City, dam failure will not be profiled for this update. • Due to the levee system located in the City, levee failure was identified as a hazard of concern for the city. • The 2018 State of Texas HMP includes dam/levee failure as a hazard of concern for the State.
Drought	• Fort Bend County was the subject of two disaster declarations for drought that occurred in 2015 and 2019. • The County and City have been impacted by eight drought events of varied length since 2015. • Due to the history of occurrence and the impacts drought can have, drought was identified as a hazard of concern for the City of Sugar Land.
Earthquakes	• Earthquakes were identified as a hazard of concern in the 2018 State of Texas Hazard Mitigation Plan. • While there have been no recorded earthquakes in Fort Bend County or the City of Sugar Land, there is the potential that earthquake can impact the City. • Because the City of Sugar Land has had little to no impacts from earthquakes, earthquakes are not identified as a hazard of concern for the City.
Erosion (Coastal)	• While coastal erosion is identified as a hazard of concern in the 2018 State of Texas Hazard Mitigation Plan, however, due to its inland location, coastal erosion does not impact the City of Sugar Land. Therefore, coastal erosion is not identified as a hazard of concern for the City.
Erosion (Inland)	• The Brazos River is a major river that flows through Sugar Land. Erosion has been a longstanding concern. • Recent rainfall events and shoreline hardening have led to increased erosion. • Inland erosion is identified as a hazard of concern in the 2018 State of Texas Hazard Mitigation Plan.

Hazard	Description
	• Due to the history of occurrence in the City, inland erosion is identified as a hazard of concern for the City of Sugar Land.
Expansive Soils	• According to the 2018 State of Texas HMP, the City of Sugar Land is underlaid by soils with a high potential for swelling. • Groundwater withdrawal will continue to increase the risk for expansive soil issues. An increase in development will increase the need for groundwater. • While portions of the City are underlaid by expansive soils, the City has had little to no impacts. Therefore, expansive soils is not identified as a hazard of concern.
Extreme Temperatures	• Extreme heat and extreme cold temperatures were identified as hazards of concern in the State of Texas HMP; however, they were profiled individually. • Fort Bend County has been impacted by eight heat events between 1996 and 2019. • The City of Sugar Land has experienced extreme heat and cold events and will continue to experience them in the future. Therefore, extreme temperatures was identified as a hazard of concern for the City.
Flooding (Coastal)	• While coastal flooding is identified as a hazard of concern in the 2018 State of Texas Hazard Mitigation Plan, however, due to its inland location, coastal flooding does not impact the City of Sugar Land. Therefore, coastal flooding is not identified as a hazard of concern for the City.
Flooding (Riverine)	• 56 flood events have been identified as occurring in the City of Sugar Land. The flood events have resulted in seven disaster declarations. • There have been several recent and significant flooding events in the City. The flooding has caused street flooding and erosion along the Brazos River. • As of July 2019, there are 3,969 flood insurance policies in force and claims that have totaled $3.1 million since 1979. • Riverine flooding is identified as a hazard of concern in the 2018 State of Texas HMP. The State HMP indicated Fort Bend County has a large percentage of land inside the SFHA. The County and the City of Sugar Land will continue to experience flood events. • Based on the history of events and losses, riverine flooding was identified as a hazard of concern for the City of Sugar Land.
Hailstorms	• Hailstorms were identified as a hazard of concern in the 2018 Texas State Hazard Mitigation Plan. • Fort Bend County was not subject to a hail-related major disaster/emergency declarations, however Sugar Land has been subject to a number of hail events since 2000. There is a 65% chance of the City being impacted by a hail event during a given year. • Hailstorms was identified as a hazard of concern for the City of Sugar Land.
Hurricanes, Tropical Storms, and Depressions	• Hurricanes and tropical storms were identified as a hazard of concern in the 2018 State Hazard Mitigation Plan. • Fort Bend County was included in 10 of 21 hurricane-related major disaster and emergency declarations. Since 1996, there have been four tropical storm/hurricane events. • The most recent events include Hurricane Harvey in 2017 and Tropical Depression Imelda in 2019. These storms resulted in flood damage in the vicinity of Dulles Avenue and Avenue E, as well as record river elevations for the Brazos River in the case of Hurricane Harvey. • Based on history of occurrences and losses, the hazard was identified as a hazard of concern for the City of Sugar Land.
Land Subsidence	• Land subsidence was identified as a hazard of concern in the State Hazard Mitigation Plan. The State HMP indicates that Fort Bend County and the City of Sugar Land is located within an area of the State that experiences land subsidence. • Despite the subsidence that has occurred in the past, there have been no impacts to any critical facilities, infrastructure, or other community assets, and future impacts are not expected. Therefore the City did not identify land subsidence as a hazard of concern.
Lightning	• Lightning was identified as a hazard of concern in the State Hazard Mitigation Plan. • Lightning is a somewhat frequent occurrence in the City. However, based on available data, there have been only three reported events causing damage or casualties. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Pandemic	• Sugar Land has experienced three separate public health events between 2015. These includes include West Nile Virus, Zika Virus, and Coronavirus. • At the time of this plan's writing, Coronavirus continues to impact public health both locally and globally. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Thunderstorm Wind	• Severe Winds were identified as a hazard in the State Hazard Mitigation Plan.

Hazard	Description
	• For this plan, Severe Winds were included as part of the Thunderstorm Wind hazard. • Sugar Land has regularly experienced strong winds and limited damage from thunderstorm events. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Severe Winds	• See Thunderstorms Wind.
Severe Winter Storm	• Winter weather was identified as a hazard of concern in the State Hazard Mitigation Plan. • The County and City have been historically impacted by ice storms, freezing rain, winter storms, and heavy snow. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Tornadoes	• The Texas State Hazard Mitigation Plan identified tornadoes as a state hazard of concern. • Fort Bend County has been the subject of two tornado-related FEMA disaster declarations since 1953. • There have been two funnel clouds and seven tornadoes reported in the City since 1950, causing $5.3 million in damage. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Wildfire	• The Texas State Hazard Mitigation Plan identified wildfires as a state hazard of concern. • Due to the extent of development, there are only small, scattered areas of forest cover throughout the City. • No wildfires have been reported in the City; there, the City did not identify this as a hazard of concern.
Windstorm	• See Thunderstorm Wind.
Winter Weather	• See Severe Winter Storm.
Non-Natural Hazards	
Energy/Fuel Shortage	• The Gulf Coast is one of the largest petrochemical hubs in the country. • The region’s vulnerability was exposed during Hurricane Harvey, when gas lines formed in the region. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Hazardous Material Spill	• Hazardous material spill events were not identified as a hazard of concern in the State Hazard Mitigation Plan. • Sugar Land’s location along major transportation routes for air, rail, and highway make the City vulnerable to hazardous material spills. • There have been four hazardous material spills incidents in the City between 2015 and 2020. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.
Terrorism	• There have been no reported incidents of terrorist incidents in Sugar Land. However, due to its proximity to major cities that could experience terrorist incidents, the City identified terrorism as a hazard of concern.
Transportation Accidents	• Sugar Land is located in a region experiencing high automotive traffic and heavy reliance upon private vehicles as the primary mode of transportation. • Heavily-traveled roadways have yielded nearly 4,400 traffic accidents since 2018. • There have been several plane accidents associated with the Sugar Land Regional Airport. • The hazard was identified as a Hazard of Concern for the City of Sugar Land.

4.3 HAZARD PROFILES

The following sections provide details regarding the hazards of concern that have the potential to impact the City of Sugar Land.

4.3.1 Severe Winter Storm

The following section provides the hazard profile and vulnerability assessment for the severe winter storm hazard in the City of Sugar Land.

Profile

Hazard Description

Severe winter storms bring the threat of snow, freezing rain, and ice storms to the City of Sugar Land. A winter storm is a weather event in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and dangerous wind chills. According to the National Severe Storms Laboratory (n.d.), the three basic components needed to make a winter storm include the following:

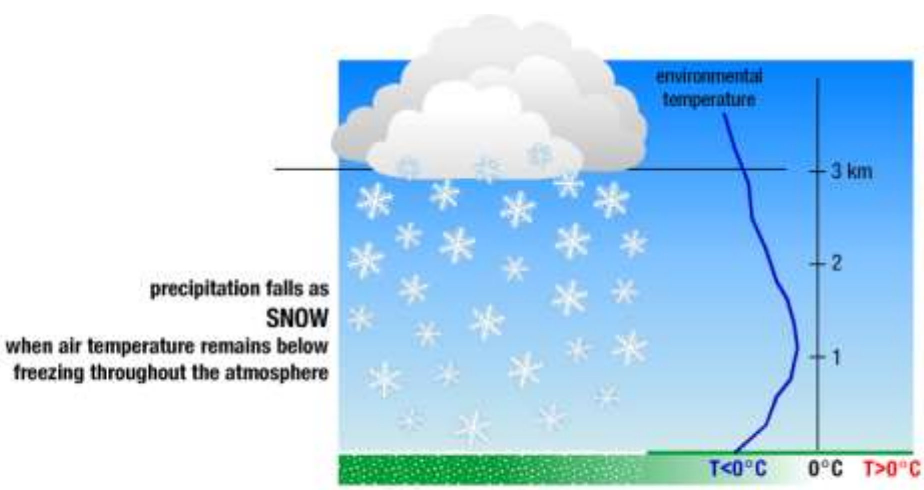
- Below freezing temperatures (cold air) in the clouds and near the ground to make snow and ice.
- Lift, something to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (oliographic lifting).
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean.

Some winter storms are large enough to immobilize an entire region while others might only affect a single community. Winter storms typically are accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. In the City of Sugar Land, winter storms include snowstorms, blizzards, and ice storms. Extreme cold temperatures and wind chills are associated with winter storms; however, they are discussed in Section 4.3.5 (Extreme Temperatures).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 °F) and water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or a snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 4-1 depicts snow creation.

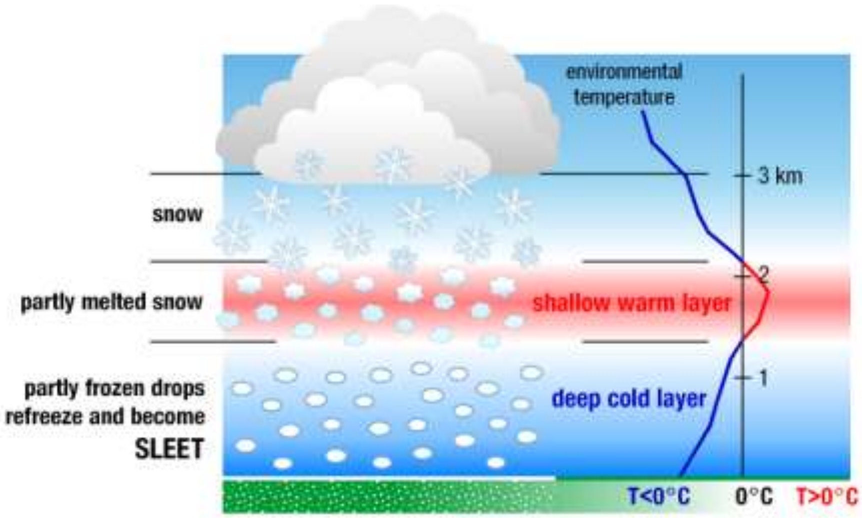
Figure 4-1. Snow Creation



Source: NOAA-NSSL, 2015

Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2013).

Figure 4-2. Sleet Creation



Source: NOAA-NSSL 2015

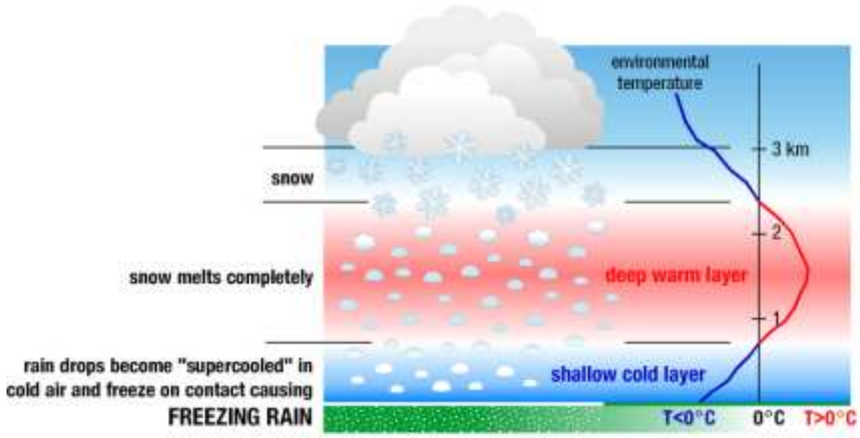
Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile, as the predominant conditions over a 3-hour period. Extremely cold temperatures often are associated with blizzard conditions but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20 °F. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25-inches or greater (NWS 2013). Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2008).

Figure 4-3. Freezing Rain Creation



Source: NOAA-NSSL 2015

Location

Winter storms occur on a regional scale and can happen anywhere in the State of Texas; therefore, the entire City of Sugar Land can experience winter storm events.

Extent

The magnitude or severity of a severe winter storm depends on several factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA 2015). Table 4-3 presents the five RSI ranking categories.

Table 4-3. RSI Ranking Categories for the South Climate Region

Category	Description	RSI Value	Snowfall Thresholds
1	Notable	1–3	<2
2	Significant	3–6	>2
3	Major	6–10	>5
4	Crippling	10–18	>10
5	Extreme	18.0+	>15

Source: NOAA 2015
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013).

According to NWS (2009), the magnitude of a severe winter storm can be qualified into five main categories by event type:

- Heavy Snowstorm – snowfall accumulating to 4 inches or more in a 12 hours or less or snowfall accumulating to six inches or more in 24 hours or less.
- Sleet Storm – Significant accumulations of solid pellets that form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists.
- Ice Storm – Significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations; significant ice accumulations are usually ¼" or greater.
- Blizzard – sustained winds or frequent gusts of 35 mph or more; considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period.
- Severe Blizzard – Wind velocity of 45 mph, temperatures of 10°F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period.

The NWS uses winter weather watches, warnings, and advisories to ensure that people know what to expect in the coming hours and days.

- Watches
  - Blizzard – Conditions are favorable for blizzard conditions to be met in the next 12 to 48 hours.
  - Winter Storm - Issued when sinter storm conditions, defined above, are possible within 24 to 48 hours.
- Warnings
  - Blizzard – Issued when sustained winds or frequent gusts ≥ 35 mph combined with blowing and or falling snow, reducing visibility below 1/4 mile for 3 hours or more, when imminent or expected within the next 36 hours. Temperatures are assumed below 32°F, and snow should accumulate at least one inch in 12 hours.
  - Winter Storm - Issued when the following conditions, capable of producing high impact and potentially life threatening conditions, are occurring or expected to occur within the 36 hours: snow - ≥1 inch in 12 hours; sleet - ≥1/2 inch in 12 hours; and or a combination of snow, sleet, ice with snow or sleet meeting warning criteria
  - Ice Storm - Issued when ≥1/8 inch of Ice is expected to accrete on trees, power lines, and bridges/overpasses for the entirety of the event. These conditions are capable of producing high impact and potentially life threatening conditions and are either occurring or expected to occur within the next 36 hours.
- Advisories
  - Winter Weather - Issued when the following conditions, capable of producing significant, but not necessarily life threatening, inconveniences, are occurring or expected to occur within the next 36 hours:
    - Snow: 1/2 to 1 inch in 12 hours
    - Sleet: < 1/2 inch in 12 hours
    - Ice: < 1/8 inch in 12 hours
    - Combination: Snow, sleet, and ice with snow or sleet meeting advisory criteria.

Worst-Case Scenario

Overall, the maximum winter weather extent that can be expected in the City of Sugar Land is a RSI Category 3 snowfall event. Because the City of Sugar Land is located in the National Centers for Environmental Information's south climate region, the amount of snow that can fall for this category event is up to 10 inches; however, the area will most likely see lower amounts of snow based on history of occurrence. But a larger number of people will be impacted based on total population and population density. A winter storm in the City has the potential to provide 1,814 tons of debris and causing over $3.5 million in property damage.

A worst-case severe winter storm scenario would be a storm similar to that of the January 9-13, 1918 blizzard that brought extreme temperature lows. Based on the RSI, this was a category 3 storm with an RSI of 6.852. It impacted over 39 million people. In Sugar Land, the City had approximately 2.5 inches of snow. A storm like this could lead to downed trees and power lines, power outages, closed roadways, and overall impact to the City. This would lead to disruption in emergency services and limited access to essentials (e.g. water, heat).

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with severe winter storm events in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI storm events database, Fort Bend County has been impacted by seven winter weather events between 1950 and 2019. Table 4-4 and Table 4-5 summarize these statistics, as well as the annual average number of events and the percent chance of these individual severe winter storm hazards occurring in the City of Sugar Land in future years (NOAA-NCEI 2020).

Table 4-4. Severe Winter Events 1950-2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Blizzard	0	0	0	$0	$0
Heavy Snow	2	0	0	$0	$0
Ice Storm	3	0	0	$2,000	$0
Sleet	0	0	0	$0	$0
Winter Storm	3	0	0	0	0
Winter Weather	0	0	0	$0	$0
Total	**8**	**0**	**0**	**$2,000**	**$0**

Source: NOAA-NCEI 2020
Note: NOAA-NCEI database includes winter-related events starting in 1996. Events that occurred prior to 1996 are not included in the table.

Between 1953 and December 2019, FEMA included the State of Texas in one winter storm-related major disaster (DR) declaration classified as a severe ice storm. Generally, these disasters cover a wide region of the state; therefore, they may have impacted many counties. Fort Bend County, including the City of Sugar Land, was not included in any winter storm-related declarations (FEMA 2020). Table 4-5 identifies the known winter storm events that impacted the City of Sugar Land between 1950 and 2019.

Table 4-5. Severe Winter Weather Events in the City of Sugar Land, 1950 to 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Event Details*
January 12-13, 1997	Ice Storm	N/A	N/A	Freezing rain and sleet effected trees, power lines, and roadways in Fort Bend County. The weight of the ice caused trees and power lines to fall, causing power outages. Over 1,100 traffic accidents were reported in southeast Texas, causing three deaths.
January 16-17, 2007	Ice Storm	N/A	N/A	In Fort Bend County, widespread ice accumulation on roads, bridges, and the roofing of general structures. Sections of FM 1093 were closed due to icing.
December 4, 2009	Winter Storm	N/A	N/A	Snow accumulations of between 1 to near 3 inches occurred across Fort Bend County.
February 3-4, 2011	Ice Storm	N/a	N/A	In Fort Bend County, a period of freezing rain and freezing drizzle led to icy roads, especially bridges and overpasses, and numerous accidents. Between one- and two-tenths of an inch of ice accumulated. Over 1,000 car accidents were reported in the greater Houston area with closure of all toll roads and large sections of interstates.
January 23, 2014	Winter Storm	N/A	N/A	Snowfall totals ranged from one to four inches and some freezing rain was produced by a storm system that moved across Fort Bend County. Freezing rain caused significant icing of bridges and overpasses, leading to road closures and numerous accidents. In the County, a tenth of an inch of ice formed on bridges and overpasses, causing multiple accidents. Many major roads were closed due to icy conditions.
February 3-4, 2014	Winter Storm	N/A	N/A	A system brought ice accumulation and freezing rain to the area, forming on cars, trees, power lines and roadways. As a result, there were numerous downed trees and power lines that caused power outages.
December 7-8, 2017	Heavy Snow	N/A	N/A	One to two inches of snow fell across Fort Bend County.
February 11-21, 2021	Winter Storm Uri	DR-4586	Yes	Winter Storm Uri was a Federally Declared Major Disaster Declaration. During the 14-day event temperatures dropped below zero and were coupled with severe icing. These conditions resulted in multiple critical infrastructure failures including more than 60% of local residents without power, a majority of the city infrastructure was on emergency generator power or without power. Emergency actions taken included: emergency utility work, mass care and sheltering, road closures, and significant increases in 911 and 311 service requests. The City Emergency Operations Center was activated with partial staffing and multiple Department Operations Centers were activated to coordinate information and resource management. Routine city services were suspended with facility closures lasting the week of 15 February. A local disaster declaration was issued in addition to the County, State and Federal Disaster Declarations.

Sources: *FEMA 2020; NOAA-NCEI 2020; Input from City*
* *Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
FEMA *Federal Emergency Management Agency*
Mph *Miles per Hour*
NCEI *National Centers for Environmental Information*
NOAA *National Oceanic and Atmospheric Administration*
N/A *Not Applicable*

Climate Change Projections

Changes in climate can affect how much snow falls and influence the timing of the winter snow season. Changes in the amount of snow covering the ground, and changes in how the snow melts in the spring, will affect the water supplies that people use for things like farming and making electricity (National Snow and Ice Data Center 2020). With these projections, the City might not experience an increase in winter weather events, but the lack of snow could impact the water supply.

According to the National Climate Assessment, rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in surface water quality, with varying impacts across regions. Future warming will add to the stress on water supplies and adversely impact the availability of water in parts of the United States (U.S. Global Change Research Program 2018).

Probability of Future Occurrences

For the 2021 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of winter storm events, of all types, for the City of Sugar Land. Table 4-6 summarizes data regarding the probability of occurrences of severe winter storm events in the City of Sugar Land based on the historic record. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 4-6. Probability of Future Occurrence of Severe Winter Weather Events in the City of Sugar Land

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Blizzard	0	0.00	0.00	0.00	0%
Heavy Snow	2	0.03	35.00	0.03	2.9%
Ice Storm	3	0.04	23.33	0.04	4.3%
Sleet	0	0.00	0.00	0.00	0%
Winter Storm	3	0.04	23.33	0.04	4.3%
Winter Weather	0	0.00	0.00	0.00	0%
Total	**8**	**0.12**	**8.75**	**0.11**	**11.4%**

Source: NOAA-NCEI 2020

Based on the number of winter weather events, the City averages less than one winter weather event each year. A winter weather event has a 11.4% chance of occurring in any given year. Based on the history of events and input from the Steering Committee, the probability for severe winter storm events occurring in the City is considered *medium* (likely to occur within 100 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed and vulnerable to the severe winter storm hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a winter weather event. The following text evaluates and estimates the potential impact of the severe winter storm hazard in the City.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of the City (86,886) is exposed to winter storm events (U.S. Census 2013-2017 ACS 5-Year Population Estimate). The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice.

According to the 2017 ACS 5-Year Population Estimate, 14.4 percent of the population in the City of Sugar Land is 65 and over. Winter storm events can reduce the ability of these populations to access emergency services.

Winter weather can immobilize a region and paralyze a city. Additional impacts include stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL 2006)

Impact on General Building Stock

The entire general building stock inventory in the City of Sugar Land is exposed and potentially vulnerable to the severe winter storm hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk to the most damage. 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. As an alternate approach, the percent damage to structures that could result from severe winter storm conditions is considered. This allows planners and emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Table 4-7 summarizes the estimated loss to structures. Given professional knowledge and the currently available information, the potential loss for this hazard is considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place). Therefore, the table's data should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 4-7. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Jurisdiction	Structure Debris	Number of Displaced Households	Number of People Requiring Short-Term Shelter	Total Value Damaged
City of Sugar Land	1,814 tons	0	0	$3,517,828

Source: Hazus 4.2

Impact on Critical Facilities

Full functionality of critical facilities, such as police, fire, and medical facilities is essential for response during and after a severe winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles, utility lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice can cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2006). Winter weather events, such as ice storms, can lead to power outages. Therefore, it is recommended that critical facilities install backup power sources.

Infrastructure at risk for this hazard includes roadways that could be damaged due to salt application and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair might be required.

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters within the county.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the county can assist in planning for future development and ensure that appropriate mitigation, planning, and preparedness measures are in place. The county considered the following factors to examine potential conditions that can 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 could be potentially impacted by the severe winter storm hazard because the entire City is exposed and vulnerable. The ability of new development to withstand severe winter storm impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. With an increase in population, more people will be exposed to winter weather events. Additionally, the age of the population, changes in their geography, and how climate change could alter the winter weather received (rain versus snow) will be important to continue to assess future changes in vulnerability.

Climate Change

Climate is defined not just as average temperature and precipitation, but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can potentially alter prevalence and severity of weather extremes, such as winter storms. While predicting changes in winter storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. EPA 2006). Based on the projections, the City can expect to experience more rain than snow during the winter months. In the immediate future, the City of Sugar Land can anticipate continuing to experience the impacts of winter weather events.

Change of Vulnerability Since 2015 HMP

The City of Sugar Land's population increased since the last plan; increasing the number of people impacted during a winter weather event. Therefore, the entire City remains vulnerable to severe winter storm events. While winter weather is a rare occurrence, they can occur and cause impacts.

Issues Identified

Important issues associated with a severe winter storm in the planning area include the following:

- Older building stock in the City might be more vulnerable to aftermath of a winter storm event. Heavy snow loads on the roofs of buildings might not be able to withstand the extra weight.
- Ice and freezing temperatures can lead to frost heaving, damaging roads, bridges, buildings, and foundations of homes and buildings.
- The impacts of drought can lead to dead or dying trees. These trees are more susceptible to falling during winter storm events from the weight of snow and ice causing power outages, closed roadways, and damage to buildings and property.
- Downed power lines from the weight of snow and ice lead to power outages, leaving many homes without a source of heat.

4.3.2 Thunderstorm Wind

The following section provides the hazard profile and vulnerability assessment for the wind-related events associated with thunderstorms in the City of Sugar Land.

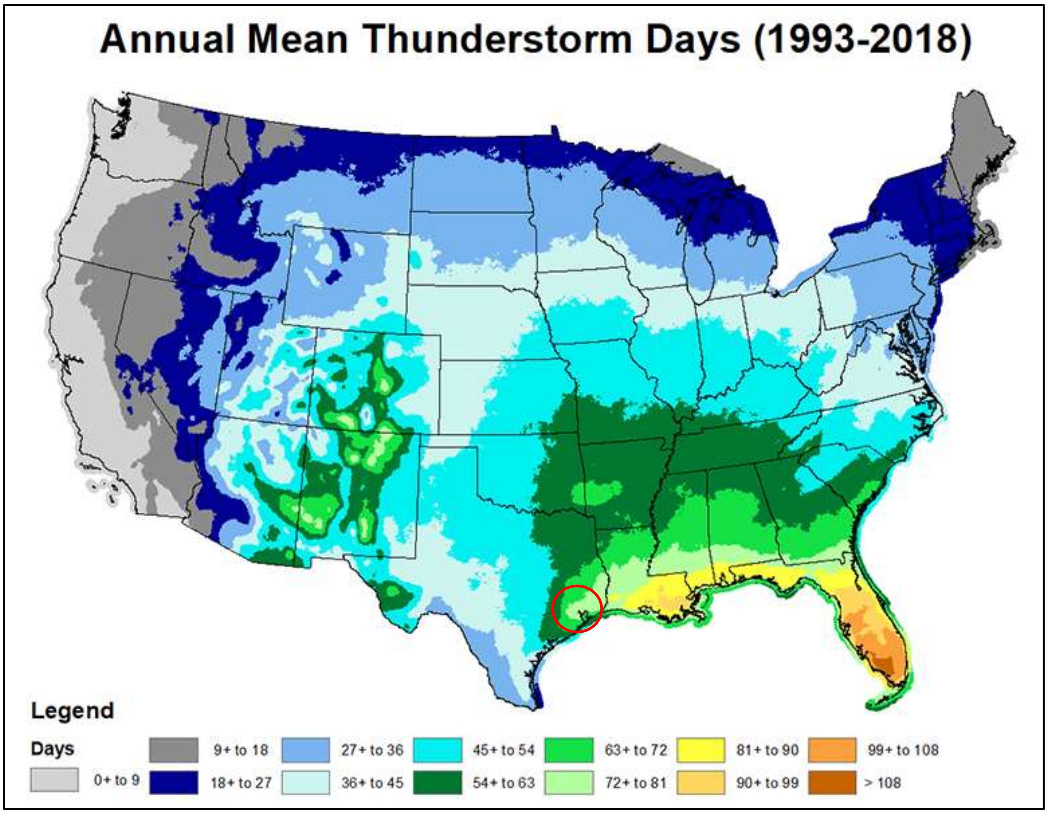
Profile

Hazard Description

A thunderstorm is a storm with lightning and thunder produced by cumulonimbus cloud, usually producing wind gusts, heavy rain, and sometimes hail or tornadoes (NWS 2009). Thunderstorms are usually short-lived (less than two hours), but they can deliver strong winds and enough rain to cause urban or flash flooding. The NWS considers a thunderstorm severe only if it produces damaging wind gusts of 58 mph or higher or large hail one-inch (quarter size) in diameter or larger or tornadoes (NWS 2009). Thunderstorms can occur at any time. However, they usually occur during the spring and summer months and during the afternoon and evening. Severe thunderstorms are most common from Texas to southern Minnesota; however, severe storms can occur anywhere in the United States (National Severe Storms Laboratory [NSSL] 2020).

It is estimated that each year there are 16 million thunderstorms worldwide. Approximately 100,000 thunderstorms occur in the United States each year (NSSL 2020). Figure 4-4 illustrates the average number of days with thunderstorms using data from 1993 to 2018. This figure shows that the City of Sugar Land experiences between 72 and 81 days of thunderstorms each year.

Figure 4-4. Annual Mean Thunderstorm Days, 1993-2018



Source: National Weather Service 2019
Note: The approximate location of the City of Sugar Land is outlined in a red circle.

Thunderstorms can lead to flooding, landslides, strong winds, tornadoes, lightning, and hail. Roads could become impassable from flooding, downed trees or power lines, or a landslide. Strong straight-line winds (up to more than 12 mph) associated with thunderstorms can down trees and utility poles, causing utility outages. Thunderstorms can create tornadoes with winds of up to 300 mph. Lightning can damage homes and injure people. In the United States, an average of 300 people are injured and 80 people are killed by lightning each year. Thunderstorms can produce hail up to the size of softballs damaging cars and windows, and killing livestock caught out in the open (NSSL 2020).

High winds are often associated by other severe weather events such as thunderstorms, tornadoes, hurricanes, and tropical storms. Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth (Rosenstiel School of Marine & Atmospheric Science 2005).

Location

Since thunderstorms can develop anywhere in the United States, all of the City of Sugar Land is exposed and vulnerable to the impacts of thunderstorms.

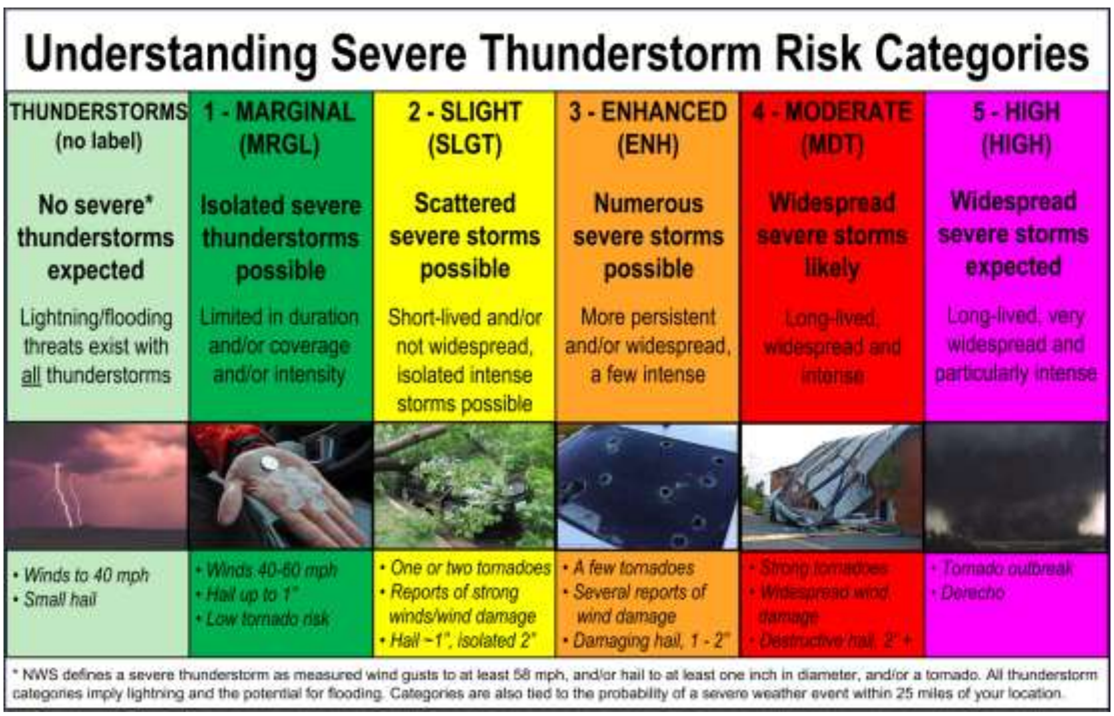
Extent

Severe thunderstorm watches and warnings are issued by the local NWS office and the Storm Prediction Center (SPC). The NWS and SPC will update the watches and warnings and notify the public when they are no longer in effect. Watches and warnings for thunderstorms in the City of Sugar Land are as follows:

- Severe Thunderstorm Warnings are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing, or forecast to produce, wind gusts of 58 mph or greater, structural wind damage, or hail one-inch in diameter or greater. A warning will include where the storm was located, what municipalities will be impacted, and the primary threat associated with the severe thunderstorm warning. After it has been issued, the NWS office will follow up periodically with Severe Weather Statements that contain updated information on the severe thunderstorm and advise the public when the warning is no longer in effect (NWS 2009, NWS 2010).
- Severe Thunderstorm Watches are issued by the SPC when conditions are favorable for the development of severe thunderstorms over a larger-scale region for a duration of at least three hours. Tornadoes are not expected in such situations, but isolated tornado development can also occur. Watches are normally issued well in advance of the actual occurrence of severe weather. During the watch, the NWS will keep the public informed on what is happening in the watch area and also advise public when the watch has expired or been cancelled (NWS 2009, NWS 2010).

Figure 4-5 presents the severe thunderstorm risk categories, as provided by the SPC.

Figure 4-5. Severe Thunderstorm Risk Categories.



Source: SPC 2017

Winds associated with thunderstorms are measured according to the Beaufort Wind Scale, as outlined in Table 4-8. This scale was one of the first to estimate wind speeds. It starts with 0 and goes to a force of 12.

Table 4-8. Beaufort Wind Scale

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects on Land
0	Less than 1	Calm	Calm, smoke rises vertically
1	1-3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Seldom experienced on land, trees broken or uprooted, considerable structural damage occurs
11	56-63	Violent Storm	If experienced on land, widespread damage
12	64+	Hurricane	Violence and destruction

Source: NWS 2020

The NWS issues advisories and warnings for winds. Issuance is normally site-specific. High wind advisories, watches, and warnings are products issued by the NWS when wind speeds can pose a hazard or are life threatening. The criterion for each of these varies from state to state. According to the NWS, wind warnings and advisories for the City of Sugar Land are as follows:

- *High Wind Warnings* are issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible.
- *Wind Advisories* are issues when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration (NWS 2020; NHC 2020).

Worst-Case Scenario

A worst-case scenario would involve prolonged high winds of 85 mph, Force 12 on the Beaufort Wind Scale, during a thunderstorm event. This type of event would have both a short- and long-term effects on the City. The strong winds would lead to downed trees and power lines, creating road closures and citywide power outages. Parts of the City could experience limited ingress and egress.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with thunderstorms in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI Storm Events Database, there were 19 thunderstorm wind events recorded in the City of Sugar Land between 1955 and 2019. Damages reported for these events totaled over $422,000 (refer to Table 4-9).

Table 4-9. Thunderstorm Wind Events in the City of Sugar Land, 1950-2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Thunderstorm Wind	19	0	0	$422,500	$3,000

Source: NOAA-NCEI 2020
Note: Due to limitations in data, not all thunderstorm wind events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated

Between 1953 and 2019, the State of Texas was included in three thunderstorm-related FEMA major disaster (DR) or emergency (EM) declarations. Of those declarations, Fort Bend County was included in two declarations (FEMA 2020). Table 4-10 lists FEMA DR and EM declarations for Fort Bend County.

Table 4-10. Thunderstorm-Related FEMA Declarations for Fort Bend County, 1953 to 2019

FEMA Declaration Number	Date(s) of Event	Incident Type	Incident Title
DR-930	December 20, 1991 to January 14, 1992	Flood	Severe Thunderstorms
DR-1041	October 14-November 8, 1994	Flood	Severe Thunderstorms and Flooding

Source: FEMA 2020

This HMP update includes known thunderstorm wind events that have impacted the City of Sugar Land between 1950 and 2019. These events are shown in Table 4-11. The events listed in Table 4-11 represent only those that were reported to the NOAA-NCEI Storm Events Database, FEMA, and the 2015 City of Sugar Land HMP, and may not represent all thunderstorm wind events that have occurred since 1950.

Table 4-11. Thunderstorm Wind in the City of Sugar Land, 1950 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Magnitude (wind speed in knots)	Fatalities	Injuries	Damages	Event Details*
December 20, 1991 – January 14, 1992	Severe Thunderstorms	DR-930	Yes	-	-	-	-	-
October 14-November 8, 1994	Severe Thunderstorms and Flooding	DR-1041	Yes	-	-	-	-	-
June 2, 1996	Thunderstorm Wind	N/A	N/A	-	0	0	$5,000 in property damage	Trees blown down in the City
December 23, 1997	Thunderstorm Wind	N/A	N/A	-	0	0	$10,000 in property damage	Strong winds downed trees and damaged roofs in the Cinco Ranch subdivision
July 23, 2000	Thunderstorm Wind	N/A	N/A	-	0	0	$200,000 in property damage	Strong winds led to fallen light poles on cars, damaging vehicles at car dealership on SH 6.
November 12, 2000	Thunderstorm Wind	N/A	N/A	-	0	0	$150,000 in property damage	High winds from a severe thunderstorm caused approximately $150, 000 in damages to a recreational vehicle park at U.S. Highway 59 and Crabb River Road. The storm downed numerous power lines; damaged several trailers; and downed signs, fences, and awnings within the City of Sugarland. The storm also produced damaging hail, causing approximately $10,000 in damages at the Sugar Land Airport.
September 20, 2001	Thunderstorm Wind	N/A	N/A	-	0	0	$2,000 in property damage	Large tree branches down in the Mission Bend area.
June 29, 2002	Thunderstorm Wind	N/A	N/A	-	0	0	$20,000 in property damage	Wind damage to homes in the Salida Del Sol Subdivision; powerlines down in the City
August 3, 2002	Thunderstorm Wind	N/A	N/A	-	0	0	$2,000 in property damage	Tree blown down 2 miles north of Mission Bend (FM 1464 & Red Timber).
December 23, 2002	Thunderstorm Wind	N/A	N/A	52	0	0	$1,000 in property damage	-
February 24, 2005	Thunderstorm Wind	N/A	N/A	60	0	0	$15,000 in property damage	Strong winds caused damage in the Mission Bend area
May 8, 2005	Thunderstorm Wind	N/A	N/A	55	0	0	$17,000 in property damage	High winds downed power lines and trees in the Pecan Grove area, resulting in approximately $17,000 in property damages.
May 8, 2005	Thunderstorm Wind	N/A	N/A	55	0	0	$5,000 in property damage	Utility pole blown down.
March 31, 2007	Thunderstorm Wind	N/A	N/A	52	0	0	-	Wind damaged occurred in Mission Bend area.
June 15, 2007	Thunderstorm Wind	N/A	N/A	52	0	0	$25,000	Storms significantly damaged a Sugar Land mobile home park. The damage inflicted on the mobile home park, a resident' s barn, and the numerous power poles blown down by the incident was estimated at $25,000.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Magnitude (wind speed in knots)	Fatalities	Injuries	Damages	Event Details*
February 11, 2009	Thunderstorm Wind	N/A	N/A	51	0	0	-	-
August 23, 2010	Thunderstorm Wind	N/A	N/A	50	0	0	-	There was a report of tree branches down just southeast of the Highway 59 and Highway 6 intersection.
June 6, 2011	Thunderstorm Wind	N/A	N/A	50	0	0	$500 in property damage	For the second day in a row, afternoon through early evening pulse severe thunderstorms developed. In the City of Sugar Land, a severe thunderstorm downed some palm trees in Sienna Plantation.
August 11, 2015	Thunderstorm Wind	N/A	N/A	53	0	0	-	-
May 14, 2016	Thunderstorm Wind	N/A	N/A	52	0	0	-	-
April 7, 2019	Thunderstorm Wind	N/A	N/A	50	0	0	$3,000 in crop damage	There were trees blown down.

Source(s): FEMA 2020; NOAA-NCEI 2020; City of Sugar Land HMP 2015
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
- Not available/not recorded
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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). Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (University Corporation for Atmospheric Research [UCAR] 2017).

Probability of Future Occurrences

Table 4-12 summarizes data regarding the probability of occurrences of thunderstorm events in the City of Sugar Land based on the historic record. The information used to calculate the probability of occurrences is based on the 2015 Sugar Land HMP, the NOAA-NCEI Storm Events Database, and FEMA.

Table 4-12. Probability of Future Occurrence of Thunderstorm Events

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Thunderstorm Wind (City)	21	0.30	3.33	0.30	30.00%

Source: NOAA-NCEI 2020; FEMA 2020; City of Sugar Land HMP 2015
Note: The total number of occurrences used to calculate the probability of occurrence included events from NOAA-NCEI and FEMA disaster declarations for Fort Bend County.

The City of Sugar Land is expected to continue experiencing the direct and indirect impacts of thunderstorms each year. Twenty-one thunderstorms in 69 years was recorded in the City of Sugar Land, giving the City a 30% chance of being impacted by a thunderstorm in any given year. However, based on historical records and input from the Steering Committee, the probability of occurrence for thunderstorm wind events in the City is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed and vulnerable to the thunderstorm hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a thunderstorm event. The following text evaluates and estimates the potential impact of the thunderstorm hazard in the City.

Impact on Life, Health and Safety

The most common problems associated with thunderstorms are immobility and loss of utilities. Although the entire population of the City is exposed to thunderstorms, some populations are more vulnerable. Vulnerable populations include the elderly, low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. In general, populations who lack adequate shelter during a thunderstorm, those who are reliant on sustained sources of power in order to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable.

The impact of thunderstorms on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of the City of Sugar Land (86,886) is assumed to be exposed to this hazard (U.S. Census 2017 ACS 5-Year Population Estimate).

People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms, and tornadoes because there is little to no warning, and shelter might not be available. Moving to a lower risk location will decrease a person's vulnerability.

As a result of the impacts of thunderstorms, residents can be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds from thunderstorms can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.

Economically disadvantaged populations are more vulnerable because they often evaluate evacuation needs and make decisions based on the economic impact to their family. The population over the age of 65 (12,570) is also vulnerable, can physically have difficulty evacuating, and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event (U.S. Census 2017 ACS 5-Year Population Estimate). Section 3 (City Profile) provides for the statistics for these populations for the City of Sugar Land.

Impact on General Building Stock

The entire building stock of the City of Sugar Land is vulnerable during a thunderstorm; however, properties in poor condition or in particularly vulnerable locations may be at a higher risk. Buildings located under or near overhead lines or near large trees are more susceptible to damages associated with downed trees and wires.

Impact on Critical Facilities

Overall, all critical facilities in the City of Sugar Land are vulnerable to being affected by thunderstorms. Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effective respond to an event and maintain the safety of its citizens.

Impact on Economy

Thunderstorm events can impact the economy of the City. Impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Hazus v4.2 estimates the total economic loss associated with each probabilistic event (direct building losses and business interruption losses). Business interruption losses include losses associated with the inability to operate a business because of the wind damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event.

Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Areas targeted for potential future growth and development could be potentially impacted by thunderstorms since the entire City is exposed to the thunderstorm hazard. However, due to increased standards and codes, new development can be less vulnerable to the thunderstorm hazard compared with the aging building stock in the City.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the thunderstorm hazard.

Climate Change

Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). An increase in storms will produce more wind events and may increase tornado activity. Additionally, an increase in temperature will provide more energy to produce storms that generate tornadoes (Climate Central 2016). Overall, the City of Sugar Land will continue to remain vulnerable to the thunderstorm hazard.

Changes in Vulnerability Since the 2015 HMP

The City of Sugar Land's population increased since the last plan; increasing the number of people impacted during a thunderstorm. Therefore, the entire City remains vulnerable to thunderstorms.

Issues Identified

Important issues associated with severe storm events in the City of Sugar Land include the following:

- Older building stock in the City could be more vulnerable to winds associated with thunderstorms as they may have been built to low or no code standards.
- Many critical facilities do not have a source of backup power; during power outages, these facilities might not function properly or provide the necessary needs to the City.
- The impacts of drought might lead to dead or dying trees. These trees are more susceptible to falling during thunderstorms. This can cause power outages, close roadways, and damage buildings and property.

4.3.3 Tornadoes

The following section provides the hazard profile and vulnerability assessment for the tornado hazard in the City of Sugar Land.

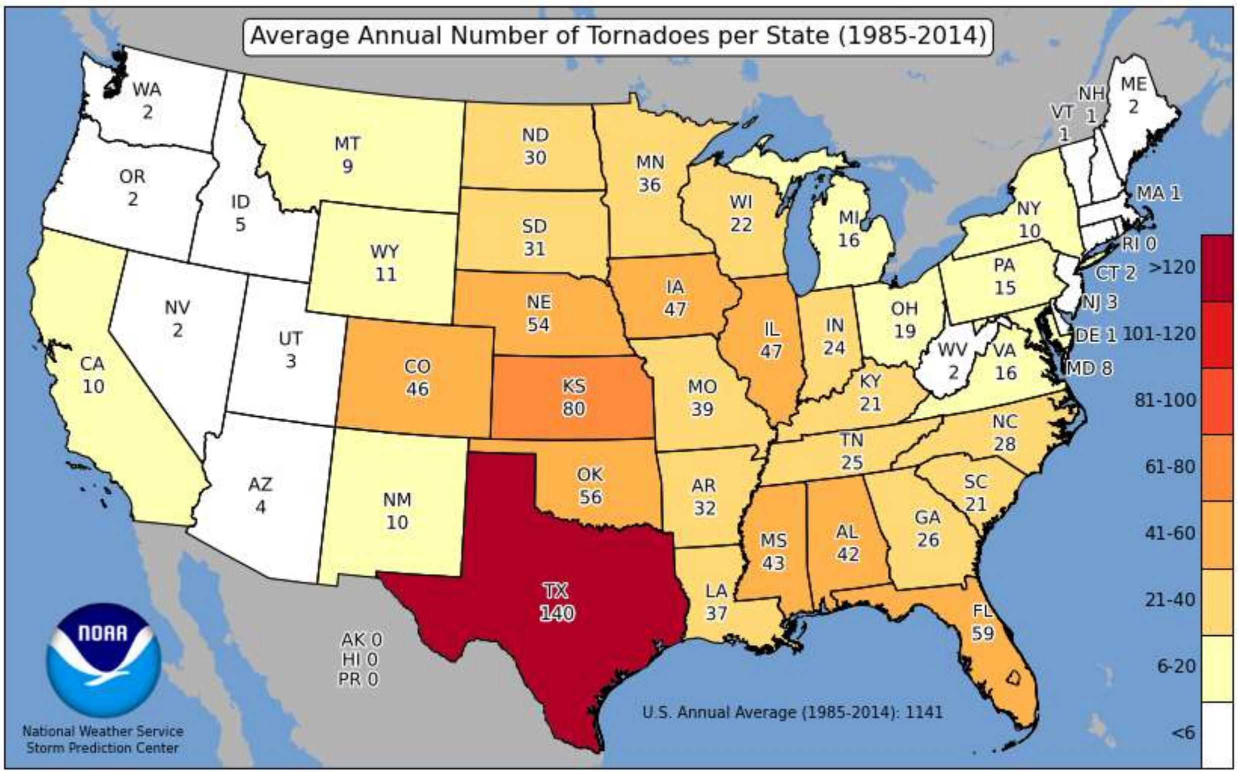
Profile

Hazard Description

A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour (mph). Damage paths can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (NSSL 2013).

An average of 1,141 tornadoes occur in the United States each year, based on tornadoes recorded between 1985 and 2014. The State of Texas averages 140 tornadoes each year.

Figure 4-6. Average Annual Number of Tornadoes, 1985 to 2014

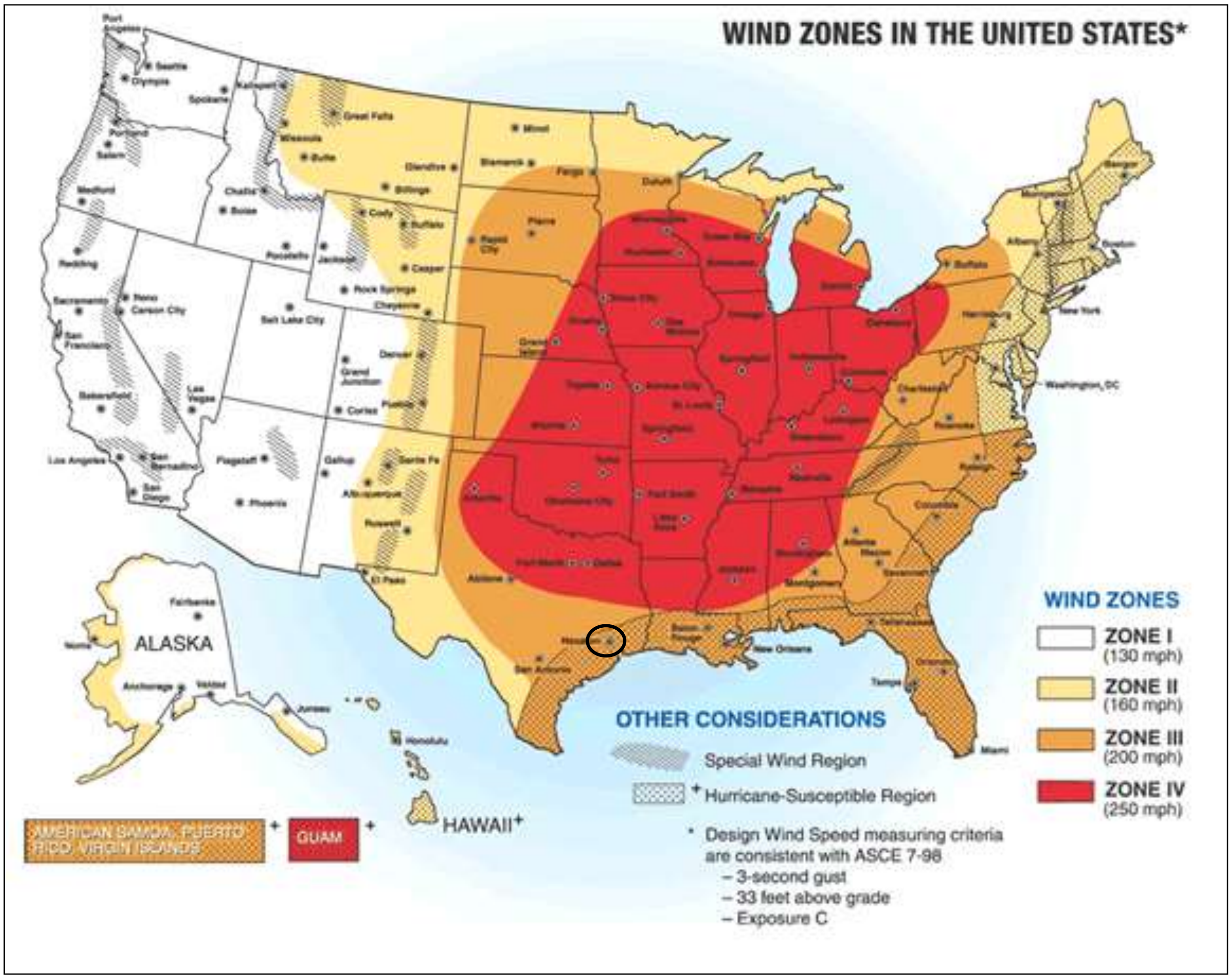


Source: SPC 2020

Location

Similar to that of thunderstorms, tornadoes do not have any specific geographic boundary and can occur anywhere in the City of Sugar Land. According to the FEMA Winds Zones of the United States map, the City of Sugar Land is located in Wind Zones III, where wind speeds can reach up to 200 mph. Additionally, the City is located in the hurricane-susceptible region. Figure 4-7 illustrates wind zones across the United States, which indicate the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 4-7. Wind Zones in the United States



Source: FEMA 2014
Note: The black oval indicates the approximate location of the City of Sugar Land.

Extent

Damage from tornadoes can vary from minor damage that break tree limbs to massive damage demolishing homes in its path. The type of damage depends on the intensity, size, and duration of the tornado. The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 4-8 illustrates the relationship between EF ratings, wind speed, and expected tornado damage. The City can experience tornadoes ranking from EF0 to EF4.

Figure 4-8. Explanation of EF-Scale Ratings

EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Source: NWS 2020

The NWS issues tornado watches and warnings. A tornado watch is issued by the SPC in Norman, Oklahoma. They are issued when conditions are favorable for the development of tornadoes in and close to the watch area. Their size can vary depending on the weather situation. Watches are typically issued for a duration of four to eight hours. A tornado warning is issued by the local NWS office and will include where the tornado was located and what municipalities will be in its path. It is issued when a tornado is indicated by a radar or spotters. Warnings are issued for a duration of 30 minutes (NWS 2020). The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2011).

Worst-Case Scenario

A worst-case scenario would be an EF3 tornado crossing through the City with 3-second wind gusts ranging from 136 to 165 mph, causing severe damage. A tornado of this magnitude would tear off roofs and tear down walls, uproot trees, and lift vehicles off the ground. This could lead to downed utility poles, street signals, and debris on roadways, disrupting normal operations and impacting emergency response times. Critical and essential facilities could also be impacts, resulting in periods of service disruption to residents due to facility damages or lack of back-up power.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with tornadoes events in Fort Bend County and the City of Sugar Land. According to NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by 74 tornado events that caused one fatality, 73 injuries, and $16.1 million in property damage. Of the 74 tornadoes, nine included losses in the City of Sugar Land.

Table 4-13. Tornado Events in the City of Sugar Land, 1996-2019

Hazard Type	Number of Occurrences Between 1996 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Funnel Cloud	2	0	0	$0	$0
Tornado	7	0	64	$5.839 million	$0
TOTAL	**9**	**0**	**73**	**$5.839 million**	**$0**

Source: NOAA-NCEI 2020

Between 1953 and 2019, the State of Texas was included in 15 tornado-related FEMA major disaster (DR) or emergency (EM) declarations. Of those declarations, Fort Bend County was included in two declarations (FEMA 2020). Table 4-10 lists FEMA DR and EM declarations for Fort Bend County.

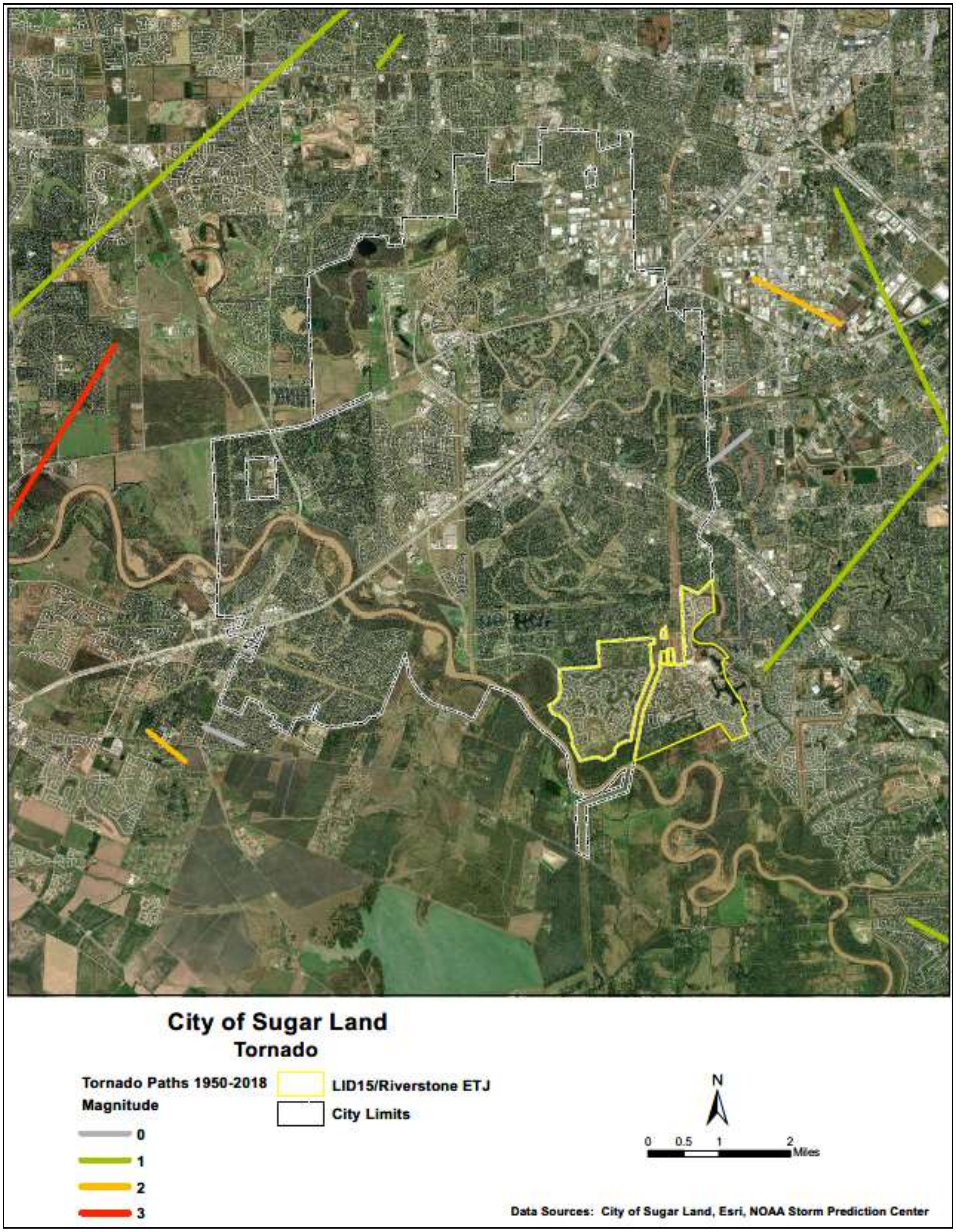
Table 4-14. Tornado-Related FEMA Declarations for Fort Bend County, 1953 to 2019

FEMA Declaration Number	Date(s) of Event	Incident Type	Incident Title
DR-1439	October 24, 2002 to November 15, 2002	Severe Storms	Severe Storms, Tornadoes, and Flooding
DR-4223	May 4, 2015 to June 22, 2015	Severe Storms	Severe Storms, Tornadoes, Straight-Line Winds and Flooding

Source: FEMA 2020

The events show in Figure 4-9 and listed in Table 4-11 represent only those that were reported to NOAA-NCEI and the Storm Prediction Center and may not represent all tornado events that have occurred since 1996. Only those events with latitude and longitude available were plotted on Figure 4-9

Figure 4-9. Tornado Events in the City of Sugar Land, 1950 to 2019



Note: *Please note that the events shown on this figure include only those reported to the NOAA Storm Prediction Center and may not include all events that occurred in the City.*

Table 4-15. Tornado Events in the City of Sugar Land, 1996 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
October 23, 1997	Tornado (EF1)	N/A	N/A	-	-	$1,100,000 in property damage	A widespread severe weather event developed across Southeast Texas on Thursday October 23, 1997 in which numerous tornadoes, funnel clouds, gusty winds and large hail were reported. Eleven separate tornadoes touched down during this event. Many of these tornadoes were spawned from the same supercell. Every tornado that formed had a tornado warning in effect before the damage was produced. Average lead time was 24 minutes between tornado warning issuance and tornado touchdown, ranging from 4 minutes to 58 minutes. No deaths occurred and only one injury was reported. The City of Sugar Land experienced the first tornado touch down. The tornado was mostly an EF0 with some EF1 damage. The tornado path length was three miles long and ¼ mile wide at its strongest stage, damaging over 100 homes and businesses. The tornado caused over $1 million in damages to homes in the City.
February 16, 1998	Tornado (EF3)	N/A	N/A	-	4	$3,700,000 in property damage	An EF3 tornado touched down at the First Colony Mall. It was 200 yards wide and on the ground for a distance of 1.2 miles. The Dillard's department store sustained major damage and many other stores in the mall were damaged as well. The tornado crossed U.S. Highway 59 and damaged an ice skating rink as well as other nearby stores. The tornado ended its path on the south side of U.S. Highway 6 and Williams Grant Road. Four people were injured from flying glass during the incident. The City had an estimated $3.7 million in damages associated with this event.
July 20, 1999	Funnel Cloud	N/A	N/A	-	-	$0 in property damage	Funnel clouds were reported south of US 59 between Brazos River and Crabb River Rd. There were no reports of damages, injuries or fatalities.
June 3, 2003	Tornado (EF0)	N/A	N/A	-	-	$14,000 in property damage	Tornado formed just northeast of the Sugar Land Airport (Hull Field) and moved north into the city. Several homes received minor roof and other property damage.
October 9, 2003	Tornado (EF0)	N/A	N/A	-	-	$25,000 in property damage	Tornado touched down along the Highway 59 and Highway 90 intersection. Several buildings were damaged, minor roof damage to a home. Sky windows were broken out of a day-care facility.
November 17, 2003	Tornado (EF2)	N/A	N/A	-	60	$500,000 in property damage	A series of severe thunderstorms caused a total of 24 tornadoes to touch down throughout southeast Texas in a 15- hour period. An EF2 tornado touched down in the City of Sugar Land during this incident. The tornado, which touched down on West Airport Drive near Industrial Drive, was 200 feet wide and traveled a distance of 1.5 miles. The storm caused 60 minor injuries, with seven people sent to hospital for further treatment. The tornado

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
							damaged several office building roofs in Industrial Park, residential homes in The Meadows subdivision, and a daycare facility at West Airport Drive and Dairy Ashford Road. There were also several reports of cars overturned or blown off the road along Airport Drive.
November 23, 2004	Tornado (EF0)	N/A	N/A	-	-	-	An EF0 tornado touched down in the City of Sugar Land, with a path length of 0.1 miles and a width of 20 yards. The tornado downed trees.
February 14, 2017	Tornado	N/A	N/A	-	-	-	NWS confirmed six tornadoes touched down in Fort Bend and Wharton Counties as severe thunderstorms moved through the area (Kirk 2017). Survey crews with the NWS said the first of the six tornadoes touched down in Wharton County at about 8 a.m., followed by tornadoes in Fairchilds and Rosenberg at about 8:15 a.m., Van Vleck in Matagorda County at 8:20 a.m., the Greatwood and Tara subdivisions near Sugar Land, Bridlewood in Missouri City, in Stafford, and in nearby Sweeny a 8:45 a.m.
August 25, 2017	Tornado (EF1)	DR-4332	Yes	-	-	$500,000 in property damage	As Tropical Storm Harvey made landfall, it produced 23 tornadoes in southeast Texas. In the City of Sugar Land, an EF1 tornado tracked across Sienna Plantation subdivision downing trees and damaging roofs on about 25 homes. Vieux Carre Ct and Steve Ct were the hardest hit areas. The City had approximately $500,000 in damages associated with this event.
May 23, 2018	Funnel Cloud	N/A	N/A	-	-	-	A funnel cloud sighted near Sienna Plantation was moving north towards Shadow Creek.

Source(s): FEMA 2020; NOAA-NCEI 2020; City of Sugar Land HMP 2015
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
- Not reported/not available
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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). An increase in storms will produce more wind events and may increase tornado activity. Additionally, an increase in temperature will provide more energy to produce storms that generate tornadoes (Climate Central 2018).

Probability of Future Occurrences

Table 4-12 summarizes data regarding the probability of occurrences of tornado events in the City of Sugar Land based on the historic record. The information used to calculate the probability of occurrences is based on NOAA-NCEI storm events database results and the SPC severe weather database files.

Table 4-16. Probability of Future Occurrence of Tornado Events

Hazard Type	Number of Occurrences Between 1996 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Funnel Cloud	2	0.09	12.00	0.08	8.33
Tornado (all magnitudes)	7	0.30	3.43	0.29	29.17
TOTAL	**9**	**0.39**	**2.67**	**0.38**	**37.50**

Source: NOAA-NCEI 2020; SPC 2020

The City of Sugar Land is expected to continue experiencing the direct and indirect impacts of tornadoes each year. The City experienced nine tornado and funnel cloud incidents in 23 years, giving the City a 37.5% chance of being impacted by a tornado of any magnitude in any given year. Based on historical records and input from the Steering Committee, the probability of occurrence for tornadoes in the City is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed and vulnerable to the tornado hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a thunderstorm event. The following text evaluates and estimates the potential impact of the tornado hazard in the City.

Impact on Life, Health and Safety

Impacts of a tornado on life, health, and safety depend on several factors, including severity of the event and whether adequate warning time was provided to residents. All residents in the City of Sugar Land are exposed to the tornado hazard.

Residents impacted by tornadoes may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by winds associated with tornadoes can lead to injury or loss of life. Similar to other natural hazards, socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and locations and construction quality of their housing. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact on their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available due to isolation during a storm event. Section 3 (City Profile) presents the statistical information regarding these populations in the City.

Impact on General Building Stock

The entire City's building stock is exposed to the tornado hazard. Damage to buildings depends on several factors, including wind speed, storm duration, path of the storm track or tornado, and distance from the tornado funnel.

Manufactured housing (i.e. mobiles homes) is particularly vulnerable to high winds and tornadoes. The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (Census, 2010)." They can include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 4-17 displays the number of manufactured housing units in the City. Total counts were obtained from the 2013-2017 American Community Survey 5-Year Estimates. While the number is a small percentage of total homes in the City, just 0.1% of the total housing units, the structures and the population living in the structures are vulnerable to tornado events.

Table 4-17. Manufactured Housing Units in the City of Sugar Land

Municipality	Number of Manufactured Homes
City of Sugar Land	39

Source: U.S. Census 2017

Impact on Critical Facilities

Utility infrastructure could suffer damage from tornadoes associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effective respond to an event and maintain the safety of its citizens.

Impact on Economy

Tornados also impact the economy, including loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, and wage loss and rental loss due to repair/replacement of buildings. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could sustain damage, and impacts could result in loss of power, which can affect business operations and provision of heating or cooling to the population.

Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City 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 could be potentially impacted by the tornado hazard because the entire City is exposed and vulnerable. Residential development, specifically manufactured homes, may be considered more vulnerable to the tornado hazard.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the tornado hazard.

Climate Change

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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). An increase in storms will produce more wind events and may increase tornado activity. Additionally, an increase in temperature will provide more energy to produce storms that generate tornadoes (Climate Central 2018). With an increased likelihood of strong winds and tornado events, all of the City's assets will experience additional risk for losses as a result of extreme wind events.

Changes in Vulnerability Since the 2015 HMP

The City of Sugar Land's population increased since the last plan; increasing the number of people vulnerable during a tornado. Therefore, the entire City remains vulnerable to tornado events.

Issues Identified

Important issues associated with tornadoes in the City of Sugar Land include the following:

- Mobile homes are vulnerable to damaging winds from tornadoes
- Dead or dying trees are more susceptible to falling during a tornado
- Power outages lead to disruption of services and can cause disruption in communication

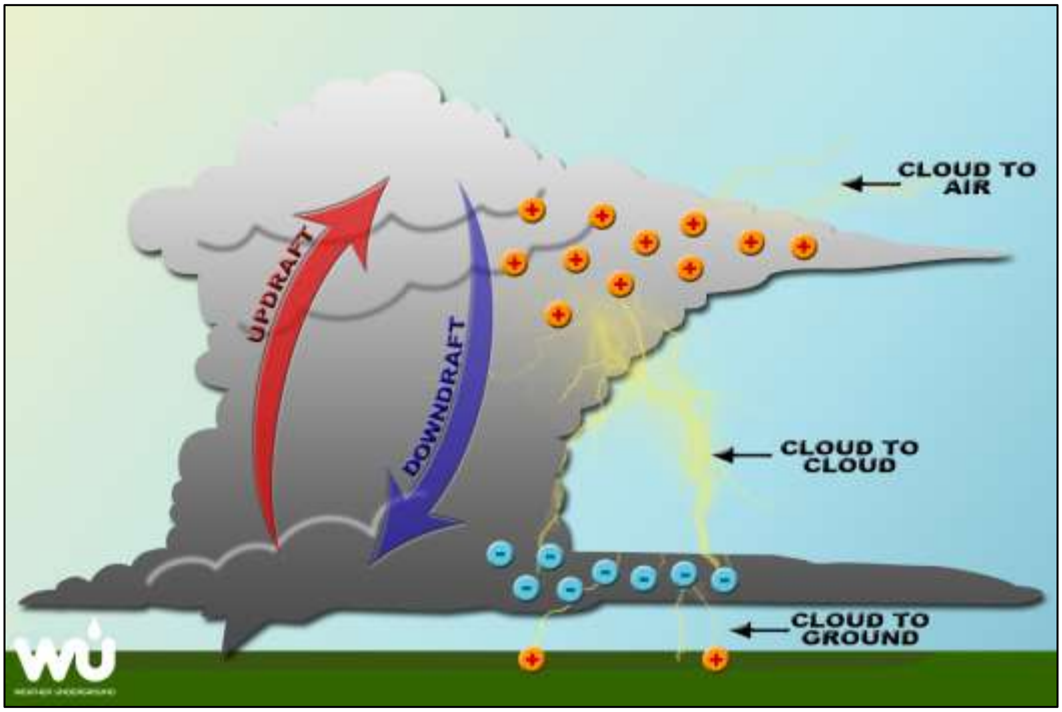
4.3.4 Lightning

The following section provides the hazard profile and vulnerability assessment for the lightning hazard in the City of Sugar Land.

Profile

Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground, produced by a thunderstorm (refer to Section 4.3.2 for details regarding the thunderstorm hazard). Energy from lightning channel heats the air to around 18,000°F. This causes the air to rapidly expand, creating a sound wave known as thunder. Thunder can be heard up to 25 miles away from the lightning discharge (NSSL 2020). Figure 4-10 illustrates how lightning develops.

Figure 4-10. How Lightning Develops



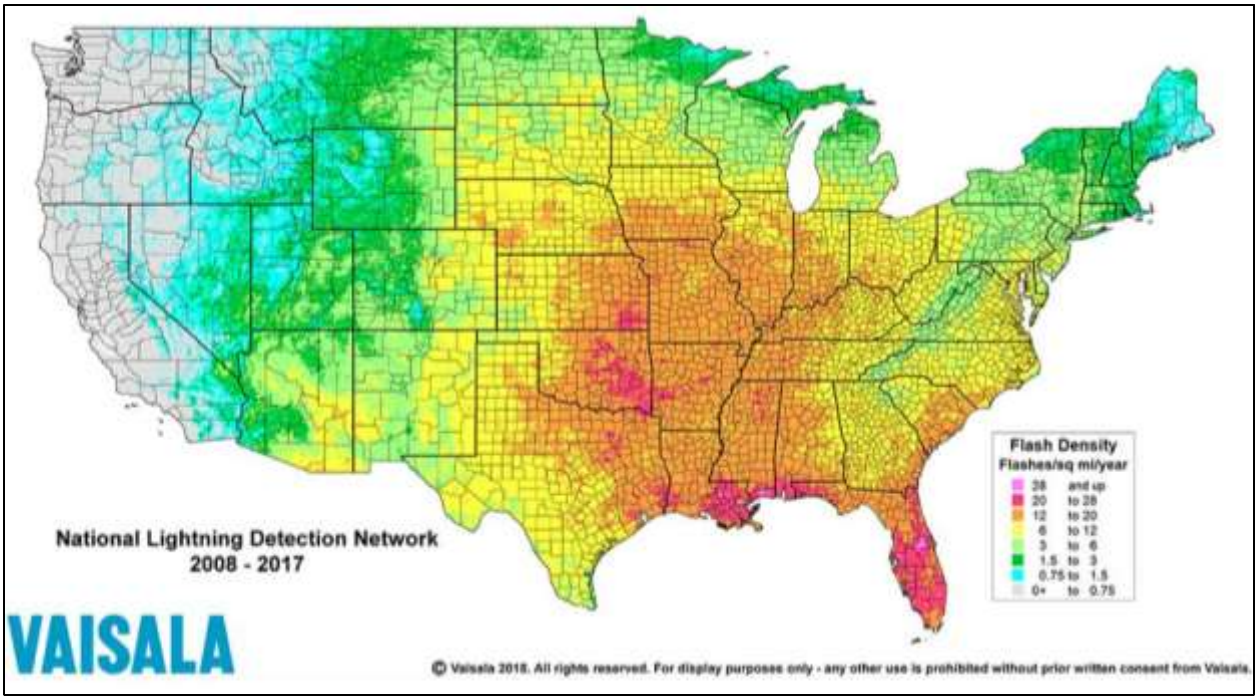
Source: Weather Underground 2020

Lightning is a major cause of storm-related deaths in the United States, with an average of 43 reported fatalities and 243 injuries each year (NWS 2020). Between 1990 and 2003, 52 lightning-related deaths was reported in the State of Texas, ranking second in the United States for deaths associated with lightning strikes (National Lightning Safety Institute 2003).

Location

Lightning occurs with every thunderstorms, making the entire City of Sugar Land susceptible to the lightning hazard. The National Lightning Detection Network (NLDN) collects cloud-to-ground lightning data for the continental United States. Figure 4-11 illustrates the cloud-to-lightning incidence across the United States. The figure shows that Fort Bend County experienced 12 to 20 flashes per square mile each year.

Figure 4-11. Cloud-to-Lightning Incidence, 2008 to 2017



Source: Vaisala 2020

Extent

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. The Lightning Activity Level (LAL) is a scale which describes lightning activity. The scale is part of the National Fire Danger Rating System. The scale is a range of numbers, from one to six, which reflects frequency and character of cloud-to-ground lightning (National Wildfire Coordinating Group 2020; NWS 2020).

Table 4-18. Lightning Activity Level

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

Sources: National Wildfire Coordinating Group 2020; NWS 2020

Worst-Case Scenario

A worst-case scenario for lightning strikes would be an event similar to that of a recent storm on May 7, 2019 that had a reported 276 lightning strikes in the City of Sugar Land. This type of event would be a 4 or 5 on the LAL scale. An event with frequent lightning strikes could lead to power outages, structural fires, injuries, and deaths. A citywide power outages would disrupt operations, inundate shelters, increase emergency response calls, and impact critical services that relies on power to assist the community.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with lightning strikes in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by 22 lightning events between 1996 and 2019 that caused $524,000 in property damage. Of those events, three events had damages specific to the City of Sugar Land (refer to Table 4-9).

Table 4-19. Lightning Events 1996-2019

Hazard Type	Number of Occurrences Between 1996 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Lightning	3	1	2	-	-

Sources: NOAA-NCEI 2020; City of Sugar Land HMP 2015
Note: Due to limitations in data, not all thunderstorm wind events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated

As stated earlier, lightning occurs with thunderstorms. Between 1953 and 2019, the State of Texas was included in three thunderstorm-related FEMA major disaster (DR) or emergency (EM) declarations. Of those declarations, Fort Bend County was included in two declarations (FEMA 2020). Table 4-10 lists FEMA DR and EM declarations for Fort Bend County.

Table 4-20. Thunderstorm-Related FEMA Declarations for Fort Bend County, 1953 to 2019

FEMA Declaration Number	Date(s) of Event	Incident Type	Incident Title
DR-930	December 20, 1991 to January 14, 1992	Flood	Severe Thunderstorms
DR-1041	October 14-November 8, 1994	Flood	Severe Thunderstorms and Flooding

Source: FEMA 2020

This HMP update includes known lightning strikes that have impacted the City of Sugar Land between 2000 and 2019. These events listed in Table 4-11 represent only those that were reported in the NOAA-NCEI Storm Events Database and the City of Sugar Land's 2015 HMP. However, local knowledge indicates more instances of lightning strikes occurring in the City. Therefore, Table 4-11 may not represent all lightning strikes that have occurred prior to or since 2000.

Table 4-21. Lightning Events in the City of Sugar Land, 1996 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Event Details*
October 7, 2002	Lightning	N/A	N/A	This event resulted in $28,000 in property damage.
July 23, 2003	Lightning	N/A	N/A	The most severe lightning incident in the City of Sugar Land occurred on July 23, 2003, when a group of three individuals installing a chain link fence took shelter under a tree during a fast approaching storm and were struck by lightning. This incident resulted in one fatality and two injuries.
May 13, 2016	Lightning	N/A	N/A	Severe thunderstorms moved across southeastern Texas, producing strong winds, hail, and lightning strikes. In the City of Sugar Land, lightning struck a home causing a structural fire. The City had approximately $15,000 in damages from this event.

Source(s): FEMA 2020; NOAA-NCEI 2020; City of Sugar Land HMP 2015
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
- *Not available/not recorded*
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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).

Climate change may lead to an increase in the number of lightning-producing storms. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). At century's end, the number of summertime storms that produce extreme downpours could increase by more than 400% across parts of the United States, including sections of the Gulf Coast, Atlantic Coast, and the Southwest. In addition, the intensity of individual extreme rainfall events could increase by as much as 70% in some areas (UCAR 2016).

Probability of Future Occurrences

Table 4-22 summarizes data regarding the probability of occurrences of lightning events in the City of Sugar Land based on the historic record. The information used to calculate the probability of occurrences is based on the 2015 Sugar Land HMP, the NOAA-NCEI Storm Events Database, and FEMA.

Table 4-22. Probability of Future Occurrence of Lightning Events

Hazard Type	Number of Occurrences Between 2002 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Lightning (City)	3	0.18	6.00	0.17	16.67

Source: NOAA-NCEI 2020; FEMA 2020; City of Sugar Land HMP 2015

The City of Sugar Land will continue experiencing the direct and indirect impacts of lightning events each year. Based on information from the 2015 Sugar Land HMP and the NOAA-NCEI Storm Events Database, there have only been three reported lightning strikes in the City in 17 years. However, as stated earlier, local knowledge indicates many more instances of lightning strikes occurring in the City. Therefore, the calculated probability based on recorded incidents might not represent the actual probability of occurrence. Based on historical records and input from the Steering Committee, the probability of occurrence for thunderstorm events in the City is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

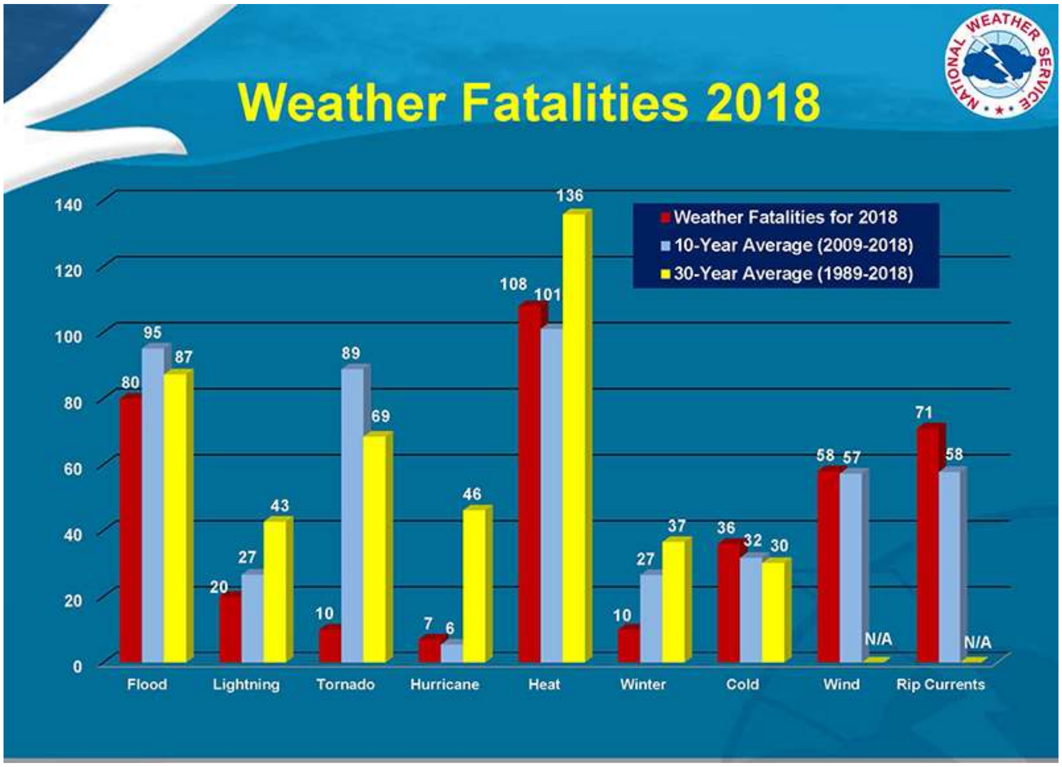
Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed and vulnerable to the lightning hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a thunderstorm event. The following text evaluates and estimates the potential impact of the lightning hazard in the City.

Impact on Life, Health and Safety

Across the United States, the 10-year average (2009 to 2018) for lightning-caused fatalities is 27, while the 30-year average (1989 to 2018) is 43 (NWS 2020). Refer to Figure 4-12 for an illustration of these statistics. According to the NOAA-NCEI Storm Events Database, there has been one fatality and two injuries as a result of lightning events from 1996 to 2019.

Figure 4-12. Weather Fatalities in the United States, 2018



Source: NOAA 2020

The impact of a lightning on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of the City of Sugar Land is assumed to be exposed to this hazard.

Lightning can be responsible for deaths, injuries, and property damage. Lightning-based deaths and injuries typically involve heart damage, inflated lungs, or brain damage, as well as loss of consciousness, amnesia, paralysis, and burns, depending on the severity of the strike. Additionally, most people struck by lightning survive, although they may have severe burns and internal damage. People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to lightning strikes because there is little to no warning, and shelter might not be available. Moving to a lower risk location will decrease a person's vulnerability.

Impact on General Building Stock

For the purpose of this plan update, the entire general building stock and all infrastructure in the City of Sugar Land are considered exposed to the lightning hazard. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems. While damage to the building stock is possible as a result of lightning, it is difficult to estimate and would not have as wide of an impact as a high wind or tornado event.

Impact on Critical Facilities

For the purpose of this plan update, all critical facilities in the City of Sugar Land are considered exposed to the lightning hazard.

Impact on Economy

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

Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Areas targeted for potential future growth and development could be potentially impacted by thunderstorms since the entire City is exposed to the lightning hazard. However, due to increased standards and codes, new development can be less vulnerable to the lightning hazard compared with the aging building stock in the City.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the lightning hazard.

Climate Change

Climate change may lead to an increase in the number of lightning strikes and lightning-producing storms. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (University Corporation for Atmospheric Research [UCAR] 2017). The changing climate may also increase the frequency of lightning flashes could rise by an estimated 50-percent across the continental United States over the next century. A warmer atmosphere can hold more moisture and moisture is one of the key ingredients for triggering a lightning strike (Lee 2014).

Changes in Vulnerability Since the 2015 HMP

The City of Sugar Land's population increased since the last plan; increasing the number of people impacted during a lightning. Therefore, the entire City remains vulnerable to lightning.

Issues Identified

Important issues associated with lightning events in the City of Sugar Land include the following:

- Lightning strikes can lead to power outages and structural fires.

4.3.5 Extreme Temperature

The following section provides the hazard profile and vulnerability assessment for the extreme temperature hazard in the City of Sugar Land.

Profile

Hazard Description

Extreme temperature includes both heat and cold events, which can have a significant impact to human health, commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). What constitutes *extreme cold* or *extreme heat* can vary across different areas of the country, based upon what the population is accustomed.

Extreme Heat

Extreme heat is defined as temperatures which hover 10 degrees or more above the average high temperature for a region. Because some areas are hotter than others, extreme heat temperatures depends on what's considered average for a particular location at that time of year (CDC 2017). A heat wave is an extended period of extreme heat of two or more consecutive days is typically called a heat wave and is often accompanied by high humidity (NWS 2009). Extreme heat during the summer months is a common occurrence in the State of Texas, including the City of Sugar Land.

Extreme Cold

Extreme cold events are when temperatures drop well below normal in an area. What constitutes as extreme cold varies in different parts of the country. In the southern United States, near freezing temperatures are considered extreme cold. Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat (NWS 2017). The City of Sugar Land typically does not experience extreme cold; however, the City does have a history of occurrence for extreme cold temperatures.

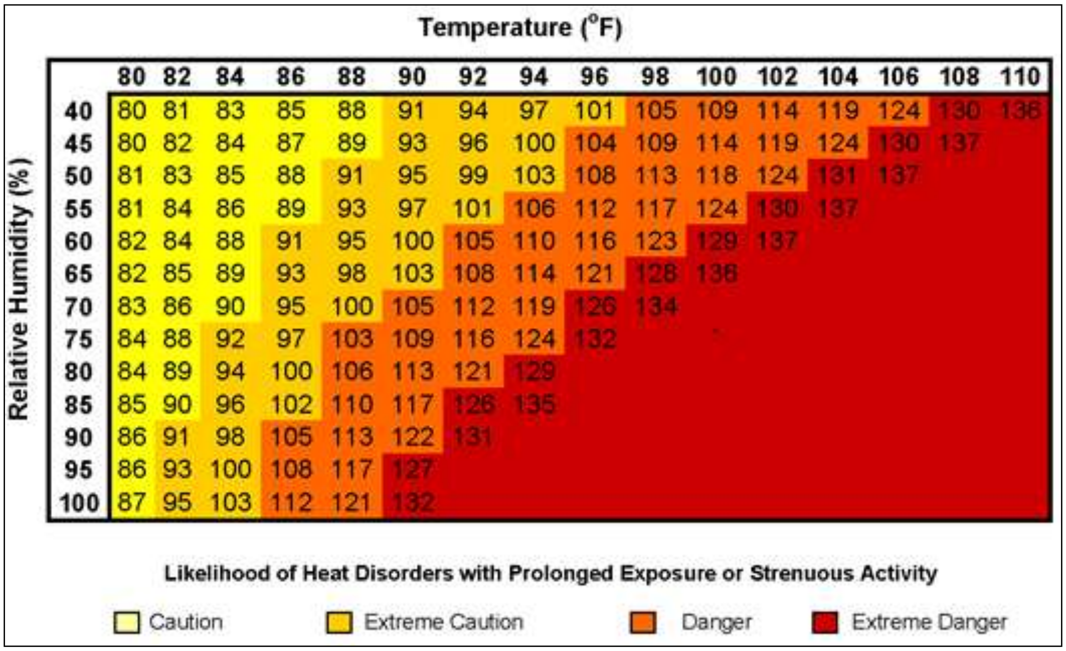
Extent

Extreme Heat

The extent of extreme heat temperatures generally is measured through the Heat Index, identified in Figure 4-13. Created by the NWS, the Heat Index is a chart that accurately measures apparent temperature of the air as it increases with the relative humidity. To determine the Heat Index, the temperature and relative humidity are needed. Once both values are identified, the Heat Index is the corresponding number of both the values. This provides a measure of how temperatures feel; however, the values are devised for shady, light wind conditions. Exposure to full sun can increase the index by up to 15 degrees.

> Relative humidity is the amount of moisture in the air at a certain temperature compared to what the air can "hold" at that temperature…it is measured as a percentage or ratio of the amount of water vapor in a volume of air RELATIVE to a given temperature and the amount it can hold at that given temperature. Warm air can hold more moisture than cold air.

Figure 4-13. Heat Index Chart



RH (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Source: NWS 2016

The NWS provides alerts when Heat Indices approach hazardous levels. Table 4-23 explains these alerts.

Table 4-23. National Weather Service Alerts

Alert	Criteria
Excessive Heat Outlook	The National Weather Service (NWS) issues an excessive heat outlook when there is a potential for an excessive heat event in the next three to seven days. The outlook is intended to provide information for those who need considerable lead-time to prepare for the excessive heat.
Heat Advisory	A heat advisory is typically issued within 12 hours of the onset of extremely dangerous heat conditions. Generally, a heat advisory is issued when the maximum heat index temperature is expected to be at 100°F or higher for at least two days, and nighttime air temperatures will not drop below 75°F; however, these criteria vary across the country, especially for areas that are not accustomed to dangerous heat conditions.
Excessive Heat Watch	An excessive heat watch is issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Excessive Heat Warning	The NWS issues an excessive heat warning within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this warning is when the maximum heat index temperature is expected to be 105°F or higher for at least two days and nighttime air temperatures will not drop below 75°F; however, these criteria also vary across the country, especially for areas not accustomed to extreme heat conditions.

Source: Texas State School Safety Center

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures generally are measured through the Wind Chill Temperature (WCT) Index. The WCT Index uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from wind chill. For details regarding the WCT Index, refer to: http://www.nws.noaa.gov/om/winter/windchill.shtml

Figure 4-14. NWS WCT Index

Temperature (°F)

Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes / 10 minutes / 5 minutes

Source: NWS 2020

The NWS provides alerts when Wind Chill indices approach hazardous levels. Table 4-24 explains these alerts.

Table 4-24. National Weather Service Alerts for Extreme Cold

Alert	Criteria
Wind Chill Advisory	NWS issues a wind chill advisory when seasonably cold wind chill values but not extremely cold values are expected or occurring.
Wind Chill Watch	NWS issues a wind chill watch when dangerously cold wind chill values are possible. As with a warning, adjust your plans to avoid being outside during the coldest parts of the day.
Wind Chill Warning	NWS issues a wind chill warning when dangerously cold wind chill values are expected or occurring.

Source: NWS 2020

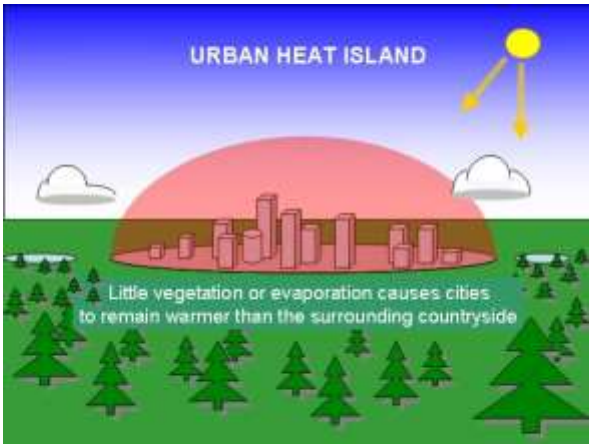
Worst-Case Scenario

An extreme temperature could impact the entire population of the City of Sugar Land. The vulnerable populations (over 65 and under 5, below poverty threshold) would be more susceptible to warmer or colder temperatures. Extreme cold temperatures could result injuries associated with an interruption of energy supplies and lack of access to medical care caused by snow or ice. Extreme heat worst-case scenario would be a multi-day event of temperatures exceeding 102°F, like that experienced in August 2015. Those that are outside could be more vulnerable to heat-related illnesses. Extreme cold worst-case scenario would be a multi-day event of temperatures only reaching 34°F, like that experienced during the February 2021 snow/cold event. Another event like this could lead to power outages, no running water, frozen pipes, and minimal heat sources.

Location

Extreme temperature events can occur in any area of the City of Sugar Land. Metropolitan areas could experience more extreme heat events due to urban heat islands. Heat island describes built up areas that are hotter than nearby rural areas. According to the U.S. EPA, the annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C). Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water pollution (EPA 2020).

Figure 4-15. Urban Heat Island



Source: weatherqusstions.com 2019

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with extreme temperatures in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by eight extreme temperature events between 1996 and 2019.

Table 4-25. Extreme Temperature Events in Fort Bend County, 1996-2019

Hazard Type	Number of Occurrences Between 1996 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Heat	8	0	0	$0	$0

Source: NOAA-NCEI 2020
Note: Extreme temperature events typically occur over a large area; therefore, the total number of events included in the table are for Fort Bend County and includes the City of Sugar Land.
Note: Due to limitations in data, not all thunderstorm wind events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated

Between 1953 and 2019, the State of Texas was included in two extreme temperature-related disaster declarations related to cold temperatures. Of those declarations, Fort Bend County was not included in either declaration (FEMA 2020).

According to Houston Sugar Land Memorial Station, the local weather data collection center with comprehensive data in the City, the mean number of days between 1997 and 2020 with a daily maximum temperature equal to or greater than 90°F was 107.5 days. The greatest number of days which the City experienced extreme heat is 134 in 1998, while the highest temperature recorded was 108°F on August 27, 2011.

Table 4-26. Monthly Number of Days with Maximum Temperature ≥ 90°F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1997	0	0	0	0	3	23	31	30	24	4	0	0	115
1998	0	0	1	1	22	27	30	28	22	3	0	0	134
1999	0	0	0	3	13	20	26	31	22	11	0	0	126

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	0	0	1	2	10	23	31	31	19	4	0	0	121
2001	0	0	0	0	8	21	27	26	12	1	0	0	95
2002	0	0	0	5	17	23	29	26	10	5	0	0	115
2003	0	0	0	0	19	24	20	24	2	1	0	0	90
2004	0	0	0	0	3	16	27	25	21	10	0	0	102
2005	0	0	0	0	9	29	29	29	25	5	0	0	126
2006	0	0	0	1	7	18	17	25	15	3	0	0	86
2007	0	0	0	0	2	17	16	28	18	3	0	0	84
2008	0	0	0	0	15	30	28	25	12	1	0	0	111
2009	0	0	0	0	10	26	31	29	9	5	0	0	110
2010	0	0	0	0	10	23	22	28	12	2	0	0	97
2011	0	0	0	2	15	29	30	30	27	0	0	0	133
2012	0	0	0	0	7	23	20	29	14	1	0	0	94
2013	0	0	1	0	2	26	25	28	22	2	0	0	106
2014	0	0	0	1	1	20	26	24	14	4	0	0	90
2015	0	0	0	0	0	19	30	27	15	5	0	0	96
2016	0	0	0	0	0	17	28	19	18	4	0	0	86
2017	0	0	0	2	4	18	29	24	21	9	2	0	109
2018	0	0	0	0	22	27	28	30	12	9	0	0	128
2019	0	0	0	0	4	22	26	31	26	10	0	0	119
2020	0	0*	-	-	-	-	-	-	-	-	-	-	0*
Averages	0	0.0**	0.1**	0.7**	8.8**	22.7**	26.3**	27.3**	17.0**	4.4**	0.1**	0.0**	107.5**
Sums	0	0**	3**	17**	203**	521**	606**	627**	392**	102**	2**	0**	2473**
Maximums	0	0**	1**	5**	22**	30**	31**	31**	27**	11**	2**	0**	134**
Minimums	0	0**	0**	0**	0**	16**	16**	19**	2**	0**	0**	0**	84**

Source: Midwest Regional Climate Center 2020
Notes:
- = indicates that there is no available data
** = indicates that the data are not complete*
*** = indicates that the value is being computed using only the years with complete data*

According to Houston Sugar Land Memorial Station, the local weather data collection center with comprehensive data in the City, the mean number of days between 1997 and 2020 with a daily maximum temperature equal to or less than 32°F was 7.6 days. The greatest number of days which the City experienced extreme cold is 23 in 2010, while the lowest temperature recorded was 16°F on January 9, 2011.

Table 4-27. Monthly Number of Days with Maximum Temperature ≤ 32°F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1997	0	0	0	0	0	0	0	0	0	0	0	2	2
1998	0	0	0	0	0	0	0	0	0	0	0	1	1
1999	2	0	0	0	0	0	0	0	0	0	0	1	3
2000	1	0	0	0	0	0	0	0	0	0	0	2	3
2001	7	0	0	0	0	0	0	0	0	0	0	0	7
2002	4	3	3	0	0	0	0	0	0	0	0	2	12
2003	3	1	0	0	0	0	0	0	0	0	0	4	8
2004	2	0	0	0	0	0	0	0	0	0	0	5	7
2005	0	0	0	0	0	0	0	0	0	0	1	2	3
2006	2	2	0	0	0	0	0	0	0	0	0	4	8
2007	2	2	0	0	0	0	0	0	0	0	0	1	5
2008	3	0	0	0	0	0	0	0	0	0	0	1	4
2009	6	1	0	0	0	0	0	0	0	0	0	5	12
2010	10	6	0	0	0	0	0	0	0	0	1	6	23
2011	5	11	0	0	0	0	0	0	0	0	2	3	21
2012	4	0	0	0	0	0	0	0	0	0	0	6	10
2013	2	0	1	0	0	0	0	0	0	0	1	3	7
2014	8	1	2	0	0	0	0	0	0	0	1	0	12

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	2	2	1	0	0	0	0	0	0	0	0	0	5
2016	2	0	0	0	0	0	0	0	0	0	0	2	4
2017	3	0	0	0	0	0	0	0	0	0	0	1	4
2018	7	0	0	0	0	0	0	0	0	0	2	0	9
2019	1	0	1	0	0	0	0	0	0	0	1	2	5
2020	0	0*	-	-	-	-	-	-	-	-	-	-	0*
Averages	3.2	1.3**	0.3**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.0**	0.4**	2.3**	7.6**
Sums	76	29**	8**	0**	0**	0**	0**	0**	0**	0**	9**	53**	175**
Maximums	10	11**	3**	0**	0**	0**	0**	0**	0**	0**	2**	6**	23**
Minimums	0	0**	0**	0**	0**	0**	0**	0**	0**	0**	0**	0**	1**

Source: Midwest Regional Climate Center 2020
Notes:
- = indicates that there is no available data
** = indicates that the data are not complete*
*** = indicates that the value is being computed using only the years with complete data*

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. Seventy years from now, Texas is likely to have three or four times as many days per year above 100°F as it has today (EPA 2016). With the increase in temperatures, heat waves will become more frequent and intense, increasing heat-related illness and death and posing new challenges to the energy system, air quality and agriculture.

Probability of Future Occurrences

It is anticipated that the City will experience extreme temperature events each year, with a majority of the days being extreme heat days. The probability of future occurrences for extreme temperatures can be determined by assessing historical averages. Based on the information provided by the Midwest Regional Climate Center, the City can expect, on average, approximately 112 days a year with temperatures greater than or equal to 90°F. Additionally, the City can expect, on average, approximately eight days each year with temperatures less than or equal to 32°F.

Table 4-28. Probability of Occurrences of Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1997 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Temperature ≥ 90°F	2,473	112.41	0.01	107.52	100%
Temperature ≤ 32°F	175	7.95	0.13	7.61	100%
Total	**2648**	**120.36**	**0.01**	**115.13**	**100%**

Source: *Midwest Regional Climate Center 2020*
Note: Probability was calculated using the available data provided in the Midwest Regional Climate Center data for the Houston Sugar Land Memorial Station.

Based on historical records and input from the Steering Committee, the probability of occurrence for extreme temperatures in the City of Sugar Land is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the extreme temperature hazard, the entire City has been identified as exposed; therefore, all assets are potentially vulnerable. The following text estimated potential impacts of extreme temperatures on the City of Sugar Land.

Impact on Life, Health and Safety

The entire population (86,886) of the City of Sugar Land is exposed to the extreme temperature hazard. Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals with chronic medical conditions (e.g., heart disease, high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC 2017a).

Table 4-29. Vulnerable Populations in the City of Sugar Land

Jurisdiction	Population Over 65	Population Under 5	Population Below Poverty Threshold
City of Sugar Land	12,570	4,702	5,213

Source: 2013-2017 American Community Survey 5-Year Estimate

Exposure to excessive heat can pose a number of health risks to individuals. Table 4-30 and Table 4-31 identify different health hazards related to extreme heat conditions.

Table 4-30. Health Effects of Extreme Cold

Health Hazard	Symptoms
Wind Chill	Wind chill is not the actual temperature but rather how wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. Animals are also affected by wind chill; however, cars, plants and other objects are not.
Frostbite	Frostbite is damage to body tissue caused by extreme cold. A wind chill of -20°F will cause frostbite in just 30 minutes. Frostbite causes a loss of feeling and a white or pale appearance in extremities, such as fingers, toes, ear lobes or the tip of the nose. If symptoms are detected, get medical help immediately! If you must wait for help, slowly re-warm affected areas. However, if the person is also showing signs of hypothermia, warm the body core before the extremities.
Hypothermia	Hypothermia is a condition brought on when the body temperature drops to less than 95°F. It can kill. For those who survive, there are likely to be lasting kidney, liver and pancreas problems. Warning signs include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness and apparent exhaustion.

Source: CDC 2020

Table 4-31. Health Effects of Extreme Heat

Health Hazard	Symptoms
Sunburn	Redness and pain. In severe cases: swelling of skin, blisters, fevers, and headaches
Dehydration	Excessive thirst, dry lips, and slightly dry mucous membranes
Heat Cramps	Painful spasms, usually in muscles of legs and abdomen, and possible heavy sweating
Heat Exhaustion	Heavy sweating; weakness; cold, pale and clammy skin; weak pulse; possible fainting and vomiting
Heat Stroke	High body temperature (104ºF or higher), hot and dry skin, rapid and strong pulse, and possible coma

Source: CDC 2020

Meteorologists can accurately forecast extreme heat and cold event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions, and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All the building stock in the City is exposed to the extreme temperature hazard. Extreme heat generally does not impact buildings; however, elevated summer temperatures increase the energy demand for cooling. Losses can be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles, as well as increasing vulnerability to home fires. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities can have inadequate capabilities to withstand extreme temperatures.

Impact on Critical Facilities

All critical facilities in the City are exposed to the extreme temperature hazard. Impacts to critical facilities are the same as described for general building stock. Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as *brown-outs*, due to increased usage from air conditioners and other energy-intensive appliances. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption. Backup power is recommended for critical facilities and infrastructure.

Impact on Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage to and loss of inventory. Business-owners can be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills, or business interruption due to power failure (i.e., loss of electricity, telecommunications).

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 and Change in Population

The ability of new development to withstand extreme temperature impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. New development will change the landscape where buildings, roads, and other infrastructure potentially replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas forming an *island* of higher temperatures (EPA 2009).

Climate Change

As the climate warms, extreme cold events might decrease in frequency, while extreme heat events might increase in frequency; the shift in temperatures could also result in hotter extreme heat events. With increased temperatures, vulnerable populations could face increased vulnerability to extreme heat and its associated illnesses, such as heatstroke and cardiovascular and kidney disease. Additionally, as temperatures rise, more buildings, facilities, and infrastructure systems may exceed their ability to cope with the heat.

Change of Vulnerability Since the 2015 HMP

Overall, the entire City remains vulnerable to extreme temperatures. As existing development and infrastructure continue to age they can be at increased risk to failed utility systems (e.g., HVAC) if they are not properly maintained. Similarly, an increase in the elderly population remaining in the City increases the vulnerable population.

Issues Identified

The potential issues identified with extreme temperature events include:

- The aging population of the City may result in an increase of residents vulnerable to extreme temperature events as the senior population is less able to withstand extreme temperatures due to age and health conditions.
- Prolonged extreme heat events can lead to drought conditions and impact the drinking water supply for residents.
- Extreme temperature events can damage aging infrastructure and buildings as highways and roads are damaged by excessive heat as the asphalt softens, and roadways can be damaged from extreme cold temperatures causing frost heaving of road infrastructure.

4.3.6 Hail

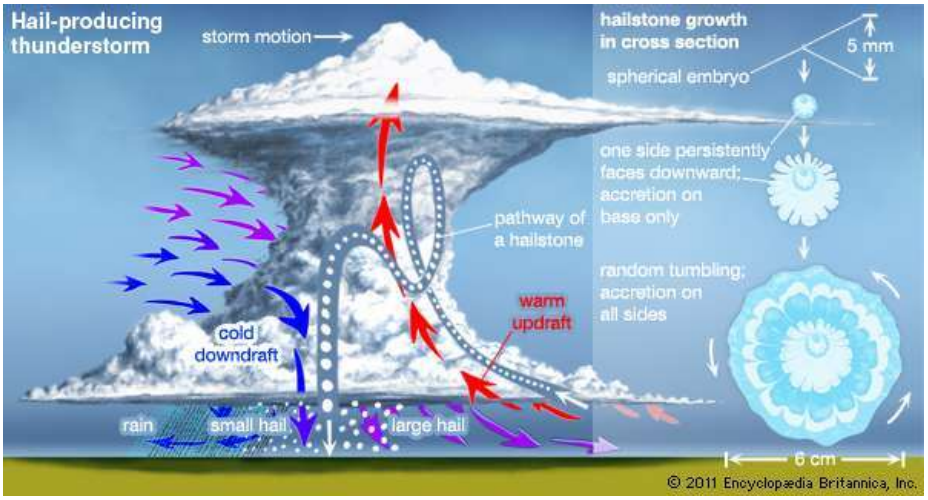
The following section provides the hazard profile and vulnerability assessment for the hail hazard in the City of Sugar Land.

Profile

Hazard Description

Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 °F or colder. As the frozen droplet begins to fall, it might thaw as it moves into warmer air toward the bottom of the thunderstorm, or the droplet might be picked up again by another updraft and carried back into the cold air to re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Figure 4-16 shows the hail formation process. Most hail is small and typically less than two inches in diameter (NWS 2009).

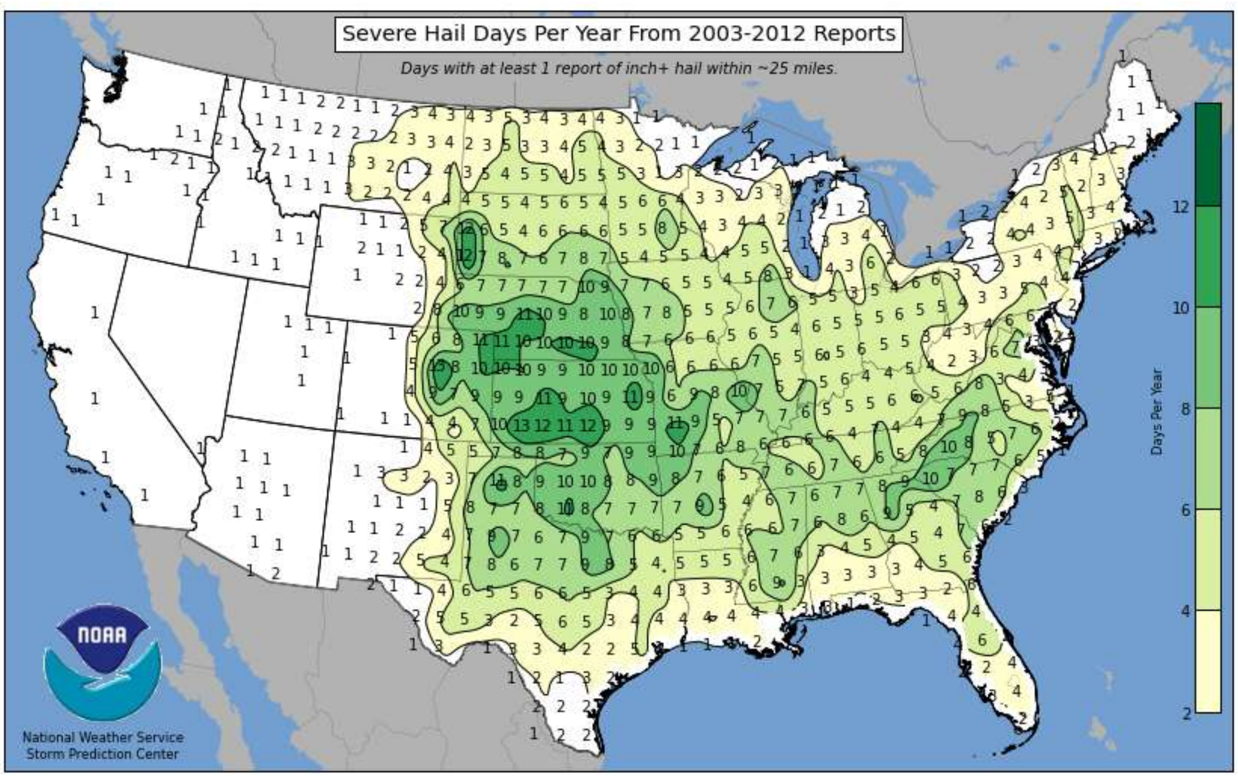
Figure 4-16. Hail Formation



Source: Encyclopedia Britannica 2011

Figure 4-17 shows the annual frequency of hailstorms in the United States as recorded from 2003 to 2012. Hailstorms have been observed in almost every location where thunderstorms occur throughout the United States. They are most frequent in the southern and central plain states where the climate produces violent thunderstorms. The figure shows that the City of Sugar Land experiences between two and four severe hail days each year. Severe hail day is defined as a day with at least one report of one-inch or more hail within 25 miles.

Figure 4-17. Severe Hail Days Per Year from 2003-2012



Source: SPC 2020

Location

All of the City of Sugar Land is exposed and vulnerable to hail.

Extent

The severity of hail is measured by duration, hail size, and geographic extent. Most hail stones from hail events are made up of variety of sizes. Only the very largest hail stones pose serious risk to people, if exposed. The size of hail is estimated by comparing it to a known object. Table 4-32 shows the different sizes of hail and the comparison to real-world objects.

Table 4-32. Hail Size

Size	Inches in Diameter
Pea	0.25 inch
Marble/mothball	0.50 inch
Dime/Penny	0.75 inch
Nickel	0.875 inch
Quarter	1.0 inch
Ping-Pong Ball	1.5 inches
Golf Ball	1.75 inches
Tennis Ball	2.5 inches
Baseball	2.75 inches
Tea Cup	3.0 inches
Grapefruit	4.0 inches
Softball	4.5 inches

Source: NOAA 2012

The Tornado and Storm Research Organization (TORRO) Hailstorm Intensity Scale (H0 to H10) relates typical damage and hail sizes.

Table 4-33. TORRO Hailstorm Intensity Scale

TORRO Hailstorm Intensity Scale	Intensity Category	Typical Hail Diameter (mm)	Typical Damage Impacts
H0	Hard Hail	5	No damage
H1	Potentially Damaging	5-15	Slight general damage to plants, crops
H2	Significant	10-20	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	Widespread glass damage, vehicle bodywork damage
H5	Destructive	30-50	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60	Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	50-75	Severe roof damage, risk of serious injuries
H8	Destructive	60-90	(Severest recorded in the British Isles) Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	>100	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: TORRO 2018

Worst-Case Scenario

Hail usually occurs with a thunderstorms. A worst-case scenario would be a severe thunderstorm producing large hail (quarter-size [1-inch] and larger). This event would be a H3 (severe) hailstorm event on the TORRO intensity scale. An event like this can cause severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored, and damage to roofs. The aftermath of a severe hail event could lead to millions of dollars in damages.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with hail events in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by 120 hail events between 1955 and 2019 that caused $2.9 million in property damage. Of those events, the City of Sugar Land reported 15 hail events between 1996 and 2019 (refer to Table 4-34).

Table 4-34. Hail Events in the City of Sugar Land, 1996-2019

Hazard Type	Number of Occurrences Between 1996 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Hail	15	0	0	$117,000	$0

Source: *NOAA-NCEI 2020*
Note: *Due to limitations in data, not all thunderstorm wind events occurring between 1950 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated*

Between 1953 and 2019, the State of Texas was included in five hail-related major disaster (DR) or emergencies (EM) declarations. Of those declarations, Fort Bend County was not included in any of those declarations. This HMP update includes known hail events that have impacted the City of Sugar Land between 1955 and 2019. These events are shown in Table 4-35. The events listed in Table 4-35 represent only those that were reported to the NOAA-NCEI Storm Events Database and the Storm Predication Center, and may not represent all hail events that have occurred in the City.

Table 4-35. Hail Events in the City of Sugar Land, 1996 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Magnitude	Fatalities	Injuries	Damages	Event Details*
September 2, 1997	Hail	N/A	N/A	0.75 inches	0	0	$5,000 in property damages	-
February 16, 1998	Hail	N/A	N/A	0.75 inches	0	0	$3,000 in property damages	-
May 10, 1999	Hail	N/A	N/A	0.88 inches	0	0	$15,000 in property damage	-
November 12, 2000	Hail	N/A	N/A	0.75 inches	0	0	$10,000 in property damages	-
April 16, 2001	Hail	N/A	N/A	0.75 inches	0	0	$20,000 in property damages	-
March 30, 2002	Hail	N/A	N/A	1.75 inches	0	0	$20,000 in property damages	-
April 7, 2003	Hail	N/A	N/A	0.75 inches	0	0	$4,000 in property damages	-
April 10, 2004	Hail	N/A	N/A	1 inch	0	0	$20,000 in property damages	-
February 24, 2005	Hail	N/A	N/A	0.88 inches	0	0	$4,000 in property damages	-
May 8, 2005	Hail	N/A	N/A	0.75 inches	0	0	$7,000 in property damages	-
June 17, 2008	Hail	N/A	N/A	0.75 inches	0	0	$9,000 in property damages	-
March 26, 2009	Hail	N/A	N/A	0.88 inches	0	0	-	-
March 31, 2013	Hail	N/A	N/A	0.88 inches	0	0	$0	Thunderstorms produced large hail and strong winds with nickel size hail reported in the City of Sugar Land.
April 28, 2013	Hail	N/A	N/A	-	-	-	-	The weight of hail and a heavy rainstorm caused a local gas station convenience store roof to collapse. Fortunately, no one was injured. The hailstorm also caused minor damage to many cars, roofs, and other property within the Sugar Land area.
August 11, 2015	Hail	N/A	N/A	1 inch	0	0	$0	Severe thunderstorms produced quarter size hail in the City of Sugar Land.
April 13, 2016	Hail	N/A	N/A	1 inch	0	0	$0	Early morning pre-dawn thunderstorms strengthened to severe as they moved eastward across southeastern Texas. These storms produced wind damage and hail along with damaging lightning strikes. Quarter size hail was reported in the City of Sugar Land.

Source(s): FEMA 2020; NOAA-NCEI 2020; SPC 2020; City of Sugar Land 2015
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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). While predicting the trends of hail as a result of climate change is difficult, it is anticipated that more frequent and intense will occur. Some of these storms can bring hail.

Probability of Future Occurrences

Table 4-36 summarizes data regarding the probability of occurrences of hail events in the City of Sugar Land based on the historic record. The information used to calculate the probability of occurrences is based on the NOAA-NCEI Storm Events Database, including only those events that identified hail occurring in the City of Sugar Land.

Table 4-36. Probability of Future Occurrence of Hail Events

Hazard Type	Number of Occurrences Between 1996 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Hail	15	0.65	1.60	0.63	62.5%

Source: NOAA-NCEI 2020; SPC 2020

The City of Sugar Land is expected to continue experiencing the direct and indirect impacts of hail events each year. The City experienced 15 hail incidents in 23 years, giving the City a 62.5% chance of being impacted by a hail incident in any given year. Based on historical records and input from the Steering Committee, the probability of occurrence for hail events in the City is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed and vulnerable to the hail hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a hail event. The following text evaluates and estimates the potential impact of the hail hazard in the City.

Impact on Life, Health and Safety

The impact of hail events on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of the City of Sugar Land (86,886) is assumed to be exposed to this hazard (U.S. Census 2017 ACS 5-Year Population Estimate).

People are vulnerable to the effects of hail events, including injuries, power outages, impacts on transportation routes, damage to homes, and damage to vehicles. First responders are also at risk of being injured during a significant hail event if they are responding to an incident. People located outdoors (e.g. recreational activities, farming, emergency responders) are considered most vulnerable to hailstorms because there is little to no warning time, and shelter might not be available. Moving to a lower risk location can decrease a person's vulnerability.

Impact on General Building Stock

Depending on the size of the hail and severity of the storm, the City could see damage from hail impacting structures. While damage to the building stock is possible as a result of hail, it is difficult to estimate and would not have as wide of an impact as a high wind or tornado event.

Impact on Critical Facilities

All critical facilities in the City of Sugar Land are vulnerable to being affected by hail events.

Impact on Economy

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

Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City 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 could be potentially impacted by the hail hazard because the entire City is exposed and vulnerable.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the hail hazard.

Climate Change

The entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). Section 4.3.7 (Flood) provides a discussion related to the impact of climate change due to increases in rainfall. An increase in storms will produce more wind events and can increase tornado activity (refer to Section 4.3.3 [Tornadoes]). With an increased likelihood of strong storms, all of the City's assets will experience additional risk for losses as a result of hail-producing storm events.

Changes in Vulnerability Since the 2015 HMP

The City of Sugar Land's population increased since the last plan; increasing the number of people impacted during a hail event. Therefore, the entire City remains vulnerable to hail events.

Issues Identified

Important issues associated with hail events in the City of Sugar Land include the following:

- Older building stock in the City could be more vulnerable to hail events.

- Many critical facilities do not have a source of backup power; during power outages, these facilities might not function properly or provide the necessary needs to the City.
- Climate change might cause more severe weather patterns that could impact vulnerable populations within the City.

4.3.7 Flood

The following section provides the hazard profile and vulnerability assessment for the flood hazard in the City of Sugar Land

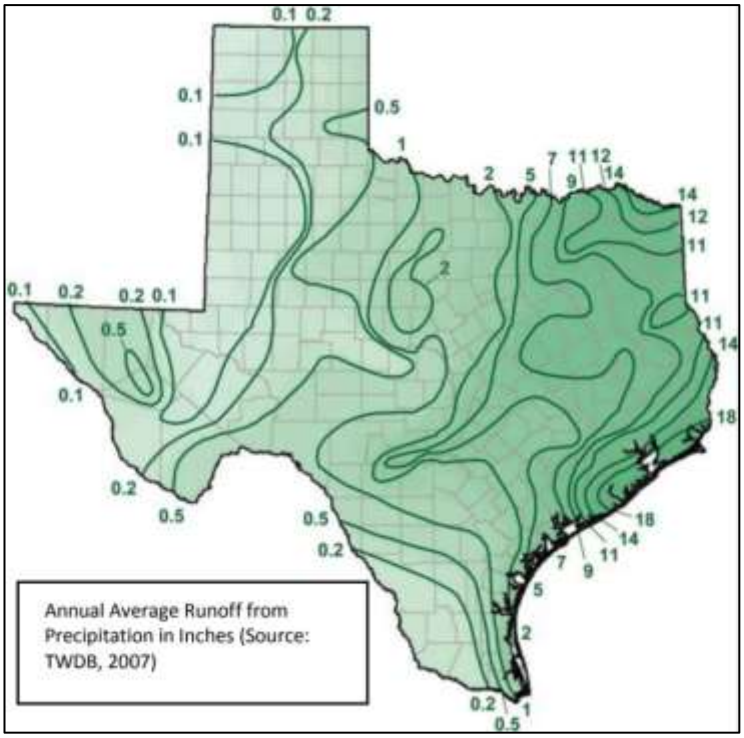
Profile

Hazard Description

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA 2007). As defined in the State of Texas HMP, floods are the accumulation of water within a water body and the overflow of excess water into adjacent floodplain lands (State of Texas HMP 2014).

In hydrologic analysis, runoff is that portion of rainfall which, in combination with other factors, contributes to the stream flow of any surface drainage way. When runoff exceeds the carrying capacity of the stream or drainage, flooding occurs. Runoff is a product of two major groups of factors, climate and physiographic. Climatic factors may include precipitation, evaporation, transpiration and interception. Physiographic factors would include the characteristics of the watershed such as size, shape and slope of the basin's drainage area, the general land use within the basin. Average annual runoff decreases unevenly moving east to west across Texas, the localized variations based on these factors listed above (State of Texas HMP 2014). Figure 4-18 illustrates the annual average runoff from precipitation across the State. In Fort Bend County, the average runoff is between one and five inches.

Figure 4-18. Annual Average Runoff from Precipitation, in Inches



Source: State of Texas HMP 2014

When surface water runoff enters into streams, rivers, or dry creek beds, riverine flooding conditions occurs whenever the water carrying capacity of the water channel is compromised by excess runoff (State of Texas HMP 2014).

If the local basin drainage area is relatively flat, shallow, slow-moving floodwater can last for days. In drainage areas with substantial slope, or the channel is narrow and confined, rapidly moving and extreme high water conditions, called a flash flood, can occur (State of Texas HMP 2014).

Types of Flooding

Flooding generally takes one of the following forms:

- **Riverine Flooding—**Riverine flooding occurs when rivers overflow their banks in response to excessive precipitation levels and water runoff volumes within the watershed. Riverine floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.
- **Coastal Flooding—**Coastal flooding is primarily caused by storm surge, a cascading effect of hurricanes and coastal storms that pushes water toward the shore. The result can be waves that extend further inland, causing damage to development that would not normally be subject to wave action. Storm surge heights, and associated waves, are dependent upon the local width of the continental shelf and the depth of the ocean bottom. A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. Due to the high risk and vulnerability to this flood specific hazard, it was analyzed independently in this chapter rather than as a cascading effect of hurricanes.
- **Flash Flooding—**Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. However, flash flooding events can also

occur from accelerated snow melt due to heavy rains, a dam or levee failure within minutes or hours of heavy amounts of rainfall, or from a sudden release of water held by an ice jam. Although flash flooding occurs often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces. Flash flood waters move at very high speeds, uprooting trees, destroying buildings, and obliterating bridges and roads.

- **Urban Flooding—**Urban flooding occurs when development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

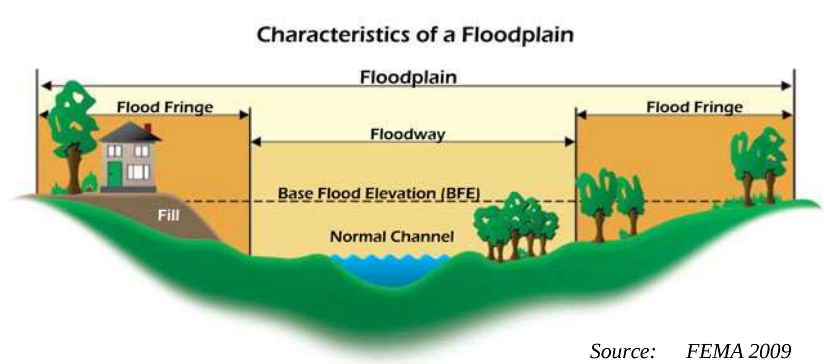
For the purpose of this HMP and as deemed appropriate by Steering Committee, riverine, flash, and urban flooding are the main flood types of concern for the City.

Location

Flooding potential is influenced by climatology, meteorology, and topography (elevations, latitude, and water bodies and waterways). Flooding potential for each type of flooding that affects the City is described in the subsections below.

Floodplains

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 the City of Sugar Land, floodplains line the rivers and streams of the City. 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.



Source: FEMA 2009

Flood Map Terms

- Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA).
- SFHA = the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year.
- 1-percent annual chance flood = the base flood or 100-year flood.
- SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30.
- Zone B or Zone X (shaded) = Moderate flood hazard areas and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.
- Zone C or Zone X (unshaded) = Areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled

Source: FEMA, 2018

Flood hazard areas are identified as Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1 percent chance of being equaled to or exceeded in any given year. The 1 percent annual chance flood is also referred to as the base flood or 100-year flood. A 100-year floodplain is not a flood that will occur once every 100 years; the designation indicates a flood that has a 1-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. Similarly, the moderate flood hazard area (500-year floodplain) will not occur every 500 years but is an event with a 0.2-percent chance of being equaled or exceeded each year (FEMA 2018). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements.

Locations of flood zones in the City as depicted on the FEMA preliminary Digital Flood Insurance Rate Map (DFIRM) are illustrated in Figure 4-19 and the total land area in the floodplain, inclusive of waterbodies, is summarized in Table 4-37. Flood hazard zones occur throughout the City, with the largest areas along the Brazos River and Oyster Creek. The areas in the City that experience the most flooding are the areas near the Brazos River. The Digital Flood Insurance Rate Map (DFIRM) data provided by FEMA for the City show the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent-annual-chance flood event. This includes Zone A, Zone AE, and Zone A. Mandatory flood insurance requirements and floodplain management standards apply. Base flood elevations are provided in Zone AE. Zone AO has associated flood depths derived from detailed hydraulic analyses. Zone A has no determined flood depths.
- 0.2-Percent Annual Chance Flood Hazard: Area of minimal flood hazard, usually depicted on FIRMs as the 500-year flood level or Shaded X Zone.

Table 4-37. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area		0.2% Flood Event Hazard Area	
		Area (acres)	Percent (%) of Total	Area (acres)	Percent of Total
City of Sugar Land	29,588	6,318	21.4$	7,729	26.1%

Source: FEMA 2014
Note: The area presented includes the area of waterways.

Flood Insurance in the City of Sugar Land

National Flood Insurance Program

The City of Sugar Land participates in the NFIP and has been in the program since 1974, with 3,969 insurance policies in force providing over $1.3 billion in insurance coverage. According to FEMA statistics, 306 flood insurance claims were paid between January 1, 1978 and July 31, 2019, for a total of $3.1 million, an average of $10,102 per claim.

Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRMs in the City of Sugar Land were available in 1981.

Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

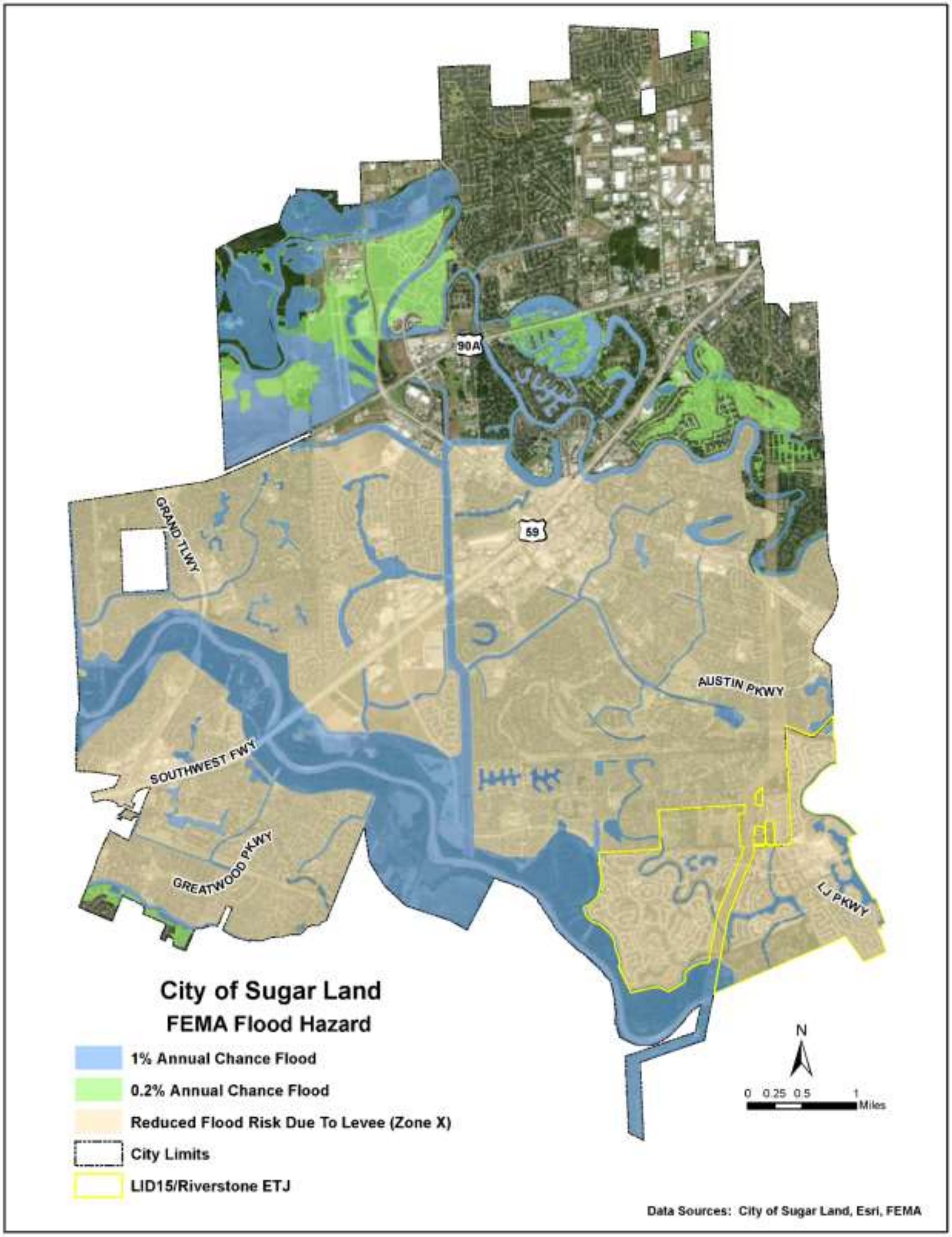
For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The discount partially depends on location of the property. Properties outside the SFHA receive smaller discounts: a 10-percent discount if the community is at Class 1 to 6 and a 5-percent discount if the community is at Class 7 to 9. The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation’s flood risk; over 66 percent of the NFIP’s policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

The City of Sugar Land participates in the CRS program. The City entered the program on May 1, 2010 and is currently ranked as a Class 7 community. This provides residents who have NFIP-backed flood insurance a 15% discount.

Figure 4-19. FEMA DFIRM Flood Hazard Areas in the City of Sugar Land



Extent

The severity of a flood event is typically determined by a combination of several factors including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and degree of vegetative clearing and impervious surface. Generally, floods are long-term events that may last for several days. Regarding the riverine flood hazard, once a river reaches flood stage, flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category is defined as follows, based on property damage and level of 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 (NWS 2011).

USGS uses stream gages to determine the severity of flood at different points along a body of water. There are two gages in the vicinity of the City of Sugar Land found along the Brazos River. The flood stage is identified for one gage; however, flood stages were not identified for the gage located in the City. The City relies on the gages to determine the height of the river during heavy rain events and to determine whether or not residents need to evacuate. Table 4-38 shows the two gages in the area of the City with their determined flood stage and their record flood event. The USGS website provides details about each of the gages (https://waterwatch.usgs.gov/index.php) and the gage heights of flooding events. The NWS provides the different flood stages for the gages (https://water.weather.gov/ahps/).

Table 4-38. Stream Gage Statistics for the Vicinity of the City of Sugar Land

Gage Site Number	Site Name	Action Stage (feet)	Minor Flood Stage (feet)	Moderate Flood Stage (feet)	Major Flood Stage (feet)	Record Flood
08114100	Brazos Rv nr Sugar Land, TX	-	-	-	-	34.05 ft on August 1, 2019
08114000	Brazos River at Richmond	20	45	48	50	55.19 ft on September 1, 2017

Source: USGS 2020
- Not Available

Figure 4-20. Flood Hydrographs for the Gages in the Vicinity of the City of Sugar Land

Source: NWS 2020

Worst-Case Scenario

The City of Sugar Land experienced its worst-case flood scenario in 2017 during Hurricane Harvey. Hurricane Harvey was identified as a 500-year and even a 1,000-year event. Meaning, a storm of this magnitude has a 0.2-annual chance to 0.1-percent annal chance of occurring in any given year. The storm brought over 30 inches of rain to the City and produced modern flooding along the Brazos River. Approximately 230 homes flooded during Hurricane Harvey, with up to 6 inches of water entering homes in the areas of Settlers Park and Chimney Stone. Stormwater systems were inundated and pump stations were not able to function properly because their limits were exceeded. This led to closed roadways, damaged infrastructure, ingress and egress issues, etc. The damages from Hurricane Harvey and the lessons learned from the response and recovery will play a significant role in the City's preparedness for future events.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with flooding in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by 56 flood events between 1996 and 2019 that caused $8 billion in property damage and five fatalities. Of those events, six events had damages specific to the City of Sugar Land (refer to Table 4-39).

Table 4-39. Flood Events in the City of Sugar Land, 1996-2019

Hazard Type	Number of Occurrences Between 1996 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Flash Flood	6	0	0	$993 million	$0

Source: NOAA-NCEI 2020

Between 1953 and 2018, FEMA included the State of Texas in 40 flood-related major disaster (DR) or emergency (EM) declarations. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Fort Bend County was included in seven of these flood-related declarations; refer to Table 4-10.

Table 4-40. Flood-Related FEMA Declarations for Fort Bend County, 1953 to 2019

FEMA Declaration Number	Date(s) of Event	Incident Type	Incident Title
DR-930	December 20, 1991-January 14, 1992	Flood	Severe Thunderstorms
DR-1041	October 14-November 8, 1994	Flood	Severe Thunderstorms and Flooding
DR-1257	October 17-November 15, 1998	Flood	TX-Flooding
DR-1439	October 24-November 15, 2002	Severe Storms	Severe Storms, Tornadoes, and Flooding
DR-4223	May 4-June 22, 2015	Severe Storms	Severe Storms, Tornadoes, Straight-Line Winds and Flooding
DR-4269	April 17-30, 2016	Flood	Severe Storms and Flooding
DR-4272	May 22-June 24, 2016	Flood	Severe Storms and Flooding

Source: FEMA 2020

This HMP update includes known flood events that have impacted the City of Sugar Land between 1996 and 2019. These events are shown in Table 4-41. The events listed in Table 4-41 represent only those that were reported to the NOAA-NCEI Storm Events Database, FEMA, and the 2015 City of Sugar Land HMP, and may not represent all flood events that have occurred since 1991.

Table 4-41. Flood Events in the City of Sugar Land, 1991 to 2019

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
December 20, 1991-January 14, 1992	Severe Thunderstorms	DR-930	Yes	-	-	-	-
October 14-November 8, 1994	Severe Thunderstorms and Flooding	DR-1041	Yes	-	-	-	-
October 17-28, 1998	TX-Flooding	DR-1257	Yes	-	-	-	Heavy rainfall led to widespread riverine flooding in Fort Bend County. On the Brazos River minor flooding occurred above Richmond to above Rosharon and moderate flooding from above Rosharon to below West Columbia.
January 9, 2001	Flash Flood	N/A	N/A	-	5	-	-
June 7-9, 2001	Flash Flooding	N/A	N/A	-	-	-	A flooding incident occurred as the remnants of Tropical Storm Allison passed through the area, leading to street flooding as well as water accumulation in some homes in the Sugar Creek subdivision. Prior to Tropical Storm Allison making landfall, the City experienced 12 inches of rain. The additional water caused many residents to be trapped in their homes, needing rescue from the fire department. The storms also produced three tornadoes, causing minor damage and no injuries. In terms of extent, the City of Sugar Land may anticipate the potential for flood depths in the range of one inch to five feet.
August 30, 2001	Flash Flooding	N/A	N/A	-	-	$50,000 property damage	Heavy rainfall in Galveston, Brazoria, Fort Bend, and southeastern Harris counties also led to street flooding, as well as water in some homes. The storms also produced three tornadoes causing minor damage and no injuries.
October 24-November 15, 2002	Severe Storms, Tornadoes, and Flooding	DR-1439	Yes	-	-	-	-
February 24, 2005	Flash Flood	N/A	N/A	-	-	-	Flash flood in the Pecan Grove area
2012	Flooding	N/A	N/A	-	-	-	A flooding incident affected multiple points in the City of Sugar Land. A severe thunderstorm poured over 6 inches of rain on the City of Sugar Land, overwhelming water pumps at key intersections and underpasses throughout the City. The underpass at Grand Parkway was flooded due to these issues, and five people were injured in the storm.
September 19, 2014	Flash Flood	N/A	N/A	-	-	-	High rainfall rates falling upon precedent saturated grounds exacerbated regional flash flooding in the Fort Bend County

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
							area. In the City of Sugar Land, flooding was reported on Corporate and Executive and Fountain Lake and Exchange Drives.
May 4-June 22, 2015	Severe Storms, Tornadoes, Straight-Line Winds and Flooding	DR-4223	Yes	-	-	-	A storm system brought 11 inches of rain in the area within eight hours
April 17-30, 2016	Severe Storms and Flooding	DR-4269	Yes	-	-	$992,000	A slow moving upper low over the Southwestern U.S. combined with near record level moisture aided in producing extremely heavy rainfall and devastating flooding over portions of Harris, Waller and Fort Bend Counties. Northwest to southeast orientated bands of precipitation commenced during the early evening hours of April 17th across extreme southwestern and western Harris County as well as north and west into Grimes, Waller, Fort Bend, Austin and Colorado Counties. Between 8:00 p.m. and 9:00 p.m. thunderstorms began to greatly intensify and slow their northward movement over Waller County and, by late evening, had stalled and began shifting eastward into western Harris County. Excessive rainfall spread across northwestern Harris County during the late evening hours of April 17th and into the early morning hours of April 18th. Slow thunderstorm movement and rain rates over 4 inches per hour resulted in a large portion of northwest Harris and Waller Counties receiving between 10 and 20 inches of rainfall over mainly a 12 hour period. A few CoCoRaHS gauges in Waller County measured over 20 inches.||The flooding resulted in 8 direct fatalities over the region, all drownings in vehicles. Six of these were in Harris County with 1 in Waller County and another in Austin County. An estimated 40000 cars and trucks were flooded. Several bayous and creeks were flooded. The Addicks Barker Reservoir was severely impacted. At least 10,000 homes were flooded. Damage was estimated from Damage Survey Reports to be near $60 million. The Brazos River turnaround at Highway 59, along with the Highway 90 underpass between Richmond and Rosenberg and Highway 90A at Highway 99, were all impassable due to flooding.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
May 22-June 24, 2016	Severe Storms and Flooding	DR-4272	Yes				
June 4, 2017	Flash Flood	N/A	N/A	-	-	$1,000	Slow moving storms led to flooding and some water rescues. Flooding caused some roads to become impassable between Mission Bend and Sugar Land.
August/September 2017	Hurricane Harvey	DR-4332	Yes	-	-	-	Following Hurricane Harvey, the Brazos River at the USGS gauge in Richmond, Texas experienced its highest ever recorded flow (122,000 cfs) and water surface elevation (83.13 feet above mean sea level). This resulted in significant accelerated erosion of the river's banks, up to 30-40 feet of bank loss in some locations. Within Memorial Park in Sugar Land, the erosion reached over 300 feet removing a significant portion of the Justin P. Brindley Mountain Bike Trail just upstream of the Ditch H outfall to the river.
May 7, 2019	Flash Flooding	N/A	N/A	-	-	-	In Sugar Land, several streets in the First Colony, Sweetwater Estates and Settlers Park area are closed due to high water. The amount of rain that fell in the City surpassed the storm drains capacity and major roadways were impassable. Fort Bend County issues a disaster declaration for flash flooding and potential Brazos River flooding during the evening of May 7th.
September 18-19, 2019	Flash Flood (Tropical Depression Imelda)	DR-4466	No	-	-	-	A weak surface low pressure system strengthened into Tropical Storm Imelda just after noon on September 17th around 15 miles south southwest of Freeport. Imelda moved onshore near Freeport and quickly weakened to a tropical depression. Imelda moved very slowly to the north-northwest then north-northeast over the next few days and produced a few heavy rain bands that caused devastating flooding across portions of Southeast Texas...with maximum amounts over 40 inches falling mainly over a 24 hour period. Imelda is the 7th wettest tropical cyclone to impact the United States, the 5th wettest in the contiguous United States, and the 4th wettest in the state of Texas. Although freshwater flooding was the main impact, an EF-1 tornado also occurred in a cell within one of the leading bands from the storm. This damaged an area on the north side of Baytown near the Highlands. In the City of Sugar Land, approximately 4.5 inches of rain fell. The Brazos River experienced a four foot rise.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
							Street flooding, vehicles stranded near Stafford and Sugar Land. Flood waters entering apartment buildings near the intersection of Dulles Avenue and Avenue E in Sugar Land. Reports included stranded vehicles in floodwaters with street flooding around Sugar Creek Boulevard.

Sources: NOAA-NCEI 2020; FEMA 2020; State of Texas HMP 2014; City of Sugar Land HMP 2015
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
- Not available/not recorded
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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). Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (University Corporation for Atmospheric Research [UCAR] 2017).

Probability of Future Occurrences

Table 4-42 summarizes data regarding the probability of occurrences of flood events in the City of Sugar Land based on the historic record. The information used to calculate the probability of occurrences is based on the 2015 Sugar Land HMP, the NOAA-NCEI Storm Events Database, and FEMA.

Table 4-42. Probability of Future Occurrence of Flood Events

Hazard Type	Number of Occurrences Between 1991 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Flood	17	0.61	1.71	0.59	58.62%

Source: NOAA-NCEI 2020; FEMA 2020; City of Sugar Land HMP 2015
Note: The total number of events used to calculate the probability of occurrence for flooding in Sugar Land includes those listed in the NOAA-NCEI database and FEMA disaster declarations. Any event type that resulted in flooding was including in the number of occurrences.

The City of Sugar Land is expected to continue experiencing the direct and indirect impacts of flood each year. Sixteen flood events in 28 years was recorded in the City of Sugar Land, giving the City a 58.62% chance of being impacted by a flood in any given year, with at least one event occurring each year. Based on historical records and input from the Steering Committee, the probability of occurrence for flood events in the City is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To assess the City of Sugar Land's risk to the flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. A quantitative assessment of exposure to the flood hazard was conducted using the asset inventory developed for this plan and three mapped flood areas:

- The area that was flooded during Hurricane Harvey
- The 1% annual chance flood hazard area; and
- The 0.2% annual chance flood hazard area

Impact on Life, Health and Safety

Impacts of flooding on life, health, and safety depend on several factors including severity of the event and whether adequate warning time is provided to residents. Vulnerable populations are all populations residing or located in the floodplain or downstream of dam failures 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.

An estimated 313 people reside in the 1-percent annual chance event boundary, 3,617 people within the 0.2-percent annual chance flood boundary, and 32,044 people within the area flooded by Hurricane Harvey. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. Table 4-43 lists population estimates within flood hazard zones in the City.

Table 4-43. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population*	1-Percent Chance Event		0.2-Percent Chance Event		Hurricane Harvey	
		Total Number**	Percent (%) of Total	Total Number	Percent of Total	Total Number	Percent of Total
City of Sugar Land	119,766	313	0.3%	3,617	3%	32,044	26.8%

Sources: FEMA 2014
Note:
**Estimated 2018 population calculated by multiplying 2010 Census block-level population (Hazus v4.2 SP03) by 10% population change from 2010 to 2018 (U.S. Census Bureau Quick Facts website).*
***Percent of residential buildings exposed multiplied by the Estimated Population.*

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because available medical services may be disrupted and as they are more likely to seek or need medical attention that may not be available due to isolation during a flood event, and they may have more difficulty evacuating.

Table 4-44 presents the estimated potential sheltering needs as a result of the 1-percent, 0.2-percent, and Hurricane Harvey flood events.

Table 4-44. Estimated Population Displaced or Seeking Short-Term Shelter from Flood Events

Flood Scenario	Total Population*	Displaced Population**	% Displaced Population	Persons Seeking Short-Term Sheltering**	% Persons Seeking Short - Term Sheltering
1-Percent Annual Chance Event	119,766	48	0.04%	2	<0.01%
0.2-Percent Annual Chance Event	119,766	749	0.63%	39	0.02%
Hurricane Harvey	119,766	16,067	13.4%	903	0.75%

Source: Hazus v4.2
**Estimated 2018 population calculated by multiplying 2010 Census block-level population (Hazus v4.2 SP03) by 10% population change from 2010 to 2018 (U.S. Census Bureau Quick Facts website).*
***Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.*

Total numbers of injuries and casualties resulting from typical riverine flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for dam failure events or flash flooding is limited. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard; this includes populations downstream of a dam failure event that cannot evacuate within the allowable time frame. The population adversely affected by a dam failure event can also include those beyond the disaster area that rely on the dam for providing potable water Like riverine flooding, economically disadvantaged populations and the elderly are more vulnerable to impacts from a sudden dam failure event or flash flooding.

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. Molds 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, 2017).

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 (CDC 2012)

Current loss estimation models such as Hazus v4.2 cannot measure public health impacts. The best ways to mitigate these impacts are 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.

Impact on General Building Stock

To assess potential impacts on buildings, both exposure (located in the hazard area) and estimated loss to the exposed inventory generated by Hazus v4.2 were examined for the three flood scenarios. Table 4-45 summarizes the results.

Table 4-45. Estimated General Building Stock Exposure to the Flood Scenarios

Flood Scenario	Total # Buildings	Total Building Value (structure and contents)	# Buildings Exposed	% Total	Estimated Losses Associated with Flood	% of Total Value
1-Percent Annual Chance Event	39,824	$49,443,726,904	103	0.26%	$4,664,142	0.01%
0.2-Percent Annual Chance Event	39,824	$49,443,726,904	1,105	2.77%	$49,422,799	0.10%
Hurricane Harvey	39,824	$49,443,726,904	10,741	26.97%	$14,113,228,862	28.54%

NFIP Statistics

A property is considered a repetitive loss property when there are "two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other and be at least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered. An SRL property is defined as a residential property covered under an NFIP flood insurance policy, and satisfying either of conditions 1 and 2, as well as condition 3 (Section 1361A of the National Flood Insurance Act 42 *United States Code* 4102a):

1. "At least four NFIP claim payments for the property (including building and contents) over $5,000 each have occurred, and the cumulative amount of such claims payments exceeded $20,000.
2. At least two separate claims payments for the property (building payments only) have occurred, and the cumulative amount of the building portion of such claims exceeded the market value of the building.
3. For either of the above, at least two of the referenced claims must have occurred within any 10-year period and must have occurred more than 10 days apart".

Table 4-46 summarizes the NFIP policies, claims, and repetitive loss statistics in the City of Sugar Land. In total, 3,975 residents are NFIP policy holders in the City, and there have been 281 claims totaling $1.5 million.

Table 4-46. NFIP Policies, Claims and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)
City of Sugar Land	3,975	281	$2,498,760	20 (19 residential; 1 commercial)	0

Source: FEMA 2020; City of Sugar Land 2021
(1) Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA June 2020.
The total number of repetitive loss properties does not include the severe repetitive loss properties. The number of claims represents claims closed by 05/31/2018.
(2) Total building and content losses from the claims file provided by FEMA.

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure within the City that may be at risk to flooding (riverine, dam failure, flash/stormwater 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 get to vulnerable populations or to make repairs. Utilities such as overhead power, cable, and phone lines could also be vulnerable due to utility poles damaged by standing water or the surge of water from a dam failure event. Loss of these utilities could create additional isolation issues for the inundation zones.

Critical facility exposure to the flood hazard was examined. In addition, Hazus v4.2 was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Table 4-47 summarizes these results.

Table 4-47. Critical Facility Types Located in the Flood Scenario Areas and Damages

Jurisdiction	Total CFs Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Exposed to 1-Percent Annual Chance Flood Event	
		Critical Facilities	% of Total Critical Facilities
City Limits	412	94	22.8%
LID15 Riverstone ETJ	3	0	0%
Total	415	94	22.7%

Impact on the 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, agricultural losses, business interruption, and effects on tourism.

In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the section earlier which discusses direct impacts to buildings in the City.

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.

Debris management may also be a large expense after a flood event. Hazus v4.2 estimates the amount of structural debris generated during a flood event. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.); (2) structural (wood, brick, etc.); and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 4-48 summarizes the Hazus v4.2 citywide debris estimates for the 1-percent annual chance flood event. Please note that this table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Table 4-48. Estimated Debris Generated from the Flood Scenarios

Scenario	Structure Debris (tons)*
1-Percent Annual Chance Event	48,064
0.2-Percent Annual Chance Event	N/A
Hurricane Harvey	209,825

Source: Hazus v4.2
**Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.*

Impact on the Environment

Floodplains serve beneficial and natural functions on ecological, environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. Floods, however, can also lead to negative impacts on the environment. Disruption of natural systems and the benefits they provide can have long-term consequences for entire regions. According to FEMA, well-known, water-related functions of floodplains include the following:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Process organic wastes
- Moderate temperatures of water
- Groundwater recharge
- Filter nutrients and impurities from runoff
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low-surface flows

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 could be impacted by the flood hazard if located in the floodplain. Article III (Provisions for Flood Hazard Reduction of the City of Sugar Land Municipal Code) regulates not only how land in designated floodplain areas may be used or altered, but the location and types of structures that are permitted in those areas as well as the specifications to which they must build. All structures, including residential and commercial properties, manufactured homes, and the developments of subdivisions are regulated.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the flood hazard.

Climate Change

Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Change of Vulnerability Since the 2015 HMP

The City of Sugar Land continues to be vulnerable to flood storms. Flood models were not run for the 2015 HMP; therefore, estimated losses were not populated for the hazard. Overall, the vulnerability assessment presented in this update uses Hazus v4.2 and a more accurate and updated building inventory. This provides more accurate estimated exposure and potential losses for the City of Sugar Land.

Identified Issues

The following flood-related issues were identified for the City:

- How climate change will affect flood conditions in the planning area is uncertain.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- As the area continues to recover from the impacts of Hurricane Harvey, financial resources to mitigate the impacts of flooding will become available to increase the flood resilience of the City.

4.3.8 Drought

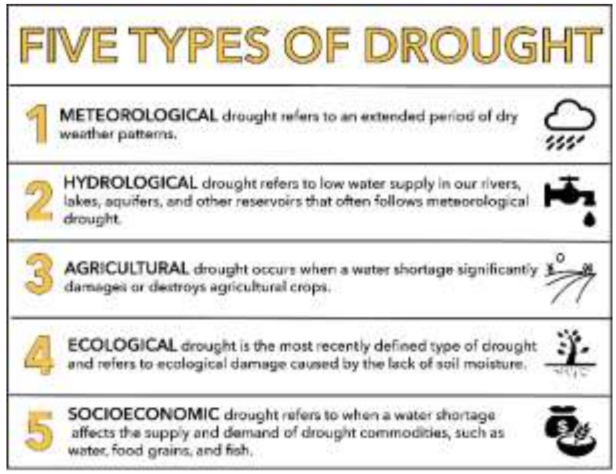
This section provides a hazard profile and vulnerability assessment of the drought hazard for the City of Sugar Land.

Hazard Profile

This section presents information regarding the description, extent, location, previous occurrences and losses, climate change projections and probability of future occurrences for the drought hazard.

Description

Drought is defined as the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length (State of Texas HMP 2018). Drought conditions occur in virtually all climatic zones. Drought characteristics vary significantly from one region to another and are relative to the normal precipitation in that region. Drought can increase wildfire/brush fire risk and can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. There are five classifications of drought, as presented in the figure to the right.



Source: University of Nevada Cooperative Extension 2020

Location

A drought occurs on a regional scale; therefore, all of the City of Sugar Land is vulnerable and at risk. Droughts can occur at any time and have the potential to directly or indirectly impact every person in the City, as well as the local economy.

Extent

The severity of a drought depends on the degree of moisture deficiency, the duration of the event, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts (University of Nevada, Reno Extension College of Agriculture, Biotechnology, and Natural Resources 2020). The City of Sugar Land has the potential to experience the entire range of effects, from extreme drought to extremely moist conditions, as described in the Palmer Drought Severity Index (PDSI).

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a map that shows the location and intensity of drought across the United States. The data is updated every Tuesday and the map is released on Thursdays. The USDM uses a five-category system, labeled Abnormally Dry or D0, (a precursor to drought, not actually drought), and Moderate (D1), Severe (D2), Extreme (D3) and Exceptional (D4) Drought. Drought categories show experts' assessments of conditions related to dryness and drought including observations of how much water is available in streams, lakes, and soils compared to usual for the same time of year. USDM data goes back to 2000 (National Integrated Drought Information System 2020). Figure 4-22 shows the USDM for March 3, 2020. The figure is shows that the City of Sugar Land was in abnormally dry conditions the week of March 3rd.

Figure 4-21. U.S. Drought Monitor for the City of Sugar Land, March 3, 2020

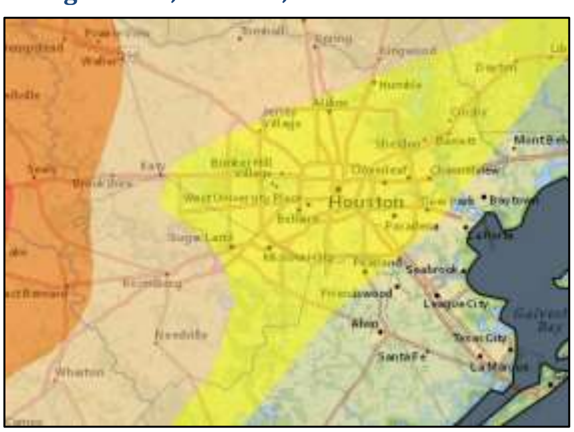
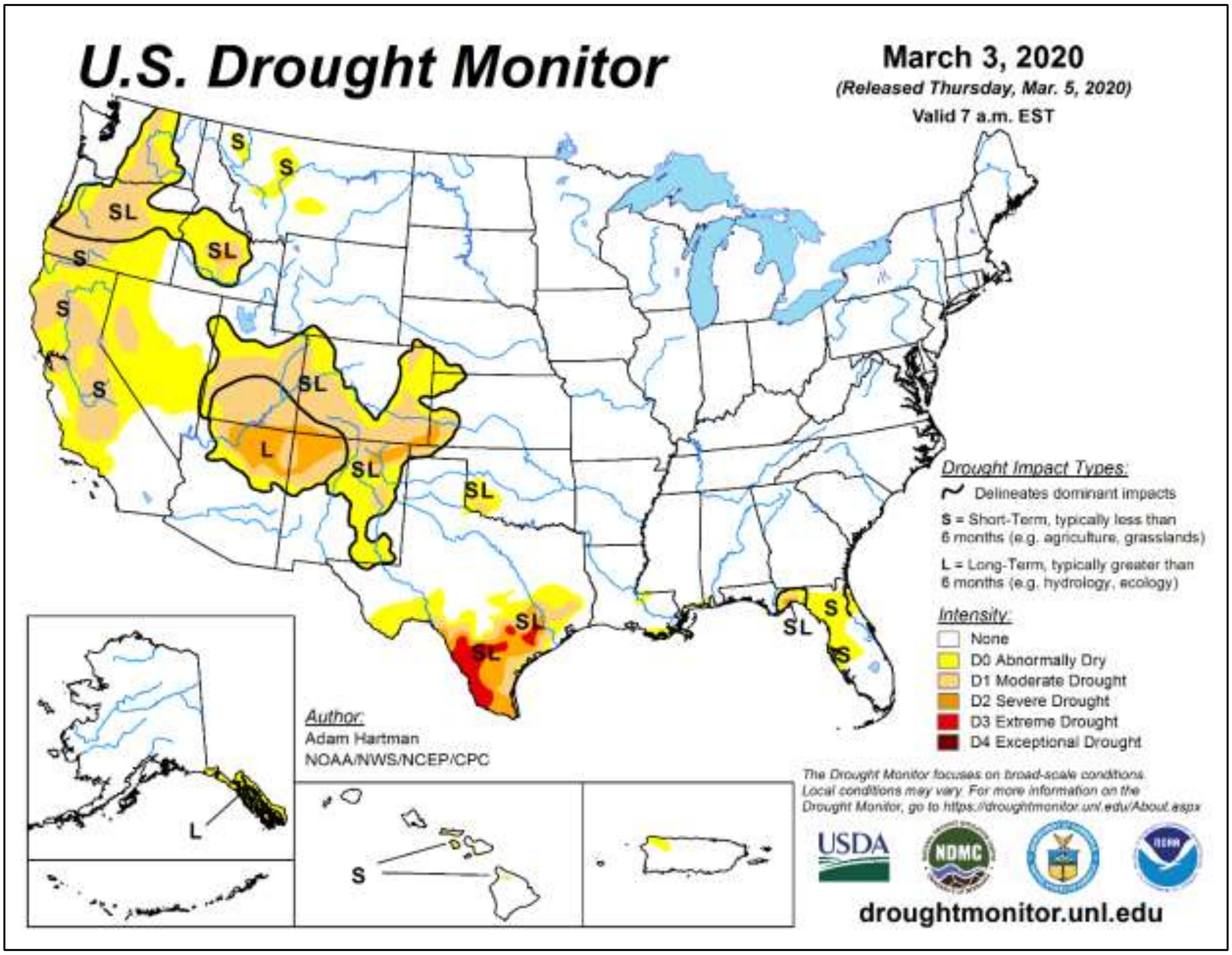


Figure 4-22. U.S. Drought Monitor for March 3, 2020



Palmer Drought Severity Index

The Palmer Drought Severity Index (PDSI) is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 4-49 lists the PDSI classifications. At the one end of the spectrum, 0 is used as normal and drought is indicated by negative numbers. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI can reflect excess precipitation using positive numbers; however, this is not shown in Table 4-49. The PDSI is commonly converted to the Palmer Drought Category (National Drought Mitigation Center [NDMC] 2013).

Table 4-49. Palmer Drought Category and Palmer Drought Index Descriptions

Category	Description	Possible Impacts (for Texas)	Palmer Drought Index
D0	Abnormally Dry	• Producers begin supplemental feeding for livestock • Planting is postponed; forage germination is stunted; hay cutting is reduced • Grass fires increase • Surface water levels decline	-1.0 to -1.99
D1	Moderate drought	• Dryland crops are stunted • Early cattle sales begin • Wildfire frequency increases	-2.0 to -2.99

Category	Description	Possible Impacts (for Texas)	Palmer Drought Index
		• Stock tanks, creeks, streams are low; voluntary water restrictions are requested	
D2	Severe drought	• Pasture conditions are very poor • Soil is hard, hindering planting; crop yields decrease • Wildfire danger is severe; burn bans are implemented • Wildlife moves into populated areas • Hydroelectric power is compromised; well water use increases; mandatory water restrictions are implemented	-3.0 to -3.99
D3	Extreme drought	• Soil has large cracks; soil moisture is very low; dust and sandstorms occur • Row and forage crops fail to germinate; decreased yields for irrigated crops and very large yield reduction for dryland crops are reported • Need for supplemental feed, nutrients, protein, and water for livestock increases; herds are sold • Increased risk of large wildfires is noted • Many sectors experience financial burden • Severe fish, plant, and wildlife loss reported • Water sanitation is a concern; reservoir levels drop significantly; surface water is nearly dry; river flow is very low; salinity increases in bays and estuaries	-4.0 to -4.99
D4	Exceptional drought	• Exceptional and widespread crop loss is reported; rangeland is dead; producers are not planting fields • Culling continues; producers wean calves early and liquidate herds due to importation of hay and water expenses • Seafood, forestry, tourism, and agriculture sectors report significant financial loss • Extreme sensitivity to fire danger; firework restrictions are implemented • Widespread tree mortality is reported; most wildlife species' health and population are suffering • Devastating algae blooms occur; water quality is very poor • Exceptional water shortages are noted across surface water sources; water table is declining • Boat ramps are closed; obstacles are exposed in water bodies; water levels are at or near historic lows	-5.0 or less

Source: NDMC 2013 and 2020

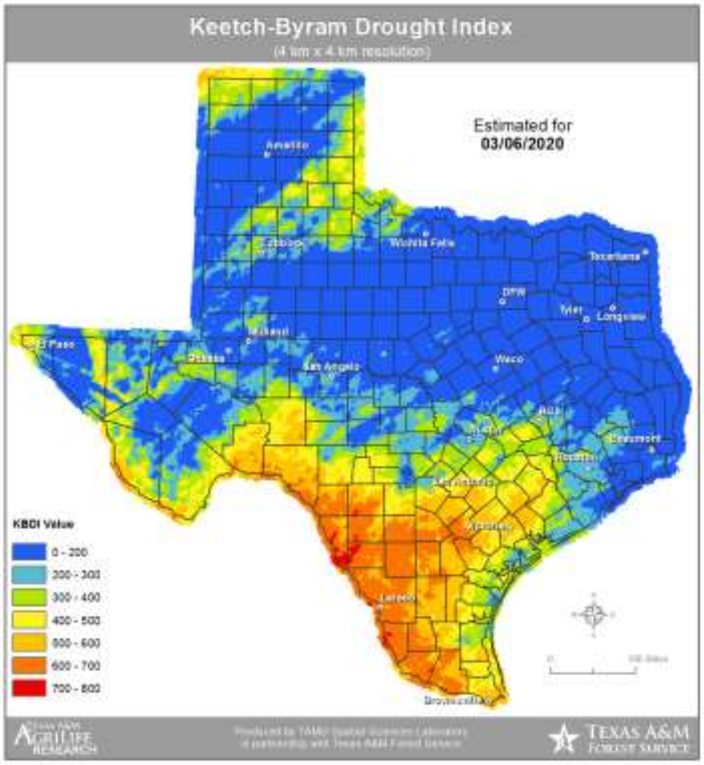
Keetch-Byram Drought Index (KBDI)

The KBDI is an index used to determining forest fire potential. The drought index is based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of eight-inches) and is expressed in hundredths of an inch of soil moisture depletion. The index ranges from 0 to 800, where a drought index of 0 represents no moisture depletion, while an index of 800 represents absolutely dry conditions (Wildland Fire Assessment System 2020).

KBDI Value	Description
0 to 200	Soil moisture and large class fuel moistures are high and do not contribute much to fire intensity. Typical of spring dormant season following winter precipitation
200 to 400	Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity
400 to 600	Typical of late summer, early fall. Lower litter and duff layers actively contribute to fire intensity and will burn actively.
600 to 800	Often associated with more severe drought with increased wildfire occurrence. Intense, deep burning fires with significant downwind spotting can be expected. Live fuels can also be expected to burn actively at these levels.

This index is currently derived from ground based estimates of temperature and precipitation resulting from weather stations and interpolated manually by experts at the Texas Forest Service (TFS) for counties across the State (Texas Weather Connection 2020). Figure 4-23 shows the KBDI for the State of Texas for March 6, 2020. The figure shows KBDI value of 200-300 for the City of Sugar Land.

Figure 4-23. KBDI for the State of Texas, March 6, 2020



Worst-Case Scenario

A multi-year drought that impacts the southeastern portion of Texas, like the 2008 to 2011 drought, is the worst-case scenario for the City. If another severe drought occurs before these systems have a chance to recover, it could exacerbate the stress already placed on existing planning area water resources. Severe droughts can also lead to crop and livestock losses, impacting the food supply and economy.

Previous Occurrences and Losses

Between 1954 and 2020, Federal Emergency Management Agency (FEMA) declared that Texas experienced 46 drought-related major disaster (DR) or emergency (EM). Generally, drought-related disasters affect a wide region of the state and can impact many counties; however, Fort Bend County was not included in the disaster declaration.

The U.S. Department of Agriculture (USDA) keeps records of agricultural disasters. Between 2014 and 2019, Fort Bend County was included two declarations related to drought.

Table 4-50. USDA Disaster Declarations for Fort Bend County, TX between 2014 and 2020

Designation Number	Incident Date(s)	Approval Date	Description of Disaster	Damages
S3693	April-May 2014	May 14, 2014	Drought	44 acres damaged; $3,192 in losses
S4571	Starting in August 2019	January 14, 2020	Drought	Over 6,000 acres damaged; nearly $1 million in losses

Source: USDA Risk Management Agency 2020; USDA Farm Service Agency 2020

According to TDEM, the State of Texas issued and renewed 57 state drought disaster proclamations between 2005 and 2020; however, Fort Bend County was not included in the drought-related proclamations. Based on available historical records, the City of Sugar Land has experienced to drought events, of all magnitudes. Table 4-51 lists known drought events between 2014 and 2020 that have occurred in Fort Bend County, as reported by NCEI, USDA, and U.S. Drought Monitor. Historical drought information shows drought activity across the County; therefore, the drought data for the City of Sugar Land is included as part of Fort Bend County.

Table 4-51. Drought Events in the City of Sugar Land, TX between 2014 and 2020

Dates of Event	Event Details*
January-May 2014	USDA drought declarations; Fort Bend County was under moderate drought conditions for 19 consecutive weeks. In April, the City of Sugar Land implemented Stage 1 voluntary water restrictions to comply with a request from the Texas governor (Chron.com 2014). Moderate drought conditions were experienced in Fort Bend County, including the City of Sugar Land. On May 14th, Fort Bend County was included in a USDA disaster declaration (S3693) due to drought conditions.
July 2015	Many fields in southeast Texas were too dry and hard for fieldwork
August-November 2015	Burn bans were adopted by Fort Bend County for 90-days due to recent and continuing hot, dry weather. Fort Bend County experienced moderate drought conditions for four consecutive weeks, and severe drought conditions for two consecutive weeks.
October-November 2016	Fort Bend County was under moderate drought conditions for six consecutive weeks.
August 2019	More than half of Texas' 254 counties had burn bans as of August 15, 2019. This includes Fort Bend County.
September 3, 2019	The USDA issued a disaster declaration (S4571) for Fort Bend County related to drought conditions.
December 2019 – February 2020	Fort Bend County was under moderate drought conditions for eight consecutive weeks. Between January 21st and February 4th, the County experienced three consecutive weeks of severe drought conditions.
February 2020	Fort Bend County is under moderate drought conditions according to the National drought Mitigation Center.

Sources: USDA 2020; NDMC 2020

* *Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table.*

Climate Change Projections

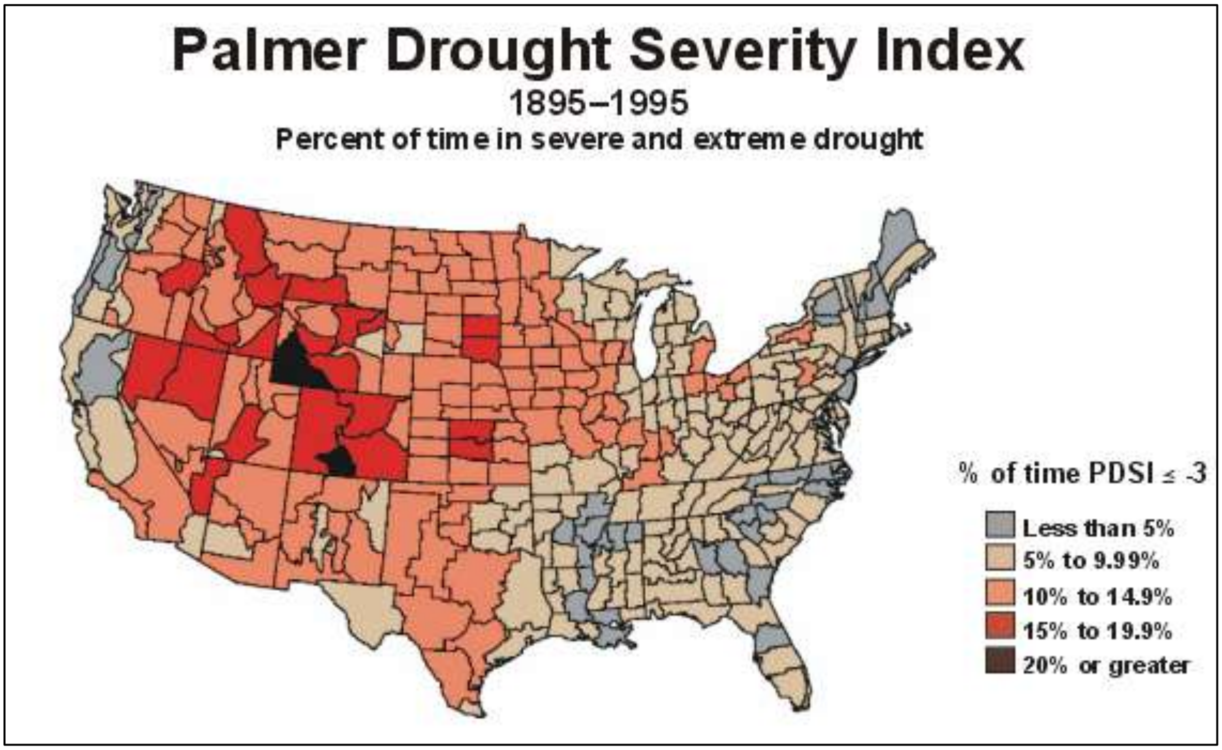
Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as droughts. While predicting changes of drought events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Wither a warmer climate, droughts can become more frequent, more severe, and longer-lasting. According to the National Climate Assessment, variable precipitation and rising temperatures are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in water survey quality. Future warming will add to the stress on water supplies and impact the availability of water supply (U.S. Global Change Research Program 2018).

Probability of Future Occurrences

The frequency of droughts is difficult to forecast as drought occurrences are cyclical in nature and will occur in the future. Based on national annual data from 1895 to 1995, Fort Bend County, including the City of Sugar Land, the City underwent severe or extreme conditions approximately 5 to 9.9% of the time (illustrated in Figure 4-24).

Figure 4-24. Palmer Drought Severity Index (1895 to 1995)



Source: National Drought Mitigation Center 2020

For the 2021 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of drought events, of all magnitudes, for the City of Sugar Land. Information from NOAA-NCEI storm events database, the 2013 State of Texas HMP, the 2018 Fort Bend County HMP, and the Drought Impact Report were used to identify the number of drought events that occurred between 1950 and 2019. Using these sources ensures the most accurate probability estimates possible. Table 4-52 presents the probability of future occurrence of drought events in the City of Sugar Land.

Table 4-52. Probability of Future Drought Events in the City of Sugar Land

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Drought	17	0.25	4.12	0.24	24.3%

Sources: NOAA NCEI 2020, State of Texas 2013, Fort Bend County 2018, Drought Impact Report 2020

Based on the 17 recorded drought events over 69 years, the City of Sugar Land averages less than one drought a year. A drought event has a 24.3% chance of occurring in any given year in the City. Based on the history of events and input from the Steering Committee, the probability for drought occurring in the City is considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed to the drought hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a drought event. The following text evaluates and estimates the potential impact of the drought hazard in the City.

Impact on Life, Health, and Safety

The entire population of the City of Sugar Land is vulnerable to drought events (2017 American Community Survey 5-Year Estimate: 86,886 people). Drought conditions can affect public health and safety, including reduced local firefighting capabilities, health problems related to low water flows and poor water quality, and health problems related to dust. If droughts are severe enough, these health problems can lead to loss of human life.

Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources, the infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions. Some drought-related health effects are short term, while others can be long term (CDC 2012).

Impact on General Building Stock

A drought event is not expected to directly affect any structures; however, a secondary hazard most commonly associated with drought is wildfire. Prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Though some structures can become vulnerable to wildfire that are within or near the wildfire urban interface, this is more likely following long periods of drought. Refer to Section 4.3.15 of the HMP for additional discussion of the wildfire hazard in the City of Sugar Land.

Impact on Critical Facilities

Water supply facilities may be affected by drought events. However, a majority of the critical facilities defined for this plan will continue to be operational during a drought.

Impact on the Economy

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably agriculture and related sectors (forestry, fisheries, and waterborne activities), power plants, and oil refineries. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors are affected—losses that include reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease. According to the 2018 State of Texas HMP, between 1996 and 2016, Fort Bend County experienced drought-related losses (property plus crop losses) ranging between $2.8 million and $12.2 million (State of Texas HMP 2018).

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 could be potentially impacted by the drought hazard because the entire City is exposed and vulnerable to droughts. Future growth and development could impact the amount of potable water available due to a drain on the available water resources. An increased drain on water resources would not only impact the county's population, but it would also exacerbate impacts to other areas of the county as discussed above, including agriculture and recreational facilities.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. With an increase in population, the demand for water supply will increase. During a drought, the amount of water needed might not be available. This might require reallocation of water resources to meet demands during a drought. If needed, the City can pass special ordinances regulating the amount of water consumed and used during periods of drought to conserve water.

Climate Change

As discussed earlier, climate change as the potential to impact the number of and the severity of droughts. An increased incidence of drought might impact availability of water supplies, primarily placing an increased stress on the population. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, could increase and threaten structures. If a wildfire were to occur during a drought, emergency services might face complications from a water shortage depending on their water source, and critical water-related service sectors might need to adjust management practices and actively manage resources. Increased incidence of drought increases the potential for impacts on the local economy, including the production of agricultural products.

Change of Vulnerability since the 2015 HMP

The 2015 HMP provided a summary of historic loss information and qualitative assessment for the drought hazard. For this HMP Update, a qualitative assessment was conducted for population, buildings and critical facilities. According to the U.S. Census Bureau 2017 Population Estimates, the population of the City of Sugar Land has increased slightly since the 2010 Census; therefore, the number of people exposed to the drought hazard has increased. Overall, the City county will continue to be exposed and vulnerable to drought events.

Issues Identified

The following have been identified as drought-related issues:

- The probability of drought frequencies and durations may increase due to climate change.
- The promotion of active water conservation even during non-drought periods should be encouraged.
- With the possibility of climate change, drought may become a larger issue due to warming trends and wider fluctuations in rainfall patterns.

- Alternative water supplies need to be identified and developed.
- Groundwater recharge techniques can be used to stabilize the groundwater supply.

4.3.9 Hurricane and Tropical Storm

The following section provides the hazard profile and vulnerability assessment for the hurricane and tropical storm hazard in the City of Sugar Land.

Profile

Hazard Description

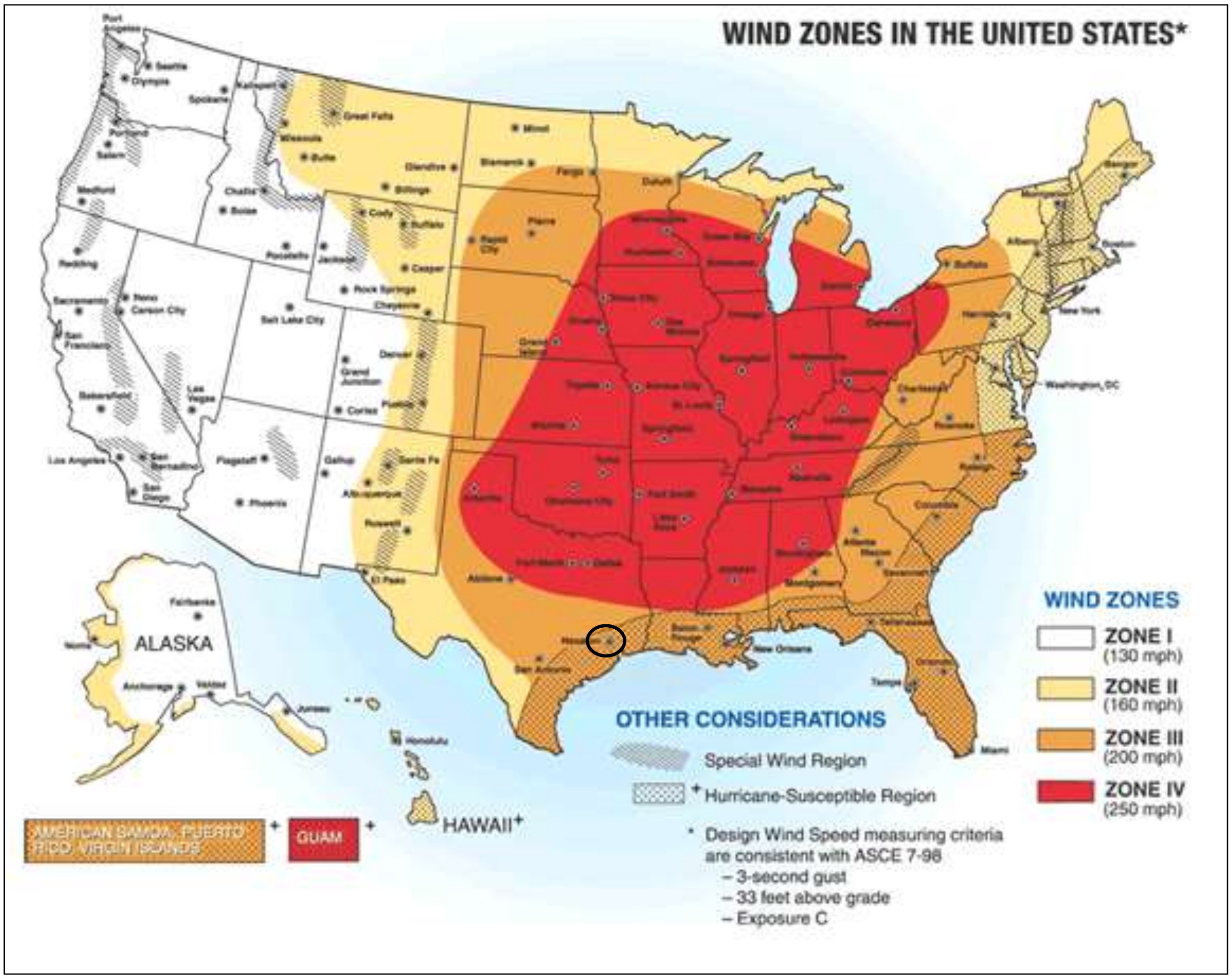
Tropical cyclones are fueled by a different heat mechanism than other cyclonic windstorms, such as Nor'easters and polar lows. The characteristic that separates tropical storms from other cyclonic systems is that at any height in the atmosphere, the center of a tropical storm will be warmer than its surroundings, a phenomenon called *warm core* storm systems (NOAA 2013). Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. Tropical cyclones begin as disturbed areas of weather, often referred to as tropical waves. As the storm organizes, it is designated as a tropical depression.

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds of 39 to 73 mph and heavy rain. A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 mph or higher. Tropical systems can develop in the Atlantic between the Lesser Antilles and the African coast or in the warm tropical waters of the Caribbean Sea and Gulf of Mexico. These storms can move up the Atlantic coast of the United States, impacting the eastern seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving eastward offshore.

Location

Similar to that of severe weather events (e.g. tornadoes, thunderstorms), hurricanes and tropical storms do not have any specific geographic boundary and can occur anywhere in the City of Sugar Land. According to the FEMA Winds Zones of the United States map, the City of Sugar Land is located in Wind Zones III, where wind speeds can reach up to 200 mph. Additionally, the City is located in the hurricane-susceptible region. Figure 4-25 illustrates wind zones across the United States, which indicate the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA (FEMA 2014).

Figure 4-25. Wind Zones in the United States



Source: FEMA 2014
Note: The black oval indicates the approximate location of the City of Sugar Land.

Extent

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1–5 based on a hurricane's increasing sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered *major hurricanes* because of their potential for significant loss of life and damage. Tropical Storms and Category 1 and 2 storms are still dangerous and require preventative measures (NOAA 2019). Figure 4-26 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Figure 4-26. The Saffir-Simpson Scale

Source: Disaster Readiness Portal 2020

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

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013).

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. The MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

Peak wind speed projections were generated using Hazus v4.2. Hazus v4.2 estimated the maximum 3-second gust wind speeds for the City of Sugar Land:

- 20-year MRP - below 79 mph (between a tropical storm and Category 1 Hurricane)
- 100-year MRP – between 108 and 111 mph (between a Category 2 and Category 3 Hurricane)
- 500-year MRP – between 122 and 126 mph (Category 3 Hurricane).

The associated impacts and losses from these 20-, 100-, and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment. Figure 4-27 through Figure 4-29 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 20-, 100-, and 500-year MRP events.

Figure 4-27. Wind Speeds for the 20-Year MRP Event

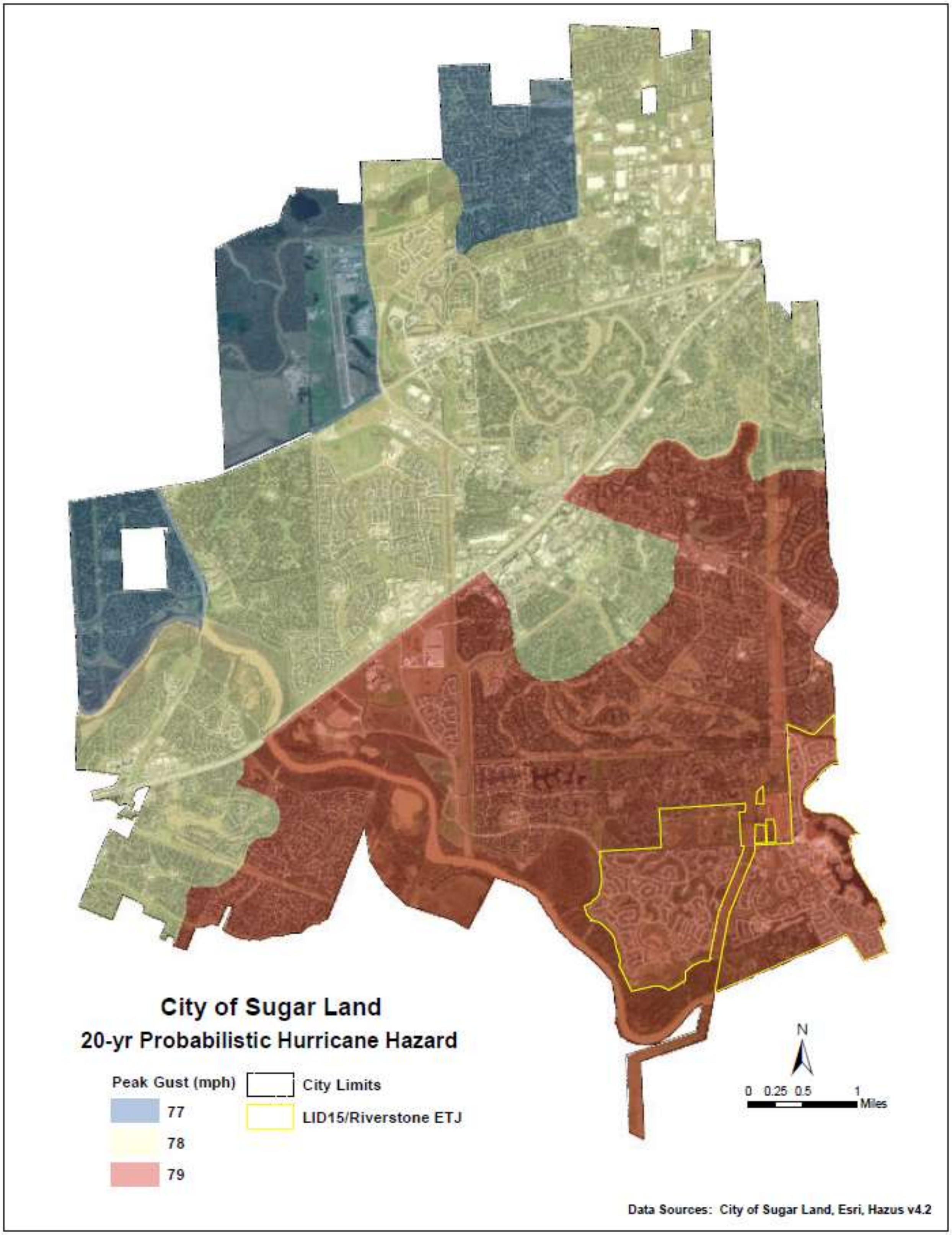


Figure 4-28. Wind Speeds for the 100-Year MRP Event

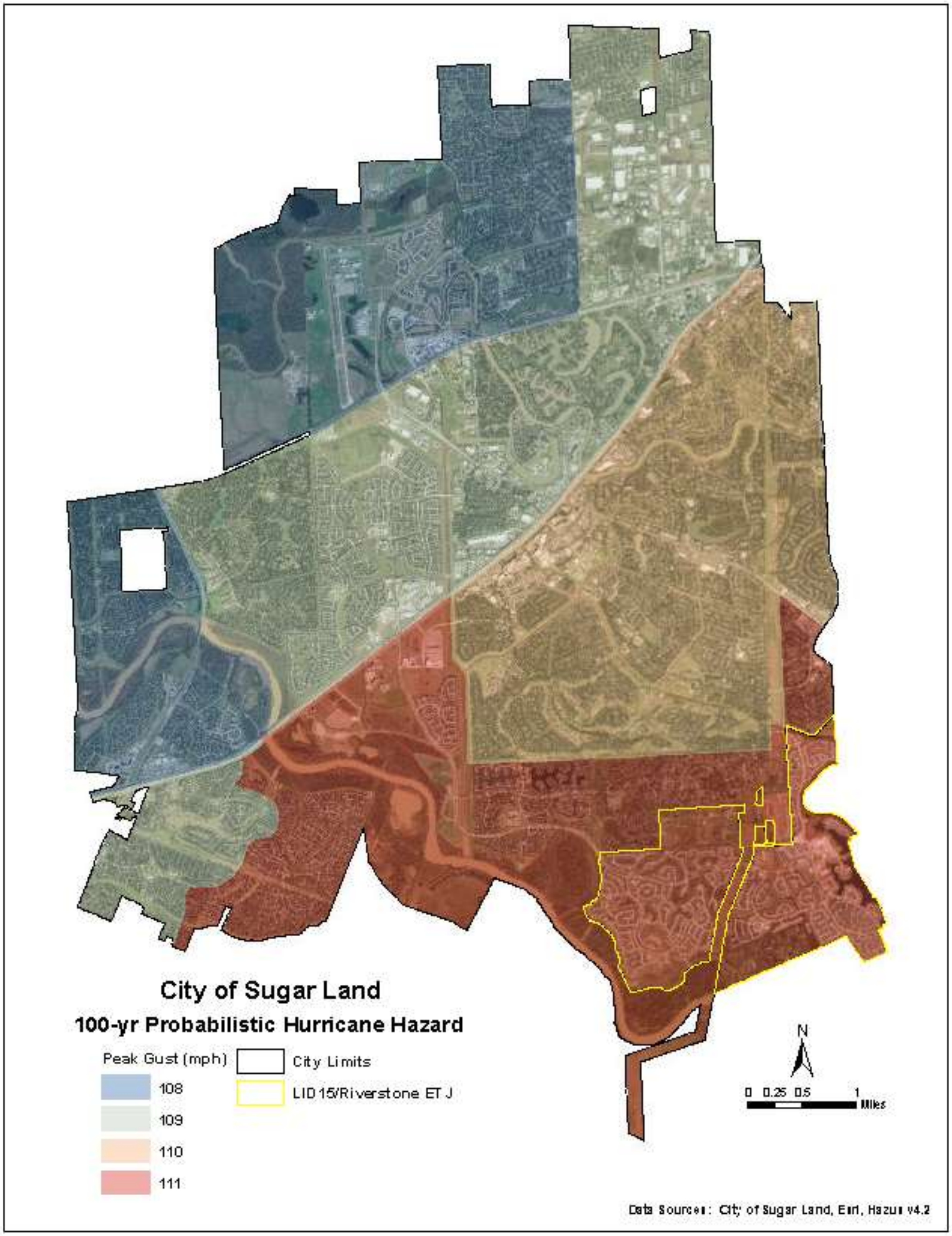
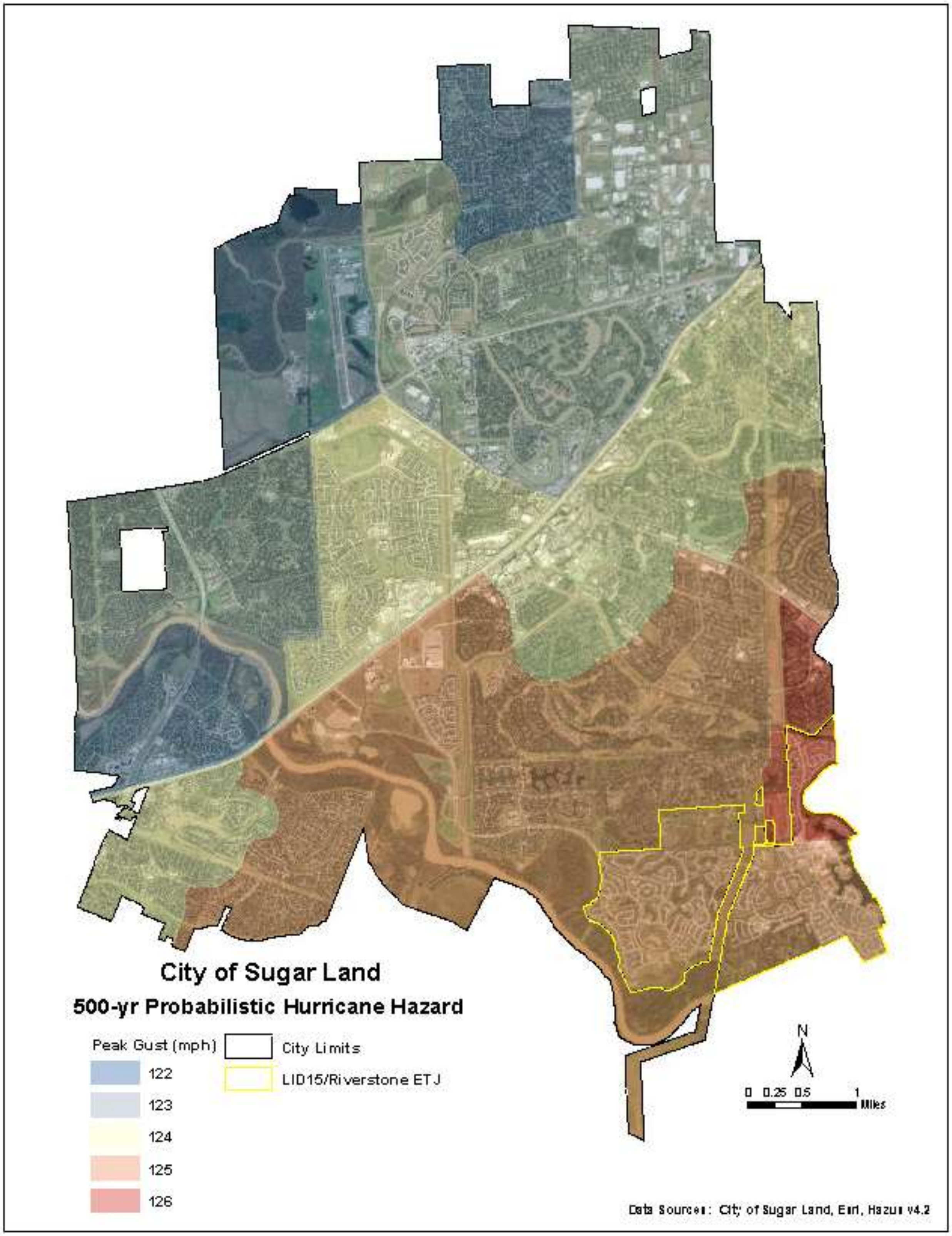


Figure 4-29. Wind Speeds for the 500-Year MRP Event



Worst-Case Scenario

A category 4 hurricane would be the worst-case scenario hurricane for the City of Sugar Land. A storm of this magnitude cause over $3 billion in building damages, displacing 383 households, forcing 236 people to seek short-term housing, and causing over 393,000 tons of debris. The extreme winds associated with a category 4 (speeds between 130 and 156 mph) would cause catastrophic damages, leading to downed trees, downed power lines, widespread power outages, significant damage to buildings and infrastructure, and limited access to areas of the City. Heavy rains from a hurricane could lead to significant flooding and associated damages.

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with hurricanes and tropical storms in Fort Bend County and the City of Sugar Land. According to the NOAA-NCEI Storm Events Database, Fort Bend County has been impacted by four hurricane and tropical storm events between 1996 and 2019 that caused over $412 million in property damage and three injuries (refer to Table 4-53). It should be noted that the NOAA-NCEI database did not list specific events in the City of Sugar Land; therefore, the total number of events represents those that impacted the Fort Bend County area.

Table 4-53. Hurricane/Tropical Storm Events in Fort Bend County, 1996-2019

Hazard Type	Number of Occurrences Between 1996 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Tropical Storm	3	0	3	$12.34 million	-
Hurricane	1	0	0	$400 million	-

Source: NOAA-NCEI 2020

Between 1953 and 2019, FEMA included the State of Texas in 21 hurricane-related major disaster (DR) or emergency (EM) declarations. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Fort Bend County was included in 10 of these hurricane-related declarations; refer to Table 4-54.

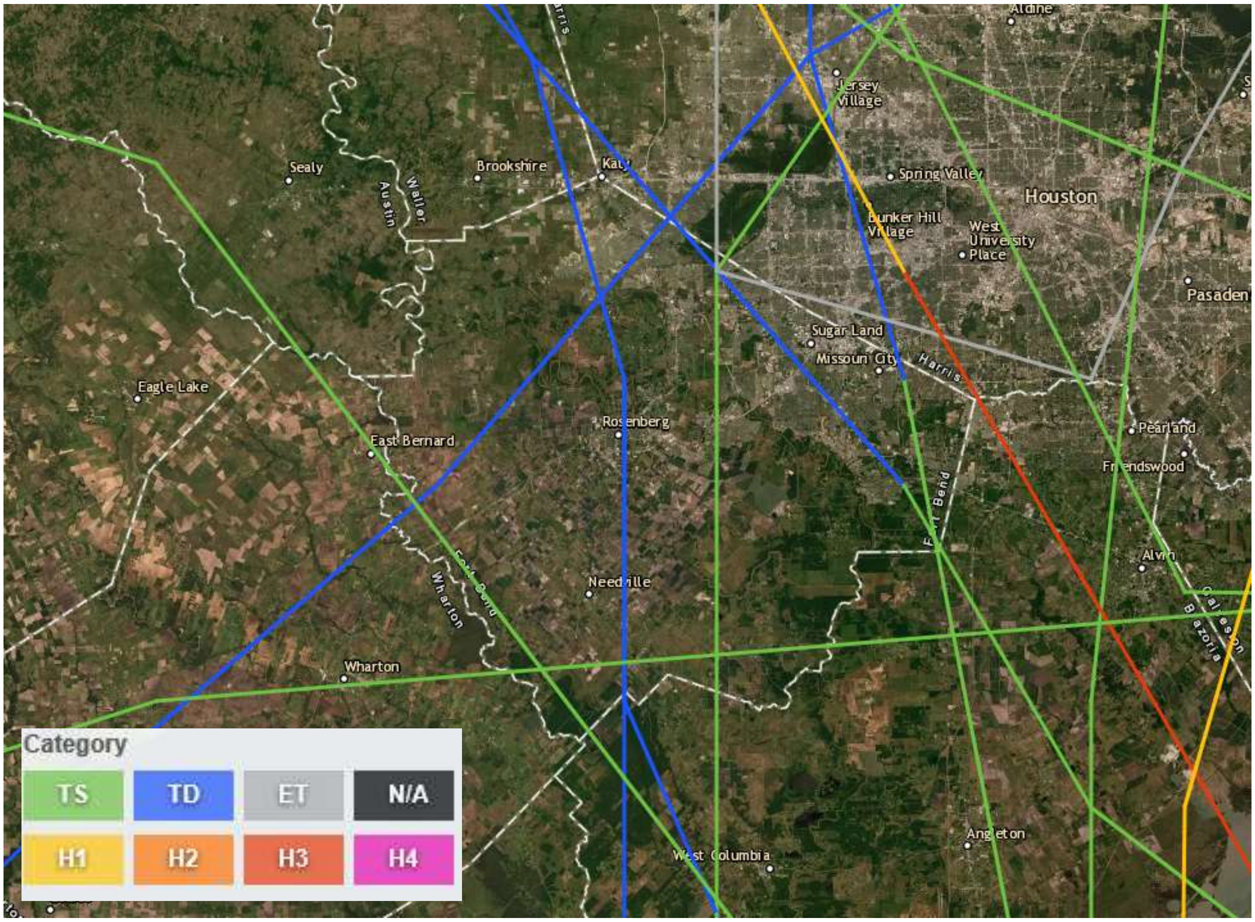
Table 4-54. Flood-Related FEMA Declarations for Fort Bend County, 1953 to 2019

FEMA Declaration Number	Date(s) of Event	Incident Type	Incident Title
DR-689	August 18-20, 1983	Hurricane	Hurricane Alicia
DR-1239	August 22-31, 1998	Severe Storm	Tropical Storm Charley
DR-1379	June 5-20, 2001	Coastal Storm	Tropical Storm Allison
EM-3261 and DR-1606	September 20-October 14, 2005	Hurricane	Hurricane Rita
EM-3277	August 17-September 5, 2007	Hurricane	Hurricane Dean
EM-3290	August 27-September 7, 2008	Hurricane	Hurricane Gustav
EM-3294 and DR-1791	September 7-October 2, 2008	Hurricane	Hurricane Ike
DR-4332	August 23-September 15, 2017	Hurricane	Hurricane Harvey

Source: FEMA 2020

Figure 4-30 from the NOAA Historical Hurricane Tracker illustrates the tracks of storms between 1950 and 2019 within 65 miles of the City of Sugar Land. NOAA showed 23 hurricanes or tropical storms being tracked within 65 miles of the City. As the figure depicts, the City is frequently impacted by hurricanes, tropical storms, and tropical depressions. Please note that the figure does not show Hurricane Harvey passing within 65 miles of the City.

Figure 4-30. Historical Hurricane Tracks within 65 miles of the City of Sugar Land, 1950 to 2019



Source: NOAA 2020
Note: Category refers to tropical cyclone strength. TS: Tropical Storm, TD: Tropical Depression, ET: Extra-tropical Storm, H1: Category 1 Hurricane, H2: Category 2 Hurricane, H3: Category 3 Hurricane, H4: Category 4 Hurricane

This HMP update includes known hurricane and tropical storm events that have impacted the City of Sugar Land between 1996 and 2019. These events are shown in Table 4-55. The events listed in Table 4-55 represent only those that were reported to the NOAA-NCEI Storm Events Database, FEMA, and the 2015 City of Sugar Land HMP, and may not represent all hurricane and tropical storm events that have occurred since 1996.

Table 4-55. Hurricane and Tropical Storm Events in the City of Sugar Land, 1996 to 2019

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
September 7-12, 1998	Tropical Storm Frances	N/A	N/A	-	-	$100,000	-
June 7-9, 2001	Tropical Storm Allison	DR-1379	Yes	-	-	$7.74 million	Tropical Storm Allison hit the Houston area, which dumped large amounts of rain on the city. The storm made landfall on the western end of Galveston Island and over the next five days produced record rainfall. These amazing amounts of precipitation led to devastating flooding across southeastern Texas. Some weather stations in the Houston area reported more than 40 inches of rain total and more than 18 inches in a 24-hour period. Fort Bend County had approximately $7.7 million in damages from this event.
September 5-7, 2002	Tropical Storm Fay	N/A	N/A	-	3	$4.5 million	The storm made landfall along the coast on the 6th. This system produced extremely heavy rainfall, strong damaging wind gusts and tornadoes. Ten to 20 inches of rain fell in eastern Wharton County. Brazoria County was hit the hardest from this system with about 1,500 homes flooded. Tropical Storm Fay produced five tornadoes, flooded many areas and caused significant wind damage. Damage of $4.5 million was reported.
September 12-13, 2008	Hurricane Ike	DR-1791	Yes	3	8	$400 million	In Fort Bend County, pockets of damage were reported with the eastern part of county being the hardest hit. An estimated 200 roofs sustained damage. Three indirect fatalities due to carbon monoxide poisoning of a family using a generator with inadequate ventilation. In the City of Sugar Land, while there was no loss of life, 200 miles of roadway had to be cleared, 700 city signs had to be reinstalled, 469 permits were issued for roof repairs, 78 city traffic signal lights had to be repaired, and 600 storm drains had to be cleared of debris. Several city buildings sustained roof damage and an extensive disaster debris cleanup operation was undertaken in involving 40 trucks and support vehicles. In total, the expenses to the city from Hurricane Ike totaled approximately six million dollars the bulk of which went to debris clean up. Damages would have been more severe had Ike made landfall in western Galveston County or in Brazoria County.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Fatalities	Injuries	Damages	Event Details*
August/September 2017	Hurricane Harvey	DR-4332	Yes				Following Hurricane Harvey, the Brazos River at the USGS gauge in Richmond, Texas experienced its highest ever recorded flow (122,000 cfs) and water surface elevation (83.13 feet above mean sea level). This resulted in significant accelerated erosion of the river's banks, up to 30-40 feet of bank loss in some locations. Within Memorial Park in Sugar Land, the erosion reached over 300 feet removing a significant portion of the Justin P. Brindley Mountain Bike Trail just upstream of the Ditch H outfall to the river.
September 18-19, 2019	Flash Flood (Tropical Depression Imelda)	N/A	N/A	-	-	-	A weak surface low pressure system strengthened into Tropical Storm Imelda just after noon on September 17th around 15 miles south southwest of Freeport. Imelda moved onshore near Freeport and quickly weakened to a tropical depression. Imelda moved very slowly to the north-northwest then north-northeast over the next few days and produced a few heavy rain bands that caused devastating flooding across portions of Southeast Texas...with maximum amounts over 40 inches falling mainly over a 24 hour period. Imelda is the 7th wettest tropical cyclone to impact the United States, the 5th wettest in the contiguous United States, and the 4th wettest in the state of Texas. Although freshwater flooding was the main impact, an EF-1 tornado also occurred in a cell within one of the leading bands from the storm. This damaged an area on the north side of Baytown near the Highlands. In the City of Sugar Land, approximately 4.5 inches of rain fell. The Brazos River experienced a four foot rise. Street flooding, vehicles stranded near Stafford and Sugar Land. Flood waters entering apartment buildings near the intersection of Dulles Avenue and Avenue E in Sugar Land. Reports included stranded vehicles in floodwaters with street flooding around Sugar Creek Boulevard.

Source(s): FEMA 2020; NOAA-NCEI 2020; City of Sugar Land HMP 2014; Office of the Texas State Climatologist 2020
** Many sources were consulted to provide an update of previous occurrences and losses; event details and loss/impact information may vary and has been summarized in the above table*
- *Not reported/not available*
FEMA *Federal Emergency Management Agency*
HMP *Hazard Mitigation Plan*
NCEI *National Centers for Environmental Information*
NOAA *National Oceanic and Atmospheric Administration*

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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). Major clusters of summertime storms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (University Corporation for Atmospheric Research [UCAR] 2017).

Probability of Future Occurrences

Using the NOAA-NCEI database, NWS, FEMA, and the 2015 Sugar Land HMP, Table 4-56 summarizes data regarding the probability of occurrences of hurricane and tropical storm events in the City of Sugar Land based on the historic record. It should be noted that many of these events impact a region; therefore, the number of events includes those identified as Fort Bend County. The information used to calculate the probability of occurrences is based on the NWS's Historic Hurricane Tracker and includes events that were tracked within 65 miles of the City.

Table 4-56. Probability of Future Occurrence of Hurricane/Tropical Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Tropical Storms	13	0.19	5.38	0.19	18.57
Hurricanes (Categories 1 and 2)	6	0.09	11.67	0.09	8.57
Major Hurricanes (Categories 3, 4, and 5)	1	0.01	70.00	0.01	1.43
TOTAL	**20**	**0.29**	**3.50**	**0.29**	**28.57**

Source: NHC 2020

The City of Sugar Land is expected to continue experiencing the direct and indirect impacts of hurricanes and tropical storms each year. Based on historical records and input from the Steering Committee, the probability of occurrence for hurricanes and tropical storm events in the City is considered *medium* (likely to occur within 100 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. Wind-related vulnerability data was generated using a HAZUS analysis for the hurricane and tropical storm hazard. A probabilistic assessment was conducted for the 20-, 100- and 500-year MRPs to analyze the hurricane and tropical storm hazard and provide a range of loss estimates.

Impact on Life, Health and Safety

The entire population of the City of Sugar Land is potentially exposed to direct and indirect impacts from hurricanes and tropical storms. Whether directly impacted or indirectly impacted, the entire population will have to deal with the consequences of hurricanes and tropical storms to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that sufferance no direct damage from the event itself.

Residents can be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds from hurricanes and tropical storms can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Hazus v4.2 currently estimates that no residents will be displaced or require temporary shelter due to either a 100-year or a 500-year MRP event. Table 4-57 summarizes the estimated impacts of modeled hurricane events on persons and households in the City of Sugar Land.

Table 4-57. Estimated Hurricane Impact on Persons and Households

Scenario	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
20-Year Probabilistic	1	1
100-Year Probabilistic	383	236
500-Year Probabilistic	383	236

Economically disadvantaged populations are more vulnerable because they often evaluate evacuation needs and make decisions based on the economic impact to their family. The population over the age of 65 is also vulnerable, can physically have difficulty evacuating, and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event. Section 3 (City Profile) presents the statistical information regarding these populations in the City.

Impact on General Building Stock

Damage to buildings depends on several factors, including wind speed, storm duration, and path of the storm. Depending on the severity of the storm, the City could see damage from hail impacting structures.

Building construction plays a major role in the extent of damage resulting from a severe storm event. Due to differences in construction, residential structures generally are more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. High-rise buildings are very vulnerable structures. Hazus v4.2 Hurricane User Manual defines a high-rise building as a one being six stories or greater in height. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

The U.S. Census Bureau defines manufactured homes as “movable dwellings, 8 feet or wider and 40 feet or more long, designed to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (U.S. Census 2010).” Manufactured homes include multi-wide and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage. According to the 2017 American Community Survey (ACS), there are 39 mobile homes in the City of Sugar Land, making up 0.1% of the total housing units in the City.

The entire City’s general building stock is exposed to the hurricane and tropical storm hazard (greater than $49 billion in replacement cost). Table 4-58 summarizes the building damage (structure and contents) estimated for the 20-, 100-, and 500-year MRP wind events for the City of Sugar Land.

Table 4-58. Loss Estimates for Scenario Hurricane Events

Scenario	Estimated Loss Associated with Hurricane			% of Total Replacement Value
	Structure	Contents	Total	
20-Year Probabilistic	$56,698,584	$1,560,897	$58,259,481	0.1%

Scenario	Estimated Loss Associated with Hurricane			% of Total Replacement Value
	Structure	Contents	Total	
100-Year Probabilistic	$639,017,760	$141,489,900	$780,507,660	1.6%
500-Year Probabilistic	$2,372,642,515	$915,478,128	$3,288,120,643	6.7%

Source: Hazus v4.2
Note: Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.

Impact on Critical Facilities

Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effective respond to an event and maintain the safety of its citizens.

The Hazus v4.2 estimates of hurricane damage to critical facilities and infrastructure in the City are summarized in Table 4-59 through Table 4-61.

Table 4-59. Damage Level to Critical Facilities Exposed to the 20-Year Hurricane

Facility Type	Loss of Use Days	Predicted Damage Level			
		Minor	Moderate	Severe	Complete
Education Facilities	0	1.89%	0.21%	0.00%	0.00%
Emergency Services	0	1.13%	0.06%	0.00%	0.00%
Government Facilities	N/A	1.84%	0.04%	0.00%	0.00%
Hazardous Material Sites	N/A	2.03%	0.07%	0.00%	0.00%
Health & Medical Facilities	0	1.53%	0.10%	0.00%	0.00%
Historical & Cultural Sites	N/A	1.89%	0.06%	0.01%	0.00%
Transportation Systems	N/A	3.00%	0.17%	0.00%	0.00%
Water Control Facilities	N/A	2.33%	0.09%	0.00%	0.00%
Total/Average	**0**	**1.95%**	**0.10%**	**0.00%**	**0.00%**

Source: Hazus v4.2
Note: The Hazus hurricane module does not calculate damages for bridges, below ground fuel tanks, or historical markers. Damages not calculated for 121 of the 415 total critical facilities.

Table 4-60. Damage Level to Critical Facilities Exposed to the 100-Year Hurricane

Facility Type	Loss of Use Days	Predicted Damage Level			
		Minor	Moderate	Severe	Complete
Education Facilities	3.5	12.91%	23.76%	1.11%	0.00%
Emergency Services	0	12.69%	7.93%	0.96%	0.01%
Government Facilities	N/A	21.38%	11.89%	2.00%	0.00%
Hazardous Material Sites	N/A	21.91%	12.16%	2.17%	0.00%
Health & Medical Facilities	0	14.65%	15.24%	0.40%	0.00%
Historical & Cultural Sites	N/A	25.16%	10.28%	1.50%	0.00%
Transportation Systems	N/A	25.80%	11.63%	2.34%	0.00%

Facility Type	Loss of Use Days	Predicted Damage Level Minor	Moderate	Severe	Complete
Water Control Facilities	N/A	22.18%	12.17%	2.15%	0.00%
Total/Average	**1.17**	**19.58%**	**13.13%**	**1.58%**	**0.00%**

Source: Hazus v4.2
Note: The Hazus hurricane module does not calculate damages for bridges, below ground fuel tanks, or historical markers. Damages not calculated for 121 of the 415 total critical facilities.

Table 4-61. Damage Level to Critical Facilities Exposed to the 500-Year Hurricane

Facility Type	Loss of Use Days	Predicted Damage Level			
		Minor	Moderate	Severe	Complete
Education Facilities	21.0	9.43%	44.03%	13.70%	0.09%
Emergency Services	0	14.79%	24.58%	11.62%	0.33%
Government Facilities	N/A	23.92%	27.03%	15.90%	0.00%
Hazardous Material Sites	N/A	24.34%	27.29%	16.59%	0.00%
Health & Medical Facilities	2.8	12.65%	39.22%	10.24%	0.36%
Historical & Cultural Sites	N/A	31.77%	26.14%	12.22%	0.01%
Transportation Systems	N/A	30.31%	27.95%	16.52%	0.03%
Water Control Facilities	N/A	24.55%	28.04%	17.58%	0.00%
Total/Average	**7.9**	**21.47%**	**30.53%**	**14.30%**	**0.10%**

Source: Hazus v4.2
Note: The Hazus hurricane module does not calculate damages for bridges, below ground fuel tanks, or historical markers. Damages not calculated for 121 of the 415 total critical facilities.

Impact on Economy

Hurricanes and tropical storms impacts the economy; with impacts including loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Hazus v4.2 estimates the total economic loss associated with each probabilistic event (direct building losses and business interruption losses). Business interruption losses include losses associated with the inability to operate a business because of the wind damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event.

Debris management can be costly and impact the local economy. Hazus v4.2 estimates the amount of debris that might be produced a result of the 20-, 100- and 500-year MRP wind events. Table 4-62 shows the amount of debris produced for each scenario.

Table 4-62. Estimated Hurricane-Caused Debris

Scenario	Debris to Be Removed (tons)
20-Year Probabilistic	9,988.00
100-Year Probabilistic	125,140.00
500-Year Probabilistic	393,142.00

Source: Hazus v4.2

Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City 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 could be potentially impacted by the hurricane and tropical storm hazard because the entire City is exposed and vulnerable; however, due to increased standards and codes, new development can be less vulnerable to the hazard compared with the aging building stock in the City.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the hurricane and tropical storm hazard.

Climate Change

The entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). An increase in storms will produce more wind events and may increase hurricane and tropical storm activity (Climate Central 2016). Overall, the City of Sugar Land will continue to remain vulnerable to the hurricane and tropical storm hazard.

Changes in Vulnerability Since the 2015 HMP

The City of Sugar Land continues to be vulnerable to hurricanes and tropical storms. Hurricane models were not run for the 2015 HMP; therefore, estimated losses were not populated for the hazard. Overall, the vulnerability assessment presented in this update uses Hazus v4.2 and a more accurate and updated building inventory. This provides more accurate estimated exposure and potential losses for the City of Sugar Land.

Issues Identified

Important issues associated with severe storm events in the City of Sugar Land include the following:

- Older building stock in the City could be more vulnerable to hurricane and tropical storm events, as they may have been built to low or no code standards.
- The hurricane vulnerability within the City is significant, representing between 0.1 and 6.7% of the total replacement value for the City. This does not include the potential flood impacts.

4.3.10 Dam and Levee Failure

The following section provides the hazard profile and vulnerability assessment for the dam and levee failure hazard in the City of Sugar Land. During the planning process, dam failure was identified as having no risk; therefore, this section will only discuss levee failure.

Profile

Hazard Description

Levees have been constructed in the State of Texas for over 100 years to protect farms, ranch land, and populated areas from flooding (State of Texas HMP 2018). 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.

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.

Regulatory Oversight for Levees

USACE and FEMA have differing roles and responsibilities related to levees. USACE addresses a range of operation and maintenance, risk communication, risk management, and risk reduction issues as part of its responsibilities under the Levee Safety Program. FEMA addresses mapping and floodplain management issues related to levees, and it accredits levees as meeting requirements set forth by the National Flood Insurance Program.

Depending on the levee system, USACE and FEMA may be involved with the levee sponsor and community independently or—when a levee system overlaps both agency programs—jointly. Under both scenarios, the long-term goals are similar: to reduce risk and lessen the devastating consequences of flooding. Some USACE and FEMA partnering activities related to levees include:

- Joint meetings with levee sponsors and other stakeholders
- Integration of levee information into the National Levee Database
- State Silver Jackets teams
- Sharing of levee information
- Targeted task forces to improve program alignment

The Silver Jackets is a program that provides an opportunity to consistently bring together multiple state, federal, tribal, and local agencies to learn from each other and apply their knowledge to reduce risk. The Program's primary goals include the following:

- Create or supplement a mechanism to collaboratively identify, prioritize, and address risk management issues and implement solutions;
- Increase and improve risk communication through a unified interagency effort;
- Leverage information and resources and provide access to such national programs as FEMA's Risk MAP and USACE's Levee Inventory and Assessment Initiative;
- Provide focused, coordinated hazard mitigation assistance in implementing high-priority actions such as those identified by state hazard mitigation plans;
- Identify gaps among agency programs and/or barriers to implementation, such as conflicting agency policies or authorities, and provide recommendations for addressing these issues.

The State of Texas has a Silver Jackets team. Their vision is to increase efficiency and coordination between the state and federal governments in developing comprehensive and sustainable solutions to flood risk management in the State of Texas. The team provides a variety of projects, plans, and outreach to help the State mitigate and prevent future floods. Information about the team can be found online: https://silverjackets.nfrmp.us/State-Teams/Texas

Coordination between USACE and FEMA with regard to levees is now standard within many of each agency's policies and practices. Over the past several years, both agencies coordinated policies where appropriate; jointly participated in meetings with stakeholders; and participated in many multiagency efforts, such as the National Committee on Levee Safety, the Federal Interagency Floodplain Management Task Force, and the Silver Jackets Program.

National Committee on Levee Safety

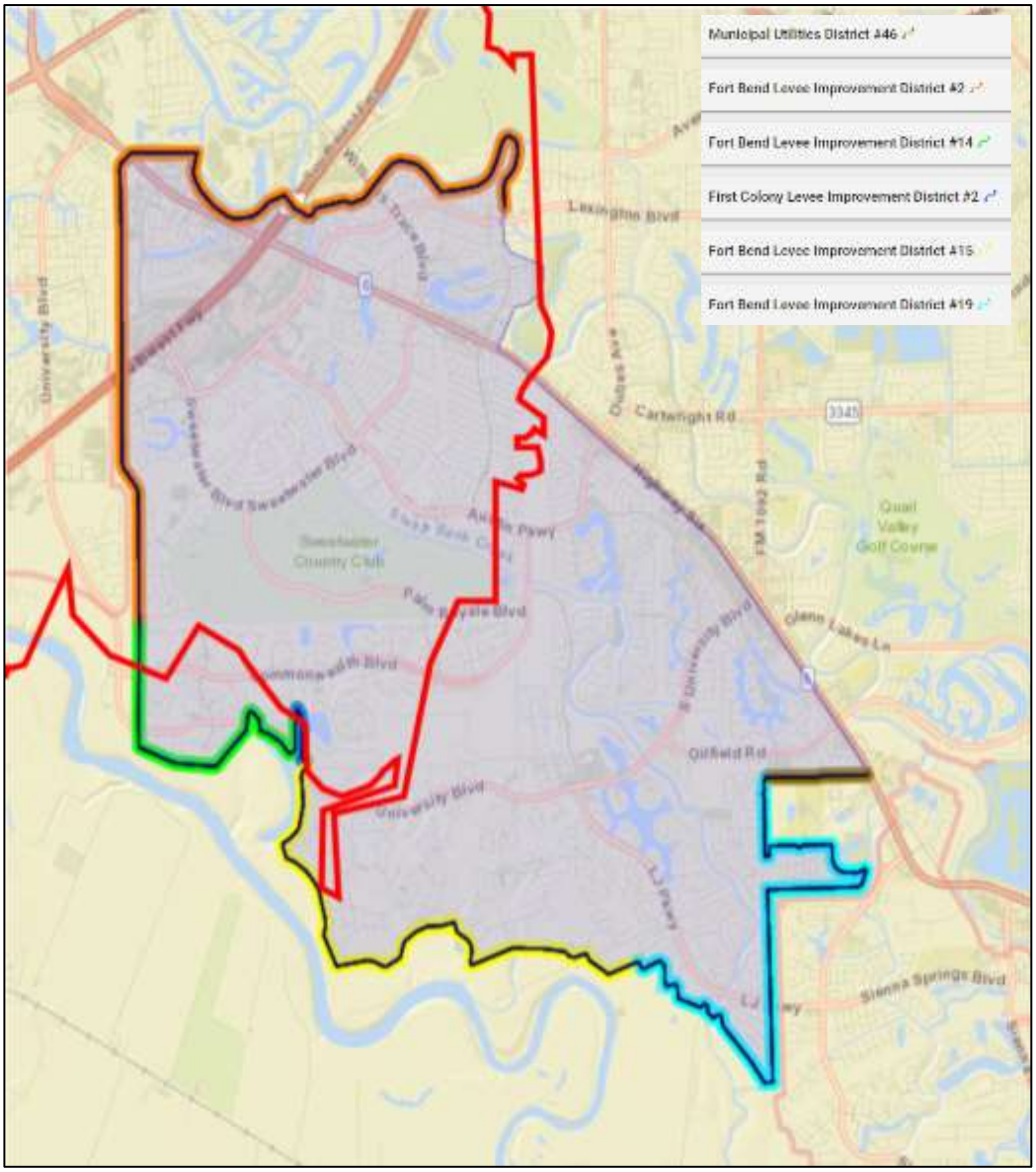
The National Committee on Levee Safety was created by Congress to "develop recommendations for a national levee safety program, including a strategic plan for implementation of the program." The Committee adopted the vision of "an involved public and reliable levee system working as part of an integrated approach to protect people and property from floods," and has been working toward this goal since October 2008 (National Committee on Levee Safety 2010). The Committee is made up of representatives from state, regional, and local agencies; the private sector; USACE; and FEMA.

Location

There are 16 levee systems located in Fort Bend County. There is one levee segment located in the City of Sugar Land. The Sugarstone levee system is an active, accredited levee. It is 19.55 miles in length and protects 66,519 people and 20,168 structures. Within the City of Sugar Land, there are two Levee Improvement Districts (LID):

- Fort Bend Levee Improvement District #2
    - This LID protects over $4 billion of property and assets in the City of Sugar Land, including major portions of First Colony, the Sugar Land Town Square, multiple hospitals, major retail centers and businesses, and critical transportation routes. As of March 2009, the district met 500-year flood standards.
- Fort Bend Levee Improvement District #14
    - The District contains approximately 567 acres of land located in the central portion of Fort Bend County, approximately 20 miles southwest of downtown Houston, Texas. The District lies entirely within the corporate limits of the City of Sugar Land. U.S. Highway 59 is north of the District and the Brazos River, at its nearest point, is south of the District.

Figure 4-31. Levee Segment in the City of Sugar Land



Source: USACE 2020

Note: The City of Sugar Land is outlined in red. The blue shading indicates the leveed area

Extent

The resulting torrent from a levee breach can quickly swamp a large area behind the failed levee with little or no warning. When a levee system fails or is overtopped, severe flood damage can occur due to increased water surface elevation associated with levees and the resulting increase in water velocity.

Worst-Case Scenario

While the probability of a levee failure is low, a worst-case scenario would be a hurricane or tropical storm that would stall over the City, causing levees to breech or overtop, impacting areas that are supposed to be protected by the levee. If a levee failure were to occur, properties protect by the levee could see up to four feet of standing water and the extent could involve impact within the protected areas including 66,519 persons, 20,168 structures, and $11.7 billion in property value.

Previous Occurrences and Losses

According to available records from the State of Texas 2018 HMP Update, City of Sugar Land 2015 HMP, and the National Performance of Dams Program, there have been no reported levee incidents recorded for the City of Sugar Land.

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. 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).

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 levee systems during future riverine flood events (State of Texas HMP 2018).

Probability of Future Occurrences

The likelihood of a levee failure in the City of Sugar Land is difficult to predict. For levees, a complete failure is infrequent and typically coincides with events that cause. Future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Since dam overtopping and levee failures are often caused by excessive rainfall, it is appropriate to relate the future vulnerability of dams and levees directly with the potential for increased rainfall in the City.

No historical events of levee failures have been recorded in the City of Sugar Land, though the risk of failures is monitored. Based on the lack of historical occurrences, the probability of a future event is considered *low* (not likely to occur in 100 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire City of Sugar Land is exposed and vulnerable to the levee failure hazard; therefore, all assets within the City (population, structures, critical facilities, and lifelines), as described in Section 3 (City Profile), are potentially vulnerable to a dam or levee event. The following text evaluates and estimates the potential impact of the dam and levee failure hazard in the City.

Impact on Life, Health and Safety

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 are considered exposed to the hazard. 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 at risk while traveling in flooded areas, or their access to emergency services is compromised during an event); the degree of that impact varies and is not strictly measurable.

Vulnerable populations are all populations downstream from levee failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly, young and individuals with disabilities, access or 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 levee failure may also include those beyond the disaster area that rely on the dam for providing potable water.

Floods created from a 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 4.3.7 (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 or levee failure events.

Impact on General Building Stock

Vulnerable properties are those closest to the levee area. These properties would experience the largest, most destructive surge of water. Transportation routes are vulnerable to dam 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 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.

Impact on Critical Facilities

Transportation routes are vulnerable to dam 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 levee. 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 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 inundation zone.

Impact on the Economy

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. Flooding as a result of levee failure can cause extensive damage to public utilities and disruptions in delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation.

Impact on the Environment

The environment is vulnerable to a number of risks in the event of a levee failure. The inundation may introduce foreign elements into local waterways, resulting in destruction of downstream habitat and impacting many animal and plant species, especially endangered species. The subsequent rush of water downstream can rapidly increase flow rate and turbidity of streams and rivers in minor dam failures or overwhelm terrestrial habitat with floodwaters in severe dam failure events.

Levee failures may result in significant water quality and debris disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooding waterway. The contents of unsecured containers of oil, fertilizers, pesticides and other chemicals get added to flood waters. Water supplies and wastewater treatment could be offline for weeks. After the flood waters subside, contaminated and flood damaged building materials and contents must be disposed of properly.

Future Changes that May Impact Vulnerability

Understanding future changes that effect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City 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 could be potentially impacted by the levee failure hazard because the entire City is exposed and vulnerable. Areas in and around the levees are the most vulnerable to losses; therefore, any development in these areas will be more susceptible to levee failure impacts.

Projected Changes in Population

The City has experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the dam and 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 levee systems during future riverine flood events (State of Texas HMP 2018).

Change of Vulnerability Since the 2015 HMP

The City of Sugar Land’s population increased since the last plan; increasing the number of people vulnerable during a levee failure event. Therefore, the entire City remains vulnerable.

Identified Issues

Important issues associated with levee failures in the City of Sugar Land include the following:

- Levee failures can occur from periods of heavy rain, flooding, earthquakes, and landslides.
- Levees may require repair and improvement to withstand climate change impacts, such as changing in the timing and intensity of rain events.
- Increasing population and development in areas protected by levees increases the number of persons and structures at risk.

4.3.11 Erosion

The following section provides the hazard profile and vulnerability assessment for the erosion hazard in the City of Sugar Land.

Hazard Profile

Description

Erosion is the process of the wearing away of beaches and bluffs along the coastline by large storms, flooding, strong wave action, sea level rise, fluvial currents, and human activities. In the State of Texas, there are two types of erosion: coastal erosion and inland erosion.

Coastal Erosion

Coastal erosion is a hydrologic hazard defined as the wearing away of land and loss of beach, shoreline, or dune material because of natural coastal processes or manmade influences. Coastal erosion is linked to hurricane damage in that healthy coastal dunes and beaches help reduce impacts of hurricane, tropical storms, tropical depressions, and severe coastal flooding. Mitigating coastal erosion also mitigates those hazards (State of Texas HMP 2018).

Erosion is measured as a rate of change in the position or displacement of a shoreline over a period of time. Short-term erosion typically results from periodic natural events, such as wave action, storm surges and wind. Long-term erosion is a result of repetitive occurrences of this type and of severe storm and flooding events. Erosion can affect natural and built environments. Impacts depend on topography, soils, building types and construction materials. Coastal erosion can affect natural systems, coastal food supplies, tourism industry, and small town viability. When sea water infiltrates freshwater wetlands, they can die, removing key habitats for animals and a protective buffer for nearby communities (State of Texas HMP 2018).

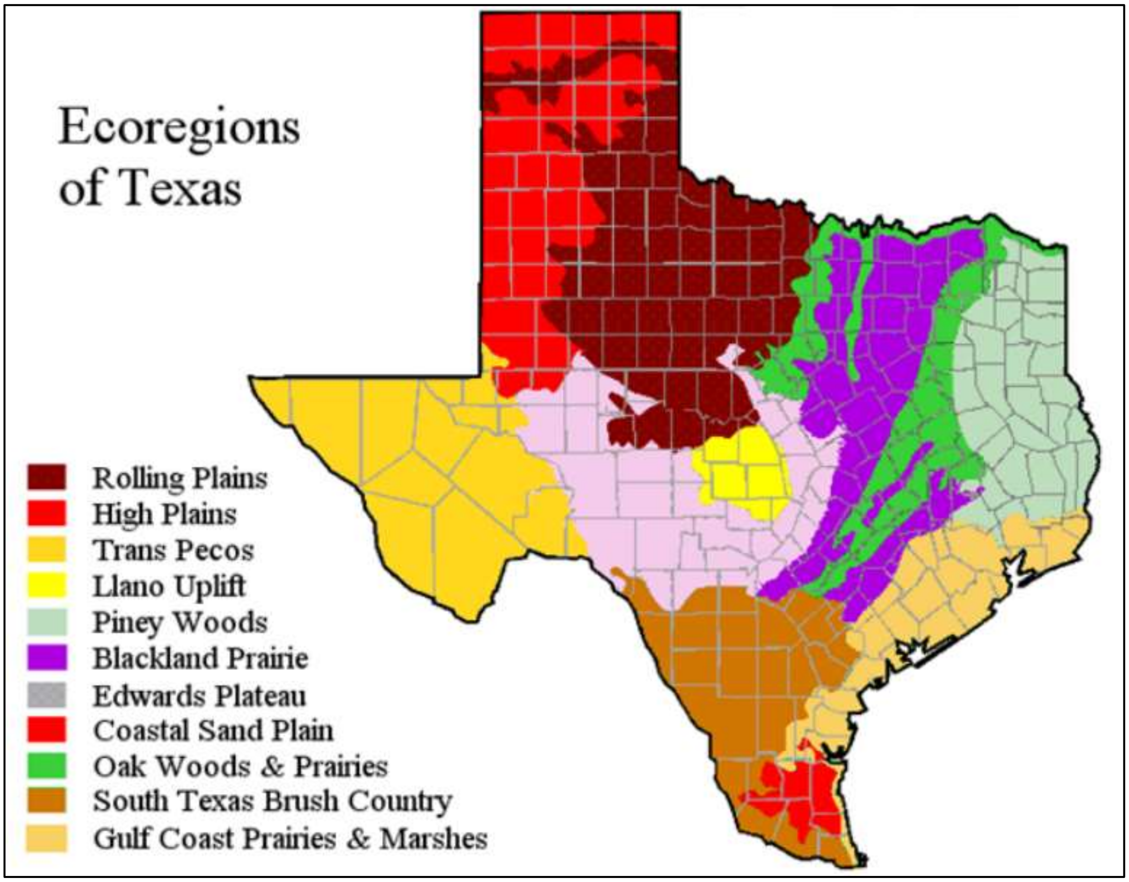
Due to the City of Sugar Land's inland location, coastal erosion is not considered a hazard of concern for the City.

Inland Erosion

Inland erosion is the wearing-away of soil or removal of the banks of streams or rivers. It involves the breakdown, detachment, transport, and redistribution of soil particles by forces of water, wind, or gravity. Soil erosion on cropland is of particular interest because of its onsite impacts on soil quality and crop productivity, and its off-site impacts on water quantity and quality, air quality, and biological activity. Erosion is measured as a rate of change in the position or displacement of a river or stream bank over a period of time or the amount of soil removal. Short-term erosion results from periodic flooding and wind. Long-term erosion is a result of repetitive events of this type and of prolonged drought.

In the State of Texas, inland erosion is more prominent in the High Plains, Rolling Plains, and Coastal Sand Plains. The most vulnerable jurisdictions in the State are the Lubbock Region and southern part of the McAllen Region, which includes Fort Bend County and the City of Sugar Land.

Figure 4-32. Location of Erosion Areas in the State of Texas



Erosion caused by water is the primary concern for the City of Sugar Land. Water erosion is the detachment and removal of soil by water. The process can occur naturally or be accelerated by human activity. The rate of erosion can be a slow process that continues relatively unnoticed or can occur very rapidly. The rate is dependent on the type of soil, the local landscape, and weather conditions (Ritter 2018; USDA 2001).

There are three types of water erosion that can occur: sheet, rill, and gully. Sheet erosion is the most difficult to see as it is a uniform soil layer being remove from an area over the surface. Rill erosion starts as water flowing over the soil surface concentrates into small streams, creating channels of water flow. Gully erosion is when rill erosion is not kept under control and creates gullies (deeper and wider cuts) (Soil Science Society of America 2020).

Erosion can be most severe where urbanization, development, recreational activities, logging and agricultural practices take place. Extreme rainfall events, lack of vegetative cover, fragile soils and steep slopes combine to accelerate erosion (Ritter 2018). In the City of Sugar Land, the banks along the Brazos River is experiencing significant erosion.

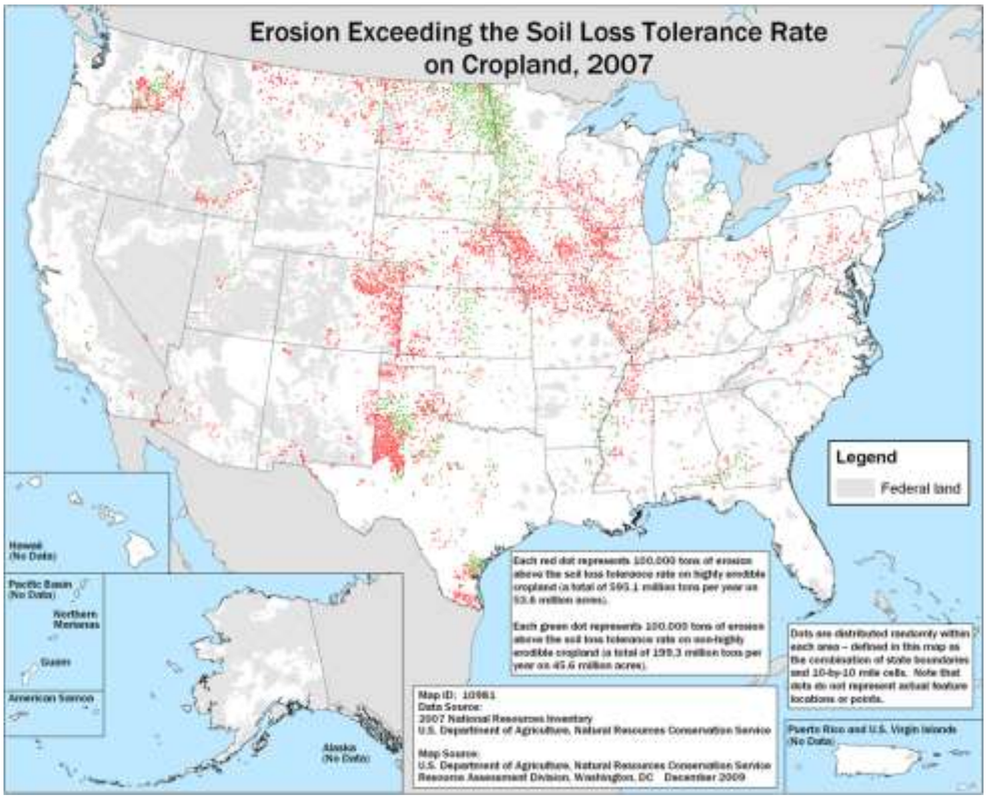
Location

The Brazos River flows through Fort Bend County. Nine miles of the river flows through the City of Sugar Land. Erosion along the banks of the river is a major concern for the City. Rainfall events that occur upstream from the City can create major flood stages and high flow rates along the river. This causes the water to move at high speeds through the County and City, causing erosion along the river (Marshall 2019).

A river's meander belt is the area within which a river shifts its channel across its floodplain over time. The Brazos River's meander is bordered on both sides by higher elevations. In the Sugar Land area, the width of the river is around 400 feet. Over the past 50 years, much of the river's original meander belt has been removed due to the construction of levees. This restriction in the river's movement leads to an increase in erosion (Huitt-Zollars 2018).

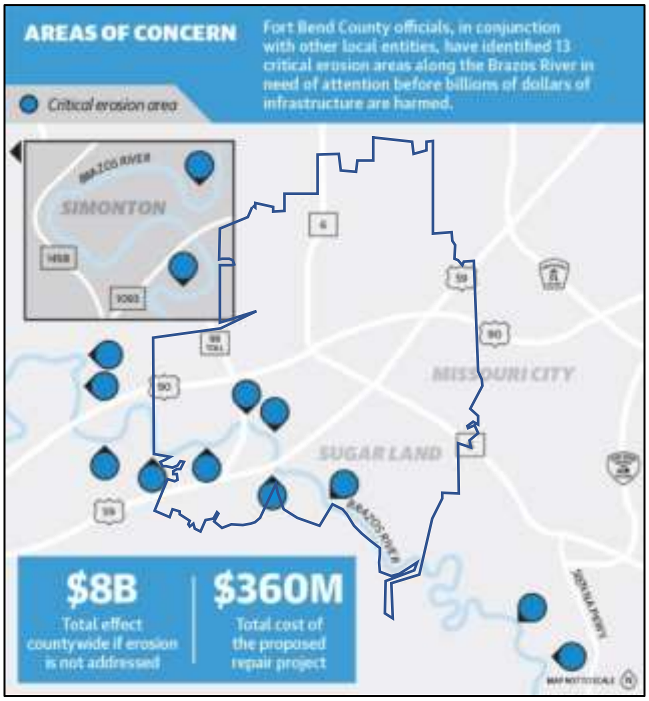
In the August 2018 *Report for Brazos River Erosion Study*, 13 critical erosion areas were identified along the portion of the Brazos River found in Fort Bend County, as illustrated in Figure 4-34.

Figure 4-33. National Erosion Loss Rates



Source: NRI 2010

Figure 4-34. Critical Erosion Areas Along the Brazos River



Note: The blue outline indicates the approximate boundary for the City of Sugar Land. It was added to the figure to show the municipal boundary.

Extent

It is difficult to directly measure erosion and the risk of erosion. There are other properties, however, that can be used to measure erosion: soil surface stability, aggregate stability, infiltration, compaction, and content of organic matter. Measuring these properties can help with understanding the susceptibility of erosion at a specific location. Comparing visual observations along with quantitative measurements can help provide information about soil surface stability, sedimentation, and soil loss (USDA 2001).

Every five years the Natural Resources Conservation Service conducts a statistical survey of natural resource conditions and trends on non-federal land in the United States called the National Resources Inventory (NRI). The NRI provides nationally consistent statistical data on erosion resulting from water and wind processes on cropland. It uses a variety of tables and maps to document the ongoing state of erosion across the county (State of Texas HMP 2018; NRI 2010).

One key measure used in the NRI is the Erodibility Index (EI). This index is a numerical expression of the potential of a soil to erode, considering climatic factors and the soils' physical and chemical properties. The higher the index, the greater is the investment needed to maintain the sustainability of the soil resource base of high-yield crops. Highly Erodible Land is defined to have an EI of at least 8 (State of Texas HMP 2018).

Another soil erosion component is the soil loss tolerant rate. Identified as 'T', this is the maximum rate of annual soil loss that will permit crop productivity to be economically sustained. Erosion is considered to be greater than 'T' if either water or wind erosion rates exceed the soil tolerance rate (State of Texas HMP 2018). Figure 4-33 illustrates the locations of where erosion exceeded the soil loss tolerance rates across the United States. Each red dot represents 100,000 tons of erosion above the soil loss tolerance. According to this figure, areas of erosion exceeding the soil loss tolerance rates was not identified in the area of the City of Sugar Land.

Worst-Case Scenario

Any storm that produces significant amounts of rain in a short period of time could lead to a worst-case scenario for an erosion incident along the section of the Brazos River in Sugar Land. However, an event similar to the aftermath of Hurricane Harvey that caused portions of the streambank along the Brazos River to lose up to 40 feet of its bank. Nine miles of the Brazos River flows through the City and erosion along its banks is a major concern for the City. Additionally, rainfall events that occur upstream from the City can create major flood stages and high flow rates along the river. This causes the water to move at high speeds through the County and City, causing erosion along the river. Impacts from such events includes road closures, damage to infrastructure and buildings, and inaccessible areas that can disrupt emergency response.

Previous Occurrences and Losses

Between 1953 and 2019, the State of Texas was not included in any erosion-related FEMA disaster declarations. For the 2021 HMP Update, there was limited information regarding erosion in the City of Sugar Land. The following information was obtained from local newspapers. These events were identified as erosion events associated with severe weather events.

- Memorial Day Flood (2015) – a storm system brought 11 inches of rain in the area within eight hours
- Tax Day Flood (2016) – On April 18, 2016, a slow moving system produced heavy rain and devastating flooding over portions of Harris, Waller, and Fort Bend Counties. Rainfall totals reach up to 20 inches over a 12-hour period. In Fort Bend County, the Brazos River turnaround at Highway 59, along with the Highway 90 underpass between Richmond and Rosenberg and Highway 90A at Highway 99, were all impassable due to flooding. This result in erosion along the Brazos River in the City of Sugar Land.
- August/September 2017 – Following Hurricane Harvey, the Brazos River at the USGS gauge in Richmond, Texas experienced its highest ever recorded flow (122,000 cfs) and water surface elevation (83.13 feet above mean sea level). This resulted in significant accelerated erosion of the river's banks, up to 30-40 feet of bank loss in some locations. Within Memorial Park in Sugar Land, the erosion reached over 300 feet removing a significant portion of the Justin P. Brindley Mountain Bike Trail just upstream of the Ditch H outfall to the river (Huitt-Zollars 2018).
- May 7, 2019 – Slow moving thunderstorms produced several inches of rain over Fort Bend County. This resulted in flooding that led to erosion along the Brazos River in the City of Sugar Land.
- Tropical Depression Imelda – September 18-19, 2019 – Around 4.5 inches of rain fell in the City of Sugar Land. The Brazos River experienced a four-foot rise (Marshall 2019).

Climate Change Projections

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for erosion to occur.

Probability of Future Events

It is anticipated that erosion will continue to occur along the Brazos River in the City of Sugar Land. As the frequency of storms occur due to climate change, the probability for future events will likely increase as well. Based on historical records and input from the Steering Committee, the probability of occurrence for erosion events in the City is considered *medium* (likely to occur within 100 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Erosion may impact public safety, property, infrastructure, environmental resources and local economies. The following text evaluates and estimates the potential impact of erosion on the City of Sugar Land.

Impact on Life, Health and Safety

Overall, an event related to erosion would be an isolated incidence and impact the population within the immediate area of the incident. Erosion can cause damage to residential buildings and displacing residents and erosion events could event block off or damage major roadways, inhibiting travel for emergency responders or populations trying to evacuate the area.

Erosion can create water quality problems in surface waters and drainage ways. These problems can adversely impact the health and biological diversity of water bodies. According to the USDA, this includes:

- Excess nutrients impact water quality through eutrophication, a process where excess nitrogen and phosphorus causes unwanted biological growth in water bodies.
- Sediment reduces water quality by making the water cloudy. Turbidity prevents sunlight from penetrating the water and reduces photosynthesis and underwater vegetation. Oxygen levels are reduced in turbid waters, further degrading habitat for fish and other aquatic organisms.
- Sediment can build up in stream channels, lowering flow capacity. The problem of low stream capacity is compounded as runoff increases from newly built-up or paved areas and causes stream channels to receive larger amounts of water in shorter periods of time. This leads to more frequent flooding in areas that never or only rarely flooded in the past. In floodprone areas, levees may need to be built or enlarged to better protect public safety.
- A financial burden results from cleanup of sediment-damaged areas. Taxpayers often bear the cost of removing sediment from public roads, road ditches, culverts or streams; not to mention damage to homes and the safety hazards associated with flooding. Other costs of erosion that are borne by the public are degraded soils, a polluted environment, more runoff, greater need for irrigation, and aesthetically unpleasing sites (USDA 2000).

Impact on General Building Stock and Critical Facilities

Erosion can impact structures located along the banks of waterways, having the potential to destabilize the foundation of structures. It can also impact infrastructure such as dams, levees, roads, and other developed land. In the City of Sugar Land, the structures and infrastructure located in the area of the Brazos River may be susceptible to damages associated with erosion.

Impact on the Economy

The impact of erosion on the economy and estimated dollar losses are difficult to measure. Erosion and other geological hazards can impose direct and indirect impacts on society. Direct costs include the actual damage sustained by buildings, property and infrastructure. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure (USGS, 2003).

Future Changes that May Impact Vulnerability

Understanding future changes that affect vulnerability in the City can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The City 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 could be affected by erosion if the growth areas are within identified hazard areas. Areas targeted for potential future growth and development could be potentially impacted by erosion if they are located within areas prone to erosion, especially along the Brazos River.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. If the population is increasing in the area of the Brazos River, more people will be exposed to erosion and its potential impacts.

Climate Change

A direct impact of climate change on erosion is difficult to determine. Multiple secondary effects of climate change have the potential to increase the likelihood of erosion. Warming temperatures resulting in wildfires would reduce vegetative cover along steep slopes and destabilize the soils due to destruction of the root system; increased intensity of rainfall events would increase saturation of soils on steep slopes. Under these future conditions, the City's assets located along the Brazos River will have an increased risk to erosion.

Change of Vulnerability

Erosion hazard was not identified as a hazard of concern in the 2015 HMP and therefore an erosion exposure analysis was not conducted as part of the 2015 HMP risk assessment.

Identified Issues

Identified issues associated with geological hazards in the City include the following:

- Erosion can cause negative environmental consequences, including water quality degradation.
- Impact the integrity of the levee and the properties located behind the levee system.

4.3.12 Land Subsidence

Despite the subsidence that has occurred in the past, there have been no impacts to any critical facilities, infrastructure, or other community assets, and future impacts are not expected. Therefore, the City of Sugar Land did not identify land subsidence as a hazard of concern. This hazard is omitted and will not be mitigated.

4.3.13 Earthquake

In the City of Sugar Land, there is no risk to the earthquake hazard and there is no expectation of future impact on the City. Therefore, this hazard is omitted and will not be mitigated.

4.3.14 Expansive Soils

In the City of Sugar Land, there is no risk to the expansive soils hazard and there is no expectation of future impact on the City. Therefore, this hazard is omitted and will not be mitigated.

4.3.15 Wildfire

In the City of Sugar Land, there is no risk to the wildfire hazard and there is no expectation of future impact on the City. Therefore, this hazard is omitted and will not be mitigated.

4.3.16 Terrorism

This section provides the hazard profile and vulnerability assessment for the terrorism hazard for the City of Sugar Land.

Profile

Hazard Description

According to the Federal Bureau of Investigation (FBI), terrorism is "the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (National Institute of Justice 2019). Acts of terrorism include: threats of terrorism, assassinations, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based attacks), and use of chemical, biological, nuclear, and radiological weapons (FEMA 2009). Various types of terrorism are discussed in the sections below.

Agriterrorism

Agriterrorism is the intentional use of plant or animal pathogens to cause devastating disease in the agricultural sector. There are similarities to bioterrorism, but the aim of agriterrorism is to specifically target crops and livestock to cause a significant economic impact or to damage food supplies (FEMA 2007).

Armed Attacks and Assassinations

Armed attacks include raids and ambushes. An assassination is the killing of a selected victim, usually by bombings or small arms. A drive-by shooting is a common technique employed by unsophisticated or loosely organized terrorist groups. Historically, terrorists have assassinated specific individuals for psychological effect.

Arson and Firebombing

Incendiary devices are inexpensive and easy to hide. Arson and fire-bombings are easily conducted by terrorist groups that may not be as well organized, equipped, or trained as a major terrorist organization. An act of arson or firebombing against a utility, hotel, government building, or industrial center portrays an image to the public that the ruling government is incapable of maintaining order.

Bioterrorism

Bioterrorism refers to intentional release of toxic biological agents to harm and terrorize civilians, in the name of a political or other cause. The U.S. Centers for Disease Control and Prevention (CDC) has classified the viruses, bacteria, and toxins that could be used in an attack. Category A Biological Diseases are most likely to cause the greatest harm. They include:

- Anthrax (*Bacillus anthracis*)
- Botulism (*Clostridium botulinum toxin*)
- Plague (*Yersinia pestis*)
- Smallpox (*Variola major*)
- Tularemia (*Francisella tularensis*)
- Hemorrhagic fever caused by Ebola virus or Marburg virus.

Bombings

Bombings are the most common type of terrorist act. Typically, improvised explosive devices are inexpensive and easy to make. Bombs can range from smaller packages to vehicle-borne bombs that are capable of catastrophic damage. Modern devices are smaller and harder to detect and have destructive capabilities. Terrorists responsible for this bombing can use materials readily available to the average consumer to construct a bomb.

Cyber Terrorism

Cyber terrorists use information technology to attack civilians and draw attention to the terrorists' cause. They may use information technology, such as computer systems or telecommunications, as a tool to orchestrate a traditional attack. More often, cyber terrorism refers to an attack on information technology itself in a way that would radically disrupt networked services. For example, cyber terrorists could disable networked emergency systems or hack into networks that house critical financial information. There is wide disagreement about the extent of the existing threat by cyber terrorists.

Hijackings and Skyjackings

Hijacking is seizure by force of a surface vehicle, its passengers, or its cargo. Skyjacking is taking of an aircraft, which creates a mobile, hostage barricade situation; provides terrorists with hostages from many nations; and draws heavy media attention. Skyjacking also provides mobility for the terrorists to relocate the aircraft to a country that supports their cause and provides them with a human shield, making retaliation difficult.

Intentional Hazardous Materials Release

Intentional hazardous materials release is intentional leak, spillage, discharge, or disposal of hazardous materials or substances (such as explosives, toxic chemicals, and radioactive materials) (DHS 2018). This could include the intentional release of chemicals commonly used in industry, or the release of chemical agents as a weapon. This might involve attacking hazardous material storage facilities or attacking storage containers in transit. Intentional hazardous materials can have a significant impact on human health and the environment.

Kidnappings and Hostage-Takings

Terrorists use kidnapping and hostage-taking to establish a bargaining position and to elicit publicity. Kidnapping is one of the most difficult acts for a terrorist group to accomplish, but a successful kidnapping can gain terrorists money, release of jailed comrades, and publicity for an extended period. Hostage-taking involves seizure of a facility or location and taking hostages present in that facility. Unlike a kidnapping, hostage-taking provokes a confrontation with authorities. It forces authorities to make dramatic decisions or to comply with the terrorist's demands. It is overt and designed to attract and hold media attention. The intended target is the audience affected by the hostage's confinement, not the hostage.

Nuclear/Radiological Terrorism

Nuclear/radiological terrorism refers to a number of different ways nuclear materials might be exploited as a terrorist tactic. These methods include attacking nuclear facilities, purchasing nuclear weapons, or building nuclear weapons or otherwise finding ways to disperse radioactive materials.

Location and Extent

Terrorism can occur anywhere within the City of Sugar Land and surrounding area depending on the individual's or organization's agenda. Any facility or structure is vulnerable to a terrorist attack, as terrorists have historically sent chemical or biological agents through the mail. High-risk targets include local, county, state, or federal government facilities; major venues and gathering places; sites with historical, cultural, or other significance; and critical infrastructure. Damage to or disruption of operations at government facilities could profoundly impact the City's population, even if the terrorism event is relatively small-scale. Due to the City's close proximity to the City of Houston, terrorist events that occur in the City of Houston could have cascading impacts on the City of Sugar Land.

Previous Occurrences and Losses

Between 1953 and 2020, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of Texas for two terrorism-related events; however, Fort Bend County (where the City of Sugar Land is located within), was not included in either declaration.

Since the 2015 HMP, terrorism-related events have not been recorded in the City of Sugar Land. However, with its proximity to the City of Houston, the City of Sugar Land could be impacted by events that occur in Houston.

Climate Change Projections

Because terrorism is a human-caused hazard, climate change is not anticipated to affected vulnerability associated with terrorism.

Probability of Future Occurrences

While the potential for future terrorism incidents in the City of Sugar Land is difficult to predict, the combination of past incidents and potential terrorist targets make a terrorism incident possible. Efforts from local, state, and federal officials must be coordinated to prevent future terrorist incidents from occurring. However, despite the best efforts of these entities, the reality is that a terrorist attack may occur in the City or the surrounding areas.

Based on the recent incident events, the future occurrence of terrorism in the City of Sugar Land can be considered *low* (not likely to occur within 100 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Terrorism events may impact public safety, property, infrastructure, environmental resources and local economies. The following text evaluates and estimates the potential impact of terrorism events on the City of Sugar Land.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population in the City of Sugar Land is exposed to terrorism events. However, because terrorists typically prefer to impact the greatest number of individuals in a given location, it can be inferred that individuals living in highly populated areas, or mass transit systems with a large number of commuters will have a greater exposure to terrorist incidents.

Impact on General Building Stock

The entire building stock in the City is exposed and vulnerable to the terrorism hazard. Accessibility, design, roof access availability, driveways underneath buildings, unmonitored areas, and the proximity of structures to transportation routes and underground pipelines makes all buildings in the City exposed and vulnerable to this hazard.

Impact on Critical Facilities

Critical facilities are exposed to terrorist attacks, particularly because of the impact that an attack has on these types of facilities. Dams, power stations, and tunnels are all examples of critical infrastructure and facilities that are vulnerable. Additionally, communications systems, first-responder stations, and emergency operations centers are all vulnerable to terrorist attacks. Disrupting one of these facilities or destroying critical infrastructure would have devastating, cascading impacts on the City. All critical facilities in the City of Sugar Land are exposed to the terrorism hazard.

Impact on Economy

Measuring the economic impact of a terrorist attack on the City of Sugar Land is difficult. The initial impact can be measured in immediate costs such as costs related to responding to the event, and those associated with the immediate loss of productivity due to closed businesses. Should a terrorist event be of a significant magnitude, there could be ramifications in the financial markets which could affect a greater geographic extent compared to the City.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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

Future development throughout the City of Sugar Land will take into consideration possible terrorist incidents; particularly if new facilities are built that could be potential terrorist targets, such as a festival site and a community center currently under construction. Any areas of growth could be potentially impacted by the terrorism hazard because the City of Sugar Land is exposed and potentially vulnerable.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the terrorism hazard as residents move into area and the population exposed increases.

Climate Change

Because terrorism is a human-caused hazard, climate change is not anticipated to affected vulnerability associated with terrorism.

Changes in Vulnerability Since the 2015 HMP

Overall, the City's vulnerability to terrorism has not changed since the 2015 HMP. The entire City will continue to be exposed and vulnerable to terrorist events.

Identified Issues

Though no terrorism incidents have been reported in Sugar Land, the City faces terrorism vulnerability due to its concentration of infrastructure and proximity to Houston. The Houston-Galveston area is reported to be the biggest petrochemical complex in the Western Hemisphere, and is the only region in the United States to have all sixteen critical infrastructure sectors identified by Presidential Policy Directive 21 (PPD-21). Though the City does not have the concentration of infrastructure observable elsewhere in the Houston metro area, the major highways and freeways, rail lines, petroleum and natural gas pipelines, and commercial/institutional buildings found in the City may be targeted for terrorism.

4.3.17 Hazardous Material Spills

This section provides the hazard profile and vulnerability assessment for the hazardous material spills hazard for the City of Sugar Land.

Profile

Hazard Description

Hazardous substances are substances that are considered severely harmful to human health and the environment, as defined by the United States Environmental Protection Agency (USEPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Superfund Law). Many are commonly used substances which are harmless in their normal uses but are quite dangerous if released. The Superfund law designates more than 800 substances as hazardous and identifies many more as potentially hazardous due to their characteristics and the circumstances of their release (USEPA 2013). Superfund's definition of a hazardous substance includes the following:

- Any element, compound, mixture, solution, or substance designated as hazardous under section 102 of CERCLA.
- Any hazardous substance designated under section 311(b)(2)(a) of the Clean Water Act (CWA), or any toxic pollutant listed under section 307(a) of the CWA. There are over 400 substances designated as either hazardous or toxic under the CWA.
- Any hazardous waste having the characteristics identified or listed under section 3001 of the Resource Conservation and Recovery Act.
- Any hazardous air pollutant listed under section 112 of the Clean Air Act, as amended. There are over 200 substances listed as hazardous air pollutants under the Clean Air Act (CAA).
- Any imminently hazardous chemical substance or mixture which the EPA Administrator has "taken action under" section 7 of the Toxic Substances Control Act (USEPA 2013).

If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures and other properties, as well as the environment. Many products containing hazardous substances are used and stored in homes and these products are shipped daily on highways, railroads, waterways, and pipelines.

Location

Hazardous material spills are likely to occur along corridors where high volumes of hazardous materials are transported, or in locations where materials are stored or manufactured. Recent spill incidents in Sugar Land have occurred at roadways, with two incidents reported on Interstate 59. According to the City's Land Use Plans, light industrial uses are predominantly concentrated in the northeast section of the City between Eldridge and Daisy Ashford Roads.

Sugar Land has numerous pipelines for natural gas and petroleum that cross through the City. Two Kinder Morgan natural gas lines run along a north-south utility line near the City's eastern boundary. An additional natural gas and methane line runs north-south in the western section of the City. Additionally, several major roadways and rail lines pass through the City, including Interstate 69, State Highway 6, US-90 Alt, and the Union Pacific rail line. The City has previously identified the adjacency of the Sugar Land Regional Airport to the Union Pacific rail line as a potential transportation-related hazard.

Extent

The extent of a hazardous substance release will depend on whether it is from a fixed or mobile source, the size of impact, the toxicity and properties of the substance, duration of the release, and the environmental conditions (for example, wind and precipitation, terrain, etc.).

Hazardous substance releases can contaminate air, water, and soils, possibly resulting in death and/or injuries. Dispersion can take place rapidly when the hazardous substance is transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Hazardous substances can include toxic chemicals, radioactive substances, infectious substances, and hazardous wastes. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

Previous Occurrences and Losses

Between 1953 and 2020, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of Texas for two terrorism-related events; however, Fort Bend County (where the City of Sugar Land is located within), was not included in either declaration. For the 2021 HMP update, known hazardous material spills that have impacted the City of Sugar Land between 2014 and 2020 are identified in

Table 4-63. Hazardous Material Spill Events in the City of Sugar Land, 2014 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Fort Bend County Designated?	Description
May 13, 2014	Hazardous Material Spill	N/A	N/A	A bird strike caused an engine fire to a plane at the Sugar Land airport. It also caused a fuel leak.
September 12, 2015	Petroleum Spill	N/A	N/A	Driver pumped against a closed valve when loading causing a spill of 35 gallons of crude oil.
July 13, 2016	Spill	N/A	N/A	After a truck left a site, a leak was observed. Appropriate clean up measures were taken.
June 7, 2018	Hazardous Material Spill	N/A	N/A	Two southbound lanes were closed on Highway 59 after an 18-wheeler leaked diesel fuel. The cause of the leak is unknown.
July 26, 2019	Hazardous Material Spill	N/A	N/A	A chemical spill near the intersection of State Highway 6 and U.S. 59 lead to the closure of northbound and southbound lanes. The chemical chemicals included Trimethylbenzene, Methanol, and Acid Phosphate.

Sources: Pipeline and Hazardous Materials Safety Administration 2020; North American Hazmat Situations and Deployments Map 2020

Climate Change Projections

Hazardous material spills are non-natural incidents; therefore, there are no implications for impacts from climate change. Secondary impacts, such as excessive heat on containers may occur, but also can occur during normal fluctuations in temperature.

Probability of Future Occurrences

Predicting future hazardous material spills in the City of Sugar Land is difficult. They can occur at anytime and anywhere in the City. Incidents can be sudden without any warning or slowly develop. Small spills, both fixed site and in-transit, occur throughout the year and the probability for these events are high. The risk of major incidents in a given year is rare.

Based on the recent incident events, the future occurrence of hazardous material spills in the City of Sugar Land can be considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. The following discusses the City of Sugar Land's vulnerability, in a qualitative nature, to the hazardous material spill hazard.

Impact on Life, Health and Safety

Depending on the type and quantity of chemicals released and the weather conditions, an incident can affect larger areas that cross jurisdictional boundaries. When hazardous substances are released in the air, water or on land they may contaminate the environment and pose greater danger to human health. The general population may be exposed to a hazardous substances release through inhalation, ingestion or dermal exposure. Exposure may be either acute or chronic, depending upon the nature of the substance and extent of release and contamination.

For the purposes of this HMP, the entire population in the City of Sugar Land is exposed to hazardous material spill events. Those particularly vulnerable to the effects of hazardous substances incidents are populations located along major transportation routes because of the quantities of chemicals transported on these major thoroughfares. Potential losses from hazardous substances incidences include human health and life and property resources. These types of incidents can lead to injury, illnesses, and/or death from both the involved persons and those living in the impacted areas. Human safety and welfare can become compromised from negative health effects of poisoning or exposure to toxic substances, fires, or explosions.

Impact on General Building Stock

Potential losses to the general building stock caused by a hazardous substance's incident is difficult to quantify. The degree of damages to the general building stock depends on the scale of the incident. Potential losses may include inaccessibility, loss of service, contamination and/or potential structural and content losses if an explosion occurs. The closure of waterways, railroads, airports and highways as a result of a hazardous material spill has the potential to impact the ability to deliver goods and services efficiently. Potential impacts may be local, regional, or statewide depending on the magnitude of the event and level of service disruptions.

Impact on Critical Facilities

Potential losses to critical facilities caused by a hazardous material spill is difficult to quantify. Potential losses may include inaccessibility, loss of service, contamination and/or potential structural and content losses if an explosion occurs. Refer to Section 3 (City Profile) which summarizes the number and type of critical facilities in the City. All critical facilities in the City of Sugar Land are exposed to the hazard.

Impact on Economy

If a significant hazardous material spill occurred, not only would life, safety, and building stock be at risk, but the economy of the City of Sugar Land could be affected as well. A significant incident in an urban area may force businesses to close for an extended period of time because on contamination or direct damage caused by an explosion if one occurred. The exact impact on the economy is difficult to determine, given the uncertain nature of the size and scope of incidents.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 could be potentially impacted by hazardous substances incidents because the entire City is exposed and vulnerable. An increase in development and population has the ability to increase the likelihood of a hazardous substance incident.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to the hazardous material spill hazard as residents move into area and the population exposed increases.

Climate Change

Because a hazardous substance incident is human-caused hazard, no climate change impacts are associated with the hazard.

Changes in Vulnerability Since the 2015 HMP

Overall, the City's vulnerability to hazardous material spills has not changed since the 2015 HMP. The entire City will continue to be exposed and vulnerable to this hazard.

Identified Issues

- Warning time for hazardous material spills is minimal to none; it is uncertain when they will occur.
- Secondary hazards can lead to fire, air quality issues, and impacts to public health.

4.3.18 Energy and Fuel Shortages

This section provides the hazard profile and vulnerability assessment for the energy and fuel shortages hazard for the City of Sugar Land.

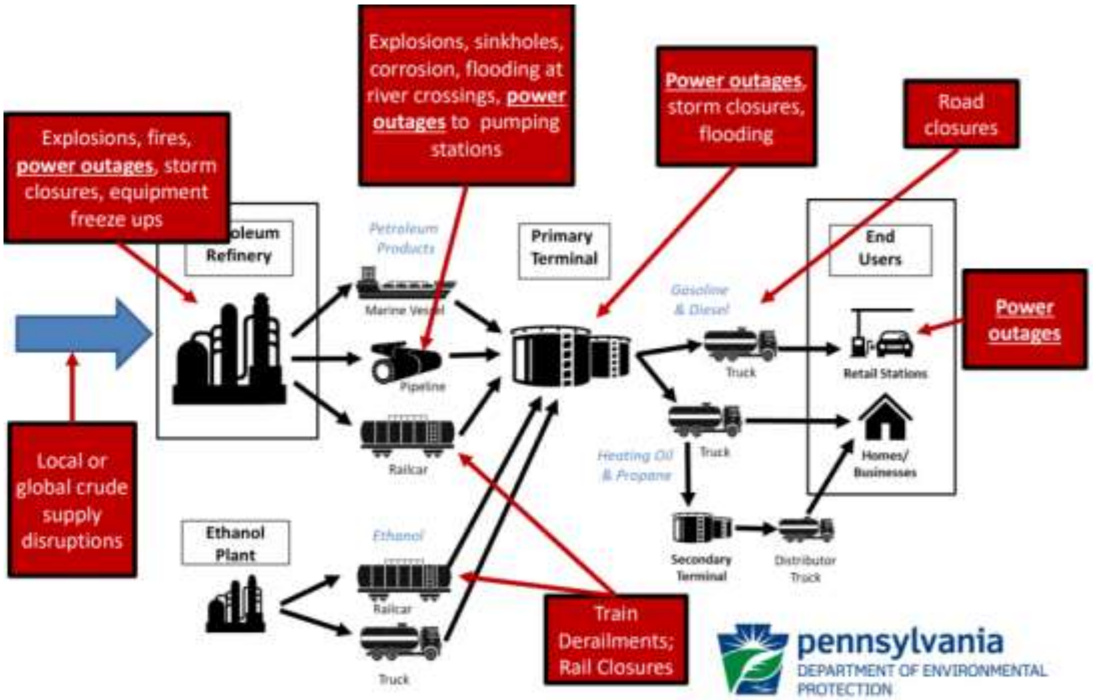
Profile

Hazard Description

Energy and fuels are the widely-used and needed products of a sensitive supply chain product with a significant impact on life and economic activity and great sensitivity to hazardous events on a global scale. On the local level, the transportation of fuel supplies into an area is highly reliant on properly functioning road networks, pipelines, and terminals. Transportation infrastructure is particularly vulnerable to all kinds of hazards, making the distribution of fuel to end users in the wake of hazard events challenging.

The liquid fuels supply chain is vulnerable to a number of different factors. These vulnerabilities are illustrated in the image below. The extraction and delivery of crude product is susceptible to local or global supply disruptions. When the crude is transported to a refinery, it is subject to equipment failures, power outages, fires, and explosions. Transporting refined product exposes the material to hazards inherent in the method of transportation (typically marine vessels, pipelines, and railcars). When fuel arrives at a funeral, it is subject to power outages and is vulnerable to storm events and flooding. Finally, delivery to end users can be hampered by road closures, power outages, and other extenuating circumstances. The supply change relies on a delicate set of independencies between the utilities, transportation, health/medical, water, emergency response, and communications sectors. The supply chain vulnerable to shocks caused by other natural hazards, particularly hurricanes.

Figure 4-35. Disruptions to the Fuel Supply Chain



Source: Pennsylvania Department of Environmental Protection

Extent and Location

The extent of an energy and fuel shortage is dynamic and difficult to anticipate. Some incidents may be local in nature (such as the preparation for Hurricane Harvey) whereas others can occur on a national scale. The type and severity of an event preceding a shortage will determine the shortage's extent. Energy and fuel shortages would likely have pronounced impacts throughout the City owing to the importance of cars and road networks to the City. Major end users of energy products are distributed throughout the City. Fueling stations tend to be located along major roadways, particularly along Interstate 69 and State Highway 6.

Previous Occurrences and Losses

Between 1953 and 2020, FEMA has not issued a disaster (DR) or emergency (EM) declaration for the State of Texas for fuel shortages. For the 2021 HMP update, known energy and fuel shortages that have impacted the City of Sugar Land between 2014 and 2020 are identified in the table below.

Table 4-64. Fuel Shortage Events in the City of Sugar Land, 2014 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Fort Bend County Designated?	Description
Sept 2017	Hurricane	DR-4332	Yes	Refinery shutdowns due to Hurricane Harvey and supply chain disruptions led to rumors of energy shortages in light of increased demand, causing gas lines throughout the region. Harvey brought more than 20% of the country's refining capacity and 50% of ethylene production offline.

Sources: FEMA 2020

Climate Change Projections

Energy and fuel shortages are non-natural incidents. However, climate change will have important implications due to its potential to exacerbate disruptions to the energy supply chain. Texas is anticipated to experience a higher frequency of hotter days and more intense storms. These effects will strain the energy supply chain and aggravate impacts already absorbed by the system.

Probability of Future Occurrences

The unavailability of data and dynamic nature of supply chain disruptions make energy and fuel shortages challenging to predict, particularly on the local level. Given the region's infrastructure and the significant demand for fuel within the City, it is anticipated that fuel shortage events will occur in the City. Based on the recent incident events, the future occurrence of energy and fuel shortages in the City of Sugar Land can be considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. The following discusses the City of Sugar Land's vulnerability, in a qualitative nature, to energy and fuel shortages.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population in the City of Sugar Land is exposed to fuel and energy shortages. Energy and fuel are crucial contributors to the sustainment of human life as it is known today. Fuel and energy shortages disrupt the flow of goods and necessary supplies and can disrupt travel. This has pronounced public safety implications. Though disruptions to energy and fuel services are rare, the pervasiveness of energy and fuel use would magnify the impacts experienced in a shortage. Fuel shortages may impact the provision of first responding services, thereby threatening life safety.

Impact on General Building Stock

Potential losses to the general building stock caused by energy and fuel shortages would likely be limited in terms of physical damages. However, impacts to building value and utility could be significant. Buildings that rely on natural gas for systems (e.g. heating, cooking, and electricity) would be significantly impacted by disruption of energy service, potentially rendering buildings unusable or uninhabitable.

Impact on Critical Facilities

Potential losses to critical facilities caused by energy shortages are not quantifiable with existing data. However, because all critical facilities and lifelines rely on energy to operate, any disruption to energy or fuel services is likely to affect critical facilities and lifelines. Though these facilities would be prioritized for service during a disruption or shortage, limited resources may result in loss of service and utility to critical facilities and diminished utility at those receiving energy service. Critical facilities with generators and alternative sources of power will likely have mitigated impacts.

Impact on Economy

Energy and fuel shortages would have a major impact on the economy of Sugar Land and the region as a whole. A substantial portion of Texas' economy is tied in some way to the energy sector.

Sugar Land residents depend heavily on cars for transportation. As of 2018, just 2.4 percent of households do not have vehicles available. A majority of households (50.1 percent) have two vehicles available. Approximately 91.4 percent of workers in the Sugar Land Combined Census District (or 130,492 workers) commute by car, truck, or van, and there are more than a dozen gas stations within the City limits. Diminished availability of fuel would have significant impacts on residents and could cripple the transportation and distribution network in the City and beyond.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 could be potentially impacted by fuel shortages. Additional growth will likely require additional energy and fuel supplies, thereby increasing the vulnerability to energy and fuel shortages.

Projected Changes in Population

Sugar Land saw population increases between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey (86,886). The population of the City is expected to increase over the next few years. The increase in population will expose more people to the energy and fuel shortage hazard as well as increase demand for fuel shortages. Though the existing infrastructure appears to be keeping pace with growth, population growth will further constrain supply and can exacerbate shortages.

Climate Change

Disruptions to the energy supply chain are anticipated to increase owing to climate change. The increase of severe weather and temperature events can strain existing systems and increase the demand for energy and fuel resources. For example, refineries and material transport will continue to be impacted by flooding events, and multiplicatively impacted by increases in the occurrence and severity of flooding. Extreme temperature events in both heat and cold events will require additional energy resources to keep buildings cool or warm. Evacuations from Sugar Land during hurricanes or other hazard events exacerbated by storms will cause short-term increases of demand that deplete supplies in both the City and surrounding region.

Changes in Vulnerability Since the 2015 HMP

Overall, the City's vulnerability to energy and fuel shortages has not changed since the 2015 HMP. The entire City will continue to be exposed and vulnerable to this hazard.

Identified Issues

- Misinformation about supply disruptions can induce actual short-term, widespread fuel shortages for end-users.
- The energy and fuel supply distribution system is complex, interconnected, and uniquely vulnerable to natural hazards. Natural hazard events occurring far away from Sugar Land can lead to supply disruptions experienced in the City.
- Dependence on fuel and energy for transportation and everyday life increases the vulnerability, which is further exacerbated by growth experienced in the City.
- Secondary hazards can lead to considerable and adverse quality of life, public health, social, and economic effects.

4.3.19 Transportation Accidents

This section provides the hazard profile and vulnerability assessment for the transportation accidents hazard for the City of Sugar Land.

Profile

Hazard Description

The Code of Federal Regulations (CFR) defines an aircraft accident as “an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage”. In the context of commercial motor vehicles, the CFR defines accidents as a fatality, bodily injury to a person who receives medical treatment away from the scene of an accident, or one or more motor vehicles incurring disabling damage as a result of the accident.

The pervasiveness of motor vehicle travel in Sugar Land and throughout the Country makes transportation accidents a frequent and disruptive hazard event. Impacts are multiplied with the volume of traffic experienced in the City. The State of Texas as a whole has the second-most vehicle miles traveled of any State in the Country excepting California and has the highest number of fatal crashes, with 3,305 in 2018 alone. The State has a high number of traffic deaths per 100,000 population and one of the highest numbers of deaths per 100 million vehicle miles traveled.

Aircraft accidents are relatively frequent events, with 1,315 occurring in 2017 alone (almost all of which in the General Aviation Segment). Nearly 16% (211 crashes) of aircraft accidents were fatal, with 347 fatalities reported overall. Though general aviation crashes have declined since 2008 (when more than 1,500 accidents were reported) aircraft accidents remain a regularly-occurring hazard.

Location

Aircraft crashes can occur near the flight path of any aircraft, though statistically takeoff and landing are more dangerous than any other aspect of the flight despite having among the shortest durations of any phases of the flight. One study by Boeing reported that nearly half (49%) of all fatal accidents occur during the final descent and landing phases of a typical flight. These statistics suggest that the most dangerous locations for aircraft accidents are those along the flight path of the take-off/initial climb and final approach/landing phases. In Sugar Land, the areas immediately north and south of the Sugar Land Regional Airport runway in the northwest section of the City are most at risk for aircraft accidents. The City is also located along the flight paths to both William P. Hobby Airport and George Bush Intercontinental Airport.

Motor vehicle crashes occur on surface and elevated roadways, highways, streets, and parking areas. Based on 2019-2020 traffic accident data from the Sugar Land Police Department, traffic accidents occur throughout the City, both on major interstates as well as

Extent

The extent of an automobile or aircraft accident varies based on the size of impact and involved vehicles, the number of passengers in affected vehicles, the duration of the accident and resulting cleanup, and the environmental conditions such as roadway and air conditions.

Aircraft and automobile accidents can contaminate air, water, and soils, possibly resulting in death and/or injuries. Accidents can occur as a result of human carelessness, natural hazards, and equipment failures. When caused by natural hazards, these incidents are known as secondary events. Accidents can affect nearby populations through bystander injuries and can acutely contaminate sensitive environmental areas.

Previous Occurrences and Losses

Between 1953 and 2020, FEMA has issued one disaster (DR) or emergency (EM) declaration for the State of Texas for aircraft crashes; however, Fort Bend County (where the City of Sugar Land is located within), was not included in that declaration (the explosion of the Space Shuttle Columbia in 2003). For the 2021 HMP update, known accidents that have impacted the City of Sugar Land between 2014 and 2020 are identified in the table below.

Table 4-65. Major Transportation Accidents in the City of Sugar Land, 2014 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Fort Bend County Designated?	Description
May 13, 2014	Aircraft Incident (Bird Strike)	N/A	N/A	A Raytheon Aircraft Company 400A lost an engine resulting from a birdstrike upon takeoff at Sugar Land Regional Airport. Debris from the strike punctured the fuel tank, causing fuel spillage on the wing surface and runway. The takeoff was aborted and the airplane safely landed.
July 26, 2016	Aircraft Incident	N/A	N/A	An Embraer EMB-505 experienced a runway excursion upon landing due to potential brake failure. The plane overran the runway and encountered a small creek near Sugar Land Regional Airport.
September 19, 2018	Aircraft Incident	N/A	N/A	An instructional flight on final approach to land at the Sugar Land Regional Airport experienced engine failure. The plane's wing struck a set of power lines and landed on a roadway, striking two vehicles in the process. The crash site was approximately 4,100 feet from the start of the runway. The aircraft was substantially damaged and there was one injury.
December 27, 2018	Aircraft Incident	N/A	N/A	A student pilot failed to maintain directional control of the aircraft, causing a runway excursion and impact with a sign at the Sugar Land Regional Airport.

Sources: National Transportation Safety Board 2020; TXDOT CRIS 2020

The Study examined data from the National Transportation Safety Board (NTSB), which includes investigations if aircraft incidents and other major transportation incidents. No highway accident, railroad, or pipeline incidents were found. However, the lack of reported incidents reflects only those investigated by the NTSB and is not reflective of all incidents. Overall, there have been 40 bird strikes reported between 2014 and May 2021 at the Sugar Land Regional Airport, most of which resulted in no damage (FAA, 2020).

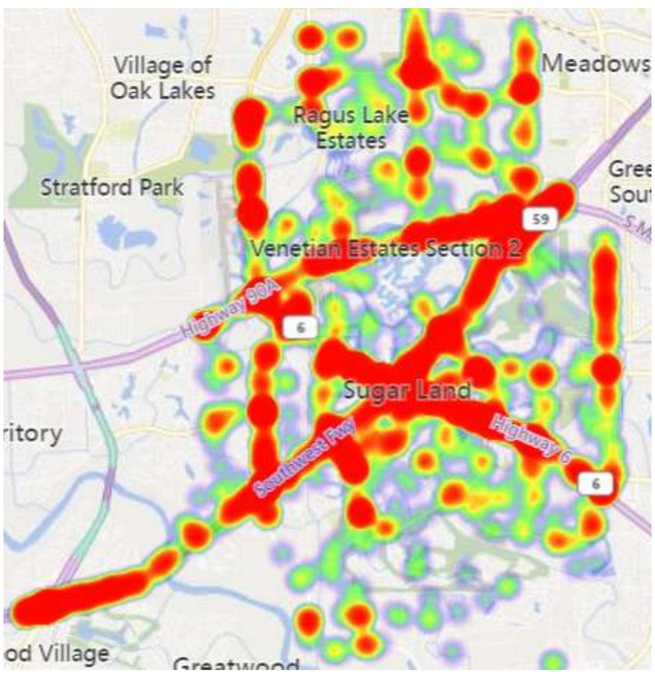
Automobile accidents are frequent occurrences in the City of Sugar Land. Data from the Texas Department of Transportation's Crash Records Information System (CRIS) reports 12,123 crashes in Sugar Land involving 33,142 people between 2014 and May 2021. Between 2018 and May 2021, there were 4,391 car crashes, eight of which involved fatalities.

Table 4-66. Crash Records for the City of Sugar Land.

Crash Severity\Crash Year	2018	2019	2020	Total
99 - UNKNOWN	38	49	17	104
A - SUSPECTED SERIOUS INJURY	36	24	7	67
B - NON-INCAPACITATING INJURY	103	121	41	265
C - POSSIBLE INJURY	303	327	95	725
K - KILLED	2	5	1	8
N - NOT INJURED	1,398	1,352	472	3,222
Total	1,880	1,878	633	4,391

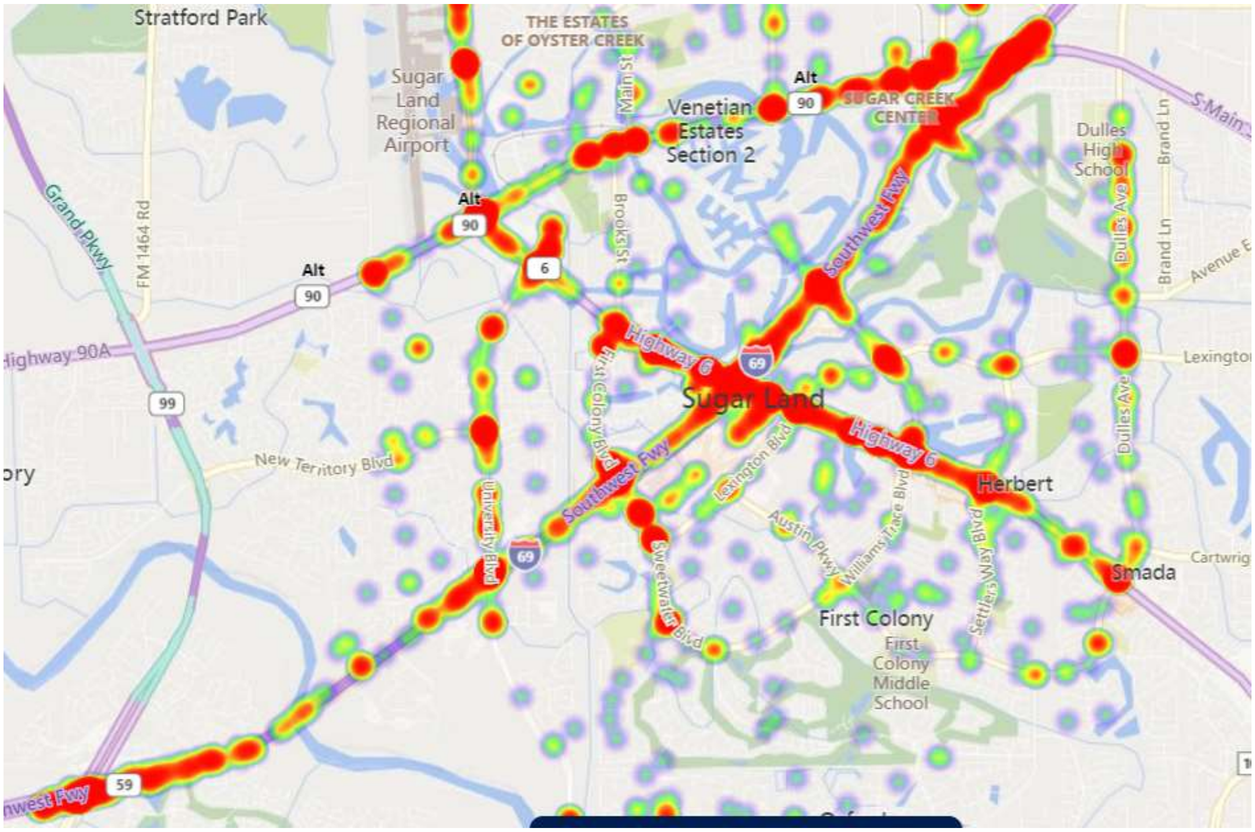
Based on data provided by CRIS shown in the maps below, traffic accidents occur throughout the City of Sugar Land. However, accidents appear to concentrate along the City's major roadways, including Interstate 69 and Highway 6.

Figure 4-36. Automobile Accidents in Sugar Land, 2018-May 2021



Source: CRIS 2020

Figure 4-37. Automobile Accidents in Sugar Land, 2018-May 2021 (Zoomed)



Source: CRIS 2020

Climate Change Projections

Climate change is expected to increase temperatures and the severity of storm events in Texas. Climate change is not anticipated to have direct impacts on aircraft and automobile accidents. However, accidents owing to adverse weather conditions may increase owing to increased frequency or severity of meteorological conditions.

Probability of Future Occurrences

Predicting aircraft and automobile accidents in the City of Sugar Land is difficult but can be modeled or anticipated using reviews of existing accident data and finding trends in accident times, locations, and environmental conditions. Broadly speaking, accidents can occur at anytime and anywhere in the City. Large-scale, mass casualty accidents within the City appear to be a rare occurrence. However, based on the number of crashes in the 2018-2019 calendar year (3,758 accidents in 730 days), an average of five traffic accidents per day can be expected. Based on the four NTSB-investigated aircraft accidents in Sugar Land between 2014 and 2020, it is expected that an aircraft accident can occur once every two years.

Based on the recent incident events, the future occurrence of aircraft and automobile accidents in the City of Sugar Land can be considered *high* (likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. The following discusses the City of Sugar Land's vulnerability, in a qualitative nature, to the aircraft and automobile accident hazard.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population in the City of Sugar Land is exposed to hazardous material transportation accidents. Those particularly vulnerable to the effects of transportation accidents are populations located along major transportation routes and those that frequently use roadways. Potential losses from hazardous substances incidences include human health and life and property resources. Transportation accidents frequently cause injury and more rarely death Human safety and welfare can become compromised from negative health effects of exposure to accidents. Long-term mental health impacts and after-effects from accidents can cause long-term impacts upon involved individuals.

Impact on General Building Stock

Potential losses to the general building stock caused by a traffic accident is not quantifiable with existing datasets. The degree of damages to the general building stock depends on the scale of the accident. Potential losses would accrue due to direct impacts, such as an aircraft striking a building. The closure of transportation networks due to crashes has the potential to disrupt the delivery of goods and services efficiently. Potential impacts may be local, regional, or statewide depending on the magnitude of the event and level of service disruptions.

Impact on Critical Facilities

Potential losses to critical facilities caused by vehicle accidents is difficult to quantify. Potential losses may include direct damage and loss of utility as well as inaccessibility. Refer to Section 3 (City Profile) which summarizes the number and type of critical facilities in the City. All critical facilities in the City of Sugar Land are exposed to the hazard.

Impact on Economy

If a significant traffic or aircraft accident occurred, the economy of the City of Sugar Land could be affected as well due to the disruption of travel in the region. A significant accident in a high-traffic-volume area would cause business disruptions. An accident involving an automobile or aircraft striking a commercial building would cause direct adverse economic impacts. The exact impact on the economy is difficult to determine, given the uncertain nature of the size and scope of accidents.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 could be potentially impacted by traffic accidents due to increased trip generation. Development in the vicinity of the Sugar Land Regional Airport will likely increase exposure to aircraft-related accidents.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase over the next few years. The increase in population will expose more people to traffic accidents as the region grows in population and more vehicles drive on regional roadways.

Climate Change

Because aircraft and automobile accidents are human-caused hazard, no direct climate change impacts are associated with the hazard.

Changes in Vulnerability Since the 2015 HMP

Overall, the City's vulnerability to aircraft and automobile accidents has not changed since the 2015 HMP. The entire City will continue to be exposed and vulnerable to this hazard.

Identified Issues

- The adjacency of the Sugar Land Regional Airport to State Highway 60 and US-90 Alt has been a noted concern of the City owing to the potential for departing and arriving aircraft to overrun the runway and impact the adjacent railway or highways.
- High-volume roadways such as Interstate 69 are major networks that see large numbers of crashes and are critically important for connecting Sugar Land to the region. The potential exists for a high intensity, mass-casualty crash to severely disrupt travel in the region.

4.3.20 Pandemic

This section provides the hazard profile and vulnerability assessment for the pandemic hazard for the City of Sugar Land.

Profile

Hazard Description

An outbreak or an epidemic occurs when new cases of a certain disease, in a given population, substantially exceed what is expected. An epidemic may be restricted to one locale, or it may be global, at which point it is called a pandemic. Pandemic is defined as a disease occurring over a wide geographic area and affecting a high proportion of the population. A pandemic can cause sudden, pervasive illness in all age groups on a local or global scale. A pandemic is a novel virus to which humans have no natural immunity that spreads from person-to-person. A pandemic will cause both widespread and sustained effects and is likely to stress the resources of both the State and federal government (Madhav et al 2017).

West Nile Virus

West Nile Virus (WNV) encephalitis is a mosquito-borne viral disease, which can cause an inflammation of the brain. WNV is commonly found in Africa, West Asia, the Middle East and Europe. West Nile Virus was first reported in Texas in 2002. In a small number of cases, WNV has been spread by blood transfusion, which has resulted in the screening of blood donations for the virus in the US, or by organ transplantation. WNV can also be spread from mother to baby during pregnancy, delivery, or breast-feeding in a small number of cases. The symptoms of severe infection (West Nile encephalitis or meningitis) can include headache, high fever, neck stiffness, muscle weakness, stupor, disorientation, tremors, seizures, paralysis, and coma. WNV can cause serious illness, and in some cases, death. Usually, symptoms occur from 2 to 14 days after being bitten by an infected mosquito (Texas Department of Health).

Influenza

The risk of a global influenza pandemic has increased over the last several years. This disease is capable of claiming thousands of lives and adversely affecting critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; immobilize core infrastructure; and induce fiscal instability.

Pandemic influenza is different from seasonal influenza (or "the flu") because outbreaks of seasonal flu are caused by viruses that are already among people. Pandemic influenza is caused by an influenza virus that is new to people and is likely to affect many more people than seasonal influenza. In addition, seasonal flu occurs every year, usually during the winter season, while the timing of an influenza pandemic is difficult to predict. Pandemic influenza is likely to affect more people than the seasonal flu, including young adults. A severe pandemic could change daily life for a time, including limitations on travel and public gatherings (Barry-Eaton District Health Department 2013).

At the national level, the CDC's Influenza Division has a long history of supporting the World Health Organization (WHO) and its global network of National Influenza Centers (NIC). With limited resources, most international assistance provided in the early years was through hands-on laboratory training of in-country staff, the annual provision of WHO reagent kits (produced and distributed by CDC), and technical consultations for vaccine strain selections. The Influenza Division also conducts epidemiologic research including vaccine studies and serologic assays and provided international outbreak investigation assistance (CDC 2010).

Coronavirus

Coronavirus disease (COVID-19) is an infectious disease first identified in 2019. The virus rapidly spread into a global pandemic by spring of 2020. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness (WHO 2020). With the virus being relatively new, information regarding transmission and symptoms of the virus is still new. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Reported illnesses have ranged from mild symptoms to severe illness and death. Reported symptoms include trouble breathing, persistent pain or pressure in the chest, new confusion or inability to arouse, and bluish lips or face. Symptoms may appear 2-14 days after exposure to the virus (based on the incubation period of MERS-CoV viruses) (CDC 2020)

In an effort to slow the spread of the virus, the federal government and states have urged the public to avoid touching of the face, properly wash hands often, and use various social distancing measures. At the time of this plan update, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments (WHO 2020).

Location

Disease outbreaks can occur without regard for location. However, factors such as density, visitation, and the length of time in which the public spends in a location all contribute to the spread of infectious diseases. For example, the 2019 novel coronavirus (COVID-19) is more likely spread by persons in close contact. Indoor areas in which people are in close contact with each other appear to be significant vectors for the disease, which is spread through respiratory droplets. Infectious diseases spread by insects may be subject to other types of location hazards. For example, the prevalence of standing water can provide breeding grounds for diseases such as West Nile Virus. Diseases that can infect humans are variable in nature and methods of transmission. Ultimately, residents need to be vigilant about diseases altogether in order to better understand and respond to disease outbreak hazards.

Extent

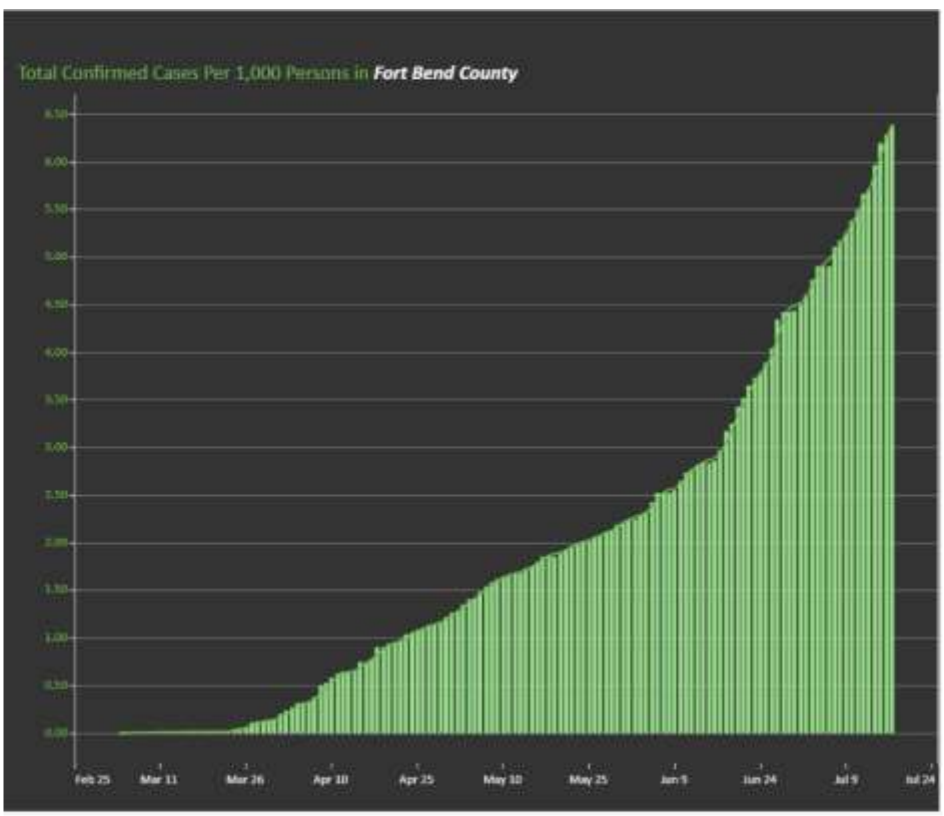
The exact size and extent of an infected population depends on how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more densely populated areas. The transmission rate of infectious diseases will depend on the mode of transmission of a given illness.

Coronavirus

The most recent large-scale pandemic is COVID-19, which is ongoing at the time of this report's publication. As of July 18, 2020, Sugar Land is located at the highest risk level (High Community Risk), which indicates "High potential for exposure to known or suspected sources of COVID-19". Activities involving gatherings are recommended to be avoided, along with all non-essential travel and use of public transportations. Sugar Land has 599 cases, or approximately 11.3 percent of Fort Bend County's total cases (5,284 cases). On a county-wide basis, there have been 67 deaths. Nearly half (45 percent) of cases involve those less than 40 years old.

Texas's first COVID-19 cases were reported on March 6th, 2020. By mid-April, hundreds of new cases were being confirmed each day. Beginning in May, daily new cases in excess of 1,000 were reported, with the number of daily new cases growing near-exponentially beginning in mid-June. The week of July 12th, 2020 saw more than 10,000 new cases reported each day. Daily new fatalities attributed to COVID-19, which had remained somewhat steady between April and late June, started rising considerably in early July, with 174 deaths reported on July 17th, 2020 – an all-time high. Fort Bend's total confirmed cases continues to increase, and is currently nearly 6.5 cases per 1,000 persons. The graph below shows the rate of cases in Fort Bend County through May 2021.

Figure 4-38. COVID-19 Case Rate in Fort Bend County, Texas



Source: Texas Department of State Health Services, 2020

A significant metric of COVID-19 has been hospital bed utilization. Efforts to "flatten the curve" of new reported cases are meant to avoid overwhelming medical systems by heading off hospital over-capacity issues. As of May 2021, COVID-19 cases account for nearly a third of general beds in use and hospital bed use appears to be below capacity in Fort Bend County, Texas.

Figure 4-39. Hospital Census Data, Fort Bend County, Texas

Source: SETRAC

Previous Occurrences and Losses

Between 1953 and 2020, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of Texas for one pandemic-related event. Fort Bend County (where the City of Sugar Land is located within), was included in this declaration for COVID-19. For the 2021 HMP update, known disease outbreaks that have impacted the City of Sugar Land between 2014 and 2020 are identified in the table below. It should be noted that disease outbreak events are typically regional; therefore, the table below includes events that impacted Fort Bend County on a whole.

Table 4-67. Public Health Events in the City of Sugar Land, 2014 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Fort Bend County Designated?	Description
2009-Present	West Nile Virus	None	N/A	Between 2009 and 2018, 25 human cases of West Nile Virus were reported in Fort Bend County. Twelve contracted West Nile Fever, and 13 contracted West Nile Virus disease.
December 2015-June 2017	Zika Virus	None	N/A	Eleven Fort Bend County residents were reported to contract Zika, a mosquito-borne illness. All cases were associated with travel, and none were reported to have been contracted locally. The vast majority of cases in Texas were determined to have not been contracted locally.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Fort Bend County Designated?	Description
March 2020-Present	Novel Coronavirus	DR-4485 EM-3458	Yes	As of July 17, 2020, there are more than 5,300 cases in Fort Bend County and 578 cases in the City of Sugar Land.

Sources: FEMA 2020; Fort Bend County Health and Human Services

Climate Change Projections

Climate change will likely have significant indirect impacts on disease outbreaks. In Texas, higher temperatures, decreased water availability, and more severe storm events are anticipated due to climate change. According to the World Health Organization, changing climatic conditions are being studied for impacts upon disease transmission. Seasonal infectious diseases that are influenced by meteorological conditions may see significant variability in recurrence and duration. The World Health Organization concludes that variations in infectious disease transmission patterns are likely major consequences of climate change.

Probability of Future Occurrences

Though occurrences of disease outbreaks overall are often difficult to predict at the local level, it is anticipated that the City of Sugar Land will continue to be impacted by disease outbreaks for the foreseeable future. Seasonality for cold and flu is well established and anticipated in Texas on an annual basis. The City of Sugar Land has adopted a Disease Control and Response Annex that is implemented by the Sugar Land Health Authority and the City.

Based on the recent incident events, the future occurrence of disease outbreaks in the City of Sugar Land can be considered *high (*likely to occur within 25 years). Refer to Section 4.4 for additional information on the hazard ranking methodology and probability criteria.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. The following discusses Sugar Land's vulnerability, in a qualitative nature, to the disease outbreak hazard.

Impact on Life, Health and Safety

The entire population of the City of Sugar Land is vulnerable to the disease outbreak hazard. Due to a lack of quantifiable loss information, a qualitative assessment was conducted to evaluate the assets exposed to this hazard and the potential impacts associated with this hazard. Healthcare providers and first responders have an increased risk of exposure due to their frequent contact with infected populations. Areas with a higher population density also have an increased risk of exposure or transmission of disease to do the closer proximity of population to potentially infected people.

Most recently with COVID-19, the Centers for Disease Control and Prevention have indicated that persons over 65 years and older, persons living in a nursing home or long-term care facility, and persons with underlying medical conditions such as diabetes, severe obesity, serious heart conditions, etc. are at a higher risk of getting severely ill (CDC 2020). According to the 2018 American Community Survey, 14.5% of Sugar Land residents (or approximately 17,137 people) are over the age of 65. As of July 17, 2020, there are 578 COVID-19 cases in Sugar Land. This represents 10.7 percent of the 5,371 cases in Fort Bend County.

Impact on General Building Stock

No structures are anticipated to be directly affected by disease outbreaks.

Impact on Critical Facilities

No critical facilities are anticipated to be affected by disease outbreaks. Hospitals and medical facilities will likely see an increase in patients, but it is unlikely that there will be damages or interruption of services. However, large rates of infection may result in an increase in the rate of hospitalization which may overwhelm hospitals and medical facilities and lead to decreased services for those seeking medical attention. The 2020 coronavirus pandemic has led to overwhelmed hospitals in numerous hotspots.

Impact on Economy

Disease outbreaks impacts on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with the activities and programs implemented to conduct surveillance and address disease outbreaks have not been quantified in available documentation. As evidenced in the COVID-19 outbreak, quarantines, shutdowns, and social distancing measures can have outsized economic impacts, particularly on the leisure, tourism, and food/accommodations sectors.

Future Changes that May Impact Vulnerability

Understanding future changes that impact vulnerability in the City can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The City 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 could be potentially impacted by the disease outbreak hazard because the entire planning area is exposed and vulnerable. Additional development of structures in close proximity to waterbodies or areas with high population density are at an increased risk.

Projected Changes in Population

The City experienced an increase in population between the 2010 Census (78,817) and the estimated 2013-2017 American Community Survey estimated population of 86,886. The population of the City is expected to increase in the near future. The increase in population will expose more people to the pandemic hazard as residents move into area and the population exposed increases. Population density changes when households move throughout the City could influence the number of persons exposed to disease outbreaks. Higher density jurisdictions are not only at risk of greater exposure to disease outbreak, density may also reduce available basic services provided by critical facilities such as hospitals and emergency facilities for persons that are not affected by a disease.

Climate Change

The relationship between infectious diseases occurrence and climate change is difficult to predict with certainty. However, there may be linkages between the two. Changes in the environment may create a more livable habitat for vectors carrying disease as suggested by the Centers for Disease Control and Prevention (CDC n.d.). Localized changes in climate and human interaction may also be a factor in the spread of disease. For example, in the wake of Hurricane Harvey prolonged and intense precipitation provided breeding grounds for mosquitos that necessitated mosquito control measures.

The relationship between climate change and infectious diseases is not universally agreed upon. Climate change may affect the spread of disease, while others are not convinced. However, research indicates that the only force at work in increasing the spread of infectious diseases into the future. Other factors, such as expanded rapid travel and evolution of resistance to medical treatments, are already changing the ways pathogens infect people, plants, and animals. As climate change accelerates it is likely to work synergistically with many of these factors, especially in populations increasingly subject to massive migration and malnutrition (Harmon 2010).

Changes in Vulnerability Since the 2015 HMP

Disease outbreak is a new hazard profile for the 2021 HMP update. The occurrence and prevalence of COVID-19 in the City underscores the need to address disease outbreak as part of the hazard mitigation planning process.

Identified Issues

- The COVID-19 pandemic revealed that social distancing and quarantine had unprecedented impacts on public gatherings, shopping and activities. This caused significant, unanticipated impacts on economic and social activity, as well as government. The need to adjust operations to account for social distancing has been identified.
- Secondary hazards can lead to long term physical and mental health impacts.
- Standing water that results from rainstorms and hurricanes can serve as breeding grounds for mosquitos that carry diseases such as West Nile Virus.

4.4 RISK RANKING

FEMA requires all hazard mitigation planning partners to have jurisdiction-specific mitigation actions based on local risk, vulnerability, and community priorities. This plan includes a risk ranking protocol for the City of Sugar Land, in which ‘risk’ was calculated by multiplying probability by impact on people, property, and the economy.

Numerical ratings of probability and impact were used based on the hazard profiles and vulnerability assessments in Section 4.3. Using that data, the city ranked the risk of all the hazards of concern included in the plan update. When available, estimates of risk were generated with data from HAZUS or GIS. For hazards of concern with less specific data available, qualitative assessments were used. As appropriate, results were adjusted based on local knowledge and other information not captured in the quantitative assessments.

Risk ranking results are used to help establish mitigation priorities. The City used its risk ranking to inform the development of its action plan. The City was directed to identify mitigation actions, at a minimum, to address each hazard with a “high” or “medium” risk ranking. Actions that address hazards with a low or no hazard ranking are optional.

4.4.1 Probability of Occurrence

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is based on past hazard events in the area and the potential for changes in the frequency of these events resulting from climate change. Table 4-68 summarizes the probability assessment for each natural hazard of concern for this plan.

Table 4-68. Probability of Hazards

Hazard Type	Probability (high, medium, low, none)	Probability Factor
Dam and Levee	None (dam), Low (levee)	1
Drought	High	3
Earthquake - 500 yr	None	0
Energy Shortage	Low	1
Erosion	Medium	2
Expansive Soil	None	0
Extreme Temperatures	High	3
Flood - 100 yr	Medium	2
Flood - 500 yr	Medium	2
Flood - Harvey	Medium	2
Hail	High	3
Hazmat Spill	High	3
Hurricane - 100 yr	Medium	2
Hurricane - 20 yr	Medium	2
Hurricane - 500 yr	Medium	2
Land Subsidence	None	0
Lightning	High	3
Pandemic	High	3
Severe Storm (Thunderstorm Wind)	High	3
Severe Winter Storm	Low	1
Terrorism	Low	1
Tornadoes	High	3
Transportation	High	3
Wildfire	None	0

4.4.2 Impact

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1. Table 4-69 through Table 4-71 summarize the impacts for each hazard.

Table 4-69. Impact on People from Hazards

Hazard Type	Impact (high, medium, low, none)	Impact Factor	Multiplied by Weighting Factor (3)
Levee	H	3	3 x 3 = 9
Dam	N	0	0 x 3 = 0
Drought	H	3	3 x 3 = 9
Earthquake - 500 yr	N	0	0 x 3 = 0
Energy Shortage	H	3	3 x 3 = 9
Erosion	M	2	2 x 3 = 6
Expansive Soil	N	0	0 x 3 = 0
Extreme Temperatures	H	3	3 x 3 = 9
Flood - 100 yr	L	1	1 x 3 = 3
Flood - 500 yr	L	1	1 x 3 = 3
Flood - Harvey	H	3	3 x 3 = 9
Hail	H	3	3 x 3 = 9
Hazmat Spill	H	3	3 x 3 = 9
Hurricane - 100 yr	H	3	3 x 3 = 9

Hazard Type	Impact (high, medium, low, none)	Impact Factor	Multiplied by Weighting Factor (3)
Hurricane - 20 yr	H	3	3 x 3 = 9
Hurricane - 500 yr	H	3	3 x 3 = 9
Land Subsidence	N	0	0 x 3 = 0
Lightning	H	3	3 x 3 = 9
Pandemic	H	3	3 x 3 = 9
Severe Storm (Thunderstorm Wind)	H	3	3 x 3 = 9
Severe Winter Storm	H	3	3 x 3 = 9
Terrorism	H	3	3 x 3 = 9
Tornadoes	H	3	3 x 3 = 9
Transportation	H	3	3 x 3 = 9
Wildfire	N	0	0 x 3 = 0

Table 4-70. Impact on Property from Hazards

Hazard Type	Impact (high, medium, low, none)	Impact Factor	Multiplied by Weighting Factor (2)
Dam	N	0	0 x 2 = 0
Levee	H	3	3 x 2 = 6
Drought	H	3	3 x 2 = 6
Earthquake - 500 yr	N	0	0 x 2 = 0
Energy Shortage	H	3	3 x 2 = 6
Erosion	H	3	3 x 2 = 6
Expansive Soil	N	0	0 x 2 = 0
Extreme Temperatures	H	3	3 x 2 = 6
Flood - 100 yr	L	1	1 x 2 = 2
Flood - 500 yr	L	1	1 x 2 = 2
Flood - Harvey	H	3	3 x 2 = 6
Hail	H	3	3 x 2 = 6
Hazmat Spill	H	3	3 x 2 = 6
Hurricane - 100 yr	H	3	3 x 2 = 6
Hurricane - 20 yr	H	3	3 x 2 = 6
Hurricane - 500 yr	H	3	3 x 2 = 6
Land Subsidence	N	0	0 x 2 = 0
Lightning	H	3	3 x 2 = 6
Pandemic	H	3	3 x 2 = 6
Severe Storm (Thunderstorm Wind)	H	3	3 x 2 = 6
Severe Winter Storm	H	3	3 x 2 = 6
Terrorism	H	3	3 x 2 = 6
Tornadoes	H	3	3 x 2 = 6
Transportation	L	1	1 x 2 = 2
Wildfire	N	0	0 x 2 = 0

Table 4-71. Impact on Economy from Hazards

Hazard Type	Impact (high, medium, low, none)	Impact Factor	Multiplied by Weighting Factor (1)
Dam	N	0	0 x 1 = 0
Levee	H	3	3 x 1 = 3
Drought	H	3	3 x 1 = 3
Earthquake - 500 yr	N	0	0 x 1 = 0

Hazard Type	Impact (high, medium, low, none)	Impact Factor	Multiplied by Weighting Factor (1)
Energy Shortage	H	3	3 x 1 = 3
Erosion	H	3	3 x 1 = 3
Expansive Soil	N	0	0 x 1 = 0
Extreme Temperatures	H	3	3 x 1 = 3
Flood - 100 yr	L	1	1 x 1 = 1
Flood - 500 yr	L	1	1 x 1 = 1
Flood - Harvey	M	2	2 x 1 = 2
Hail	H	3	3 x 1 = 3
Hazmat Spill	H	3	3 x 1 = 3
Hurricane - 100 yr	L	1	1 x 1 = 1
Hurricane - 20 yr	L	1	1 x 1 = 1
Hurricane - 500 yr	M	2	2 x 1 = 2
Land Subsidence	N	0	0 x 1 = 0
Lightning	H	3	3 x 1 = 3
Pandemic	H	3	3 x 1 = 3
Severe Storm (Thunderstorm Wind)	H	3	3 x 1 = 3
Severe Winter Storm	H	3	3 x 1 = 3
Terrorism	H	3	3 x 1 = 3
Tornadoes	H	3	3 x 1 = 3
Transportation	M	2	2 x 1 = 3
Wildfire	N	0	0 x 1 = 0

Numerical impact factors were assigned as follows:

People

Values were assigned based on the percentage of the total population exposed to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:

- High—25 percent or more of the population is exposed to a hazard (Impact Factor = 3)
- Medium—10 percent to 25 percent of the population is exposed to a hazard (Impact Factor = 2)
- Low—10 percent or less of the population is exposed to the hazard (Impact Factor = 1)
- No impact—None of the population is exposed to a hazard (Impact Factor = 0)

Property

Values were assigned based on the percentage of the total property value exposed to the hazard event:

- High—25 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
- Medium—10 percent to 25 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
- Low—10 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
- No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)

Economy

Values were assigned based on the percentage of the total property value vulnerable to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total replacement value of the property exposed to the hazard. Loss estimates separate from the exposure estimates were generated for the earthquake, flooding, and tsunami hazards using Hazus. For other hazards, such as dam failure, landslide and wildfire, vulnerability was estimated as a percentage of exposure, due to the lack of loss estimation tools specific to those hazards.

- High—Estimated loss from the hazard is 10 percent or more of the total exposed property value (Impact Factor = 3)
- Medium—Estimated loss from the hazard is 5 percent to 10 percent of the total exposed property value (Impact Factor = 2)
- Low—Estimated loss from the hazard is 5 percent or less of the total exposed property value (Impact Factor = 1)
- No impact—No loss is estimated from the hazard (Impact Factor = 0)

4.4.3 Risk Rating and Ranking

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors, as summarized in Table 4-72. Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards of highest concern are severe storm, tornadoes, lightning, extreme temperature, hail, drought, hazardous materials, energy shortage, transportation, pandemic, severe winter storm, erosion, flood, and hurricane. Hazards ranked as being of medium concern are dam/levee failure, land subsidence, expansive soil, wildfire, terrorism, and earthquake. Table 4-73 shows the hazard risk ranking for the planning area.

Table 4-72. Hazard Risk Rating

Hazard Type	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam	0	0 + 0 + 0 = 0	0
Levee	1	9 + 6 + 3 = 18	18
Drought	3	9 + 6 + 3 = 18	18
Earthquake - 500 yr	0	0 + 0 + 0 = 0	0
Energy Shortage	1	9 + 6 + 3 = 18	18
Erosion	2	6 + 6 + 3 = 15	15
Expansive Soil	0	0 + 0 + 0 = 0	0
Extreme Temperatures	3	9 + 6 + 3 = 18	18
Flood - 100 yr	2	3 + 2 + 1 = 6	6
Flood - 500 yr	2	3 + 2 + 1 = 6	6
Flood - Harvey	2	9 + 6 + 2 = 17	17
Hail	3	9 + 6 + 3 = 18	18
Hazmat Spill	3	9 + 6 + 3 = 18	18
Hurricane - 100 yr	2	9 + 6 + 1 = 16	16
Hurricane - 20 yr	2	9 + 6 + 1 = 16	16
Hurricane - 500 yr	2	9 + 6 + 2 = 17	17
Land Subsidence	0	0 + 0 + 0 = 0	0
Lightning	3	9 + 6 + 3 = 18	18
Pandemic	3	9 + 6 + 3 = 18	18
Severe Storm (Thunderstorm Wind)	3	9 + 6 + 3 = 18	18
Severe Winter Storm	1	9 + 6 + 3 = 18	18
Terrorism	1	9 + 6 + 3 = 18	18

Hazard Type	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Tornadoes	3	9 + 6 + 3 = 18	18
Transportation	3	9 + 2 + 3 = 14	13
Wildfire	0	0 + 0 + 0 = 0	0

Table 4-73. Hazard Risk Ranking

Hazard Event	Category*
Drought	High
Extreme Temperatures	High
Hail	High
Hazmat Spill	High
Lightning	High
Pandemic	High
Thunderstorm Wind	High
Tornadoes	High
Transportation	High
Flood - Harvey	High
Hurricane - 500 yr	High
Hurricane - 100 yr	High
Hurricane - 20 yr	High
Erosion	Medium
Dam and Levee	Medium
Energy Shortage	Medium
Severe Winter Storm	Medium
Terrorism	Medium
Flood - 100 yr	Low
Flood - 500 yr	Low
Earthquake - 500 yr	No Risk
Expansive Soil	No Risk
Land Subsidence	No Risk
Wildfire	No Risk

** Scores of 30 or greater are rated as "high," scores of 15 to 29 are "medium," scores of 1 to 15 are "low", and scores of 0 are "no risk"*

SECTION 5. CAPABILITY ASSESSMENT

According to FEMA's *Mitigation Planning How-To Guide #3*, a capability assessment is an inventory of a community's missions, programs, and policies and an analysis of its capacity to carry them out. Each jurisdiction has a unique set of capabilities available to accomplish mitigation and reduce long-term vulnerability to future hazard events. Capabilities include authorities, policies, programs, staff, and funding. Reviewing existing capabilities helps identify capabilities that currently implement mitigation and leads to loss reductions or that have the potential to be implemented in the future.

This assessment is an integral part of the planning process. The assessment process enables identification, review, and analysis of current federal, state, and local programs, policies, regulations, funding, and practices that could either facilitate or hinder mitigation.

During the original planning process, the City of Sugar Land identified and assessed their capabilities in the areas of existing programs, policies, and technical documents. By completing this assessment, each jurisdiction learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Limitations that could exist on undertaking actions.
- The range of local and state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing their mitigation actions.
- Actions deemed infeasible, as they are currently outside the scope of capabilities.
- Types of mitigation actions that could be technically, legally (regulatory), administratively, politically, or fiscally challenging or infeasible.
- Opportunities to enhance local capabilities to support long term mitigation and risk reduction.

During the plan update process, the City was tasked with developing or updating their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities to integrate hazard mitigation into their plans, programs, and day-to-day operations.

5.1 UPDATE PROCESS SUMMARY

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of a jurisdiction's codes, programs and policies, and evaluates its capacity to carry them out. It presents a toolkit for implementing the hazard mitigation plan and for identifying opportunities to increase the City's core capabilities to support mitigation actions. The assessment identifies potential gaps in core capabilities. Filling those gaps may eventually become mitigation actions in the plan. Assessment findings were shared with City departments as they developed the recommended mitigation actions. If a department identified an opportunity to add or expand a capability, then doing so has been identified as a mitigation action. The City views each core capability to be fully adaptable as needed to meet the best interests of the City. This adaptability is an overarching City capability that is acknowledged by this reference.

Some level of integration has already been established between local hazard mitigation planning and the following other local plans and programs. As a part of the update process the planning team identified how the

City of Sugar Land's 2015 Hazard Mitigation Plan was integrated with existing capabilities. The previous 2015 HMP was incorporated into the following plans:

- Master Drainage Plan – included flood mitigation actions from the 2015 HMP, including the design and construction of a detention Basin in Covington Woods to reduce storms events in Covington Woods; and reinforced concrete boxes south of Longview Drive to divert flow to East Sugar Creek to reduce back water. Inc. Additionally, the Master Drainage Plan incorporated projects to mitigate the consequences of Dam and Levee failure identified in the 2015 plan including a retrofit project for Dam # 23 to safety pass 75% of the Probable Maximum Flood.
- Floodplain Management Plan – identified and addressed potential flood risk at specific locations and event occurrences in accordance with Goal 7 of the 2015 HMP; involved the coordination with Levee Districts, Fort Bend County Engineering and Drainage District are detailed in accordance with Goal 9 of the 2015 HMP; and engaged public information tools through the implementation Plan of the Flood Management Plan in accordance with Goal 10 of the 2015 HMP.
- Community Rating System – By participating in the CRS program, the City meets Goal 4 of the 2015 HMP to utilize Federal flood prevention programs to ensure reduce vulnerability to flooding; additionally the 2015 HMP shows the definitions and delineations of the watersheds in the area per CRS requirements, activity 510; as well as information about dams and flood risks due to the failure of dams in the city per CRS requirements for activity 630.
- Capital Improvements Plan – included flood mitigation actions from the 2015 HMP, including the design and construction of a detention Basin in Covington Woods to reduce storms events in Covington Woods; and reinforced concrete boxes south of Longview Drive to divert flow to East Sugar Creek to reduce back water. Inc. Additionally, the Master Drainage Plan incorporated projects to mitigate the consequences of Dam and Levee failure identified in the 2015 plan including a retrofit project for Dam # 23 to safety pass 75% of the Probable Maximum Flood.

Additional information regarding existing and future opportunities for integration can be found in Tables 5-1 through 5-8.

An assessment of legal and regulatory capabilities is presented in Table 5-1. The column labeled "Integration Opportunity" in this table identifies capabilities that can support or be supported by components of this plan. Where "yes" is indicated in this column, the City has considered actions to integrate these capabilities with the plan.

Development and permitting capabilities are presented in Table 5-2. An assessment of administrative and technical capabilities is presented in Table 5-3. An assessment of fiscal capabilities is presented in Table 5-4. An assessment of education and outreach capabilities is presented in Table 5-5. Classifications under various community mitigation programs are presented in Table 5-6. Information on NFIP compliance is presented in Table 5-7. The community's adaptive capacity for the impacts of climate change is presented in Table 5-8.

5.2 PLANNING, LEGAL, AND REGULATORY CAPABILITY

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws and state statutes, and plans and programs that relate to guiding and management growth and development. Planning and regulatory capabilities refer not only to the current plans and regulations, but also to the jurisdiction's ability to change and improve those plans and regulations as needed. The following provides the planning and regulatory capabilities for the City.

Table 5-1. Planning, Legal, and Regulatory Capability

		Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances & Requirements					
Building Code		Yes	No	Yes	Yes
Comment:	City of Sugar Land, Texas Land Development Code, Chapter 7 – Building Regulations amended by Ordinance No. 2027, effective 9/2015, which adopted by reference the 2015 International Codes and 2014 National Electrical Code. ***Integration Opportunity:*** The building code could be updated to the 2018 International Code standards in the near future.				
Zoning Code		Yes	No	No	Yes
Comment:	City of Sugar Land, Texas Land Development Code, Chapter 2 – Zoning Regulations; amended by Ordinance No. 2149, effective 10/2018. ***Integration Opportunity:*** Sugar Land is adopting the Atlas 14 rainfall frequency estimates for Texas. This will result in modifications to the city's Development Code and Design Standards. Expected changes include higher finish floor elevations and new road standards.				
Subdivisions		Yes	No	No	Yes
Comment:	City of Sugar Land, Texas Land Development Code, Chapter 5 – Subdivision Regulations; Ordinance No. 2014, effective 7-21-15. Article V Section 5-36 provides design standards to mitigate flood damage to buildings through the subdivision review process. ***Integration Opportunity:*** Sugar Land recently adopted the Atlas 14 rainfall frequency estimates for Texas. This will result in modifications to the city-adopted guidelines for the review of requests to alter or develop new property within the city. Recent changes include new drainage standards and design standards that elevate buildings 2' above the 500-year floodplain.				
Stormwater Management		Yes	Yes	Yes	Yes
Comment:	City of Sugar Land, Texas Land Development Code, Chapter 11 – Stormwater Quality Management and Discharge Control; Ordinance No. 1788 effective 8/2010 and Ordinance No. 2037 effective 12/2015; City of Sugarland Stormwater Management Program 3/2018; City of Sugar Land Master Drainage Plan 2014 adopted by Ordinance No. 1977 effective 11/2014. ***Integration Opportunity:*** City-owned facilities constructed under this code may be eligible for FEMA Hazard Mitigation Assistance grants. Future updates to this plan should consider eligible stormwater management activities as potential actions. Sugar Land is adopting the Atlas 14 rainfall frequency estimates for Texas. This will result in modifications to the city's guidance for the review of requests to alter or develop new property within the city. Expected changes include new drainage standards.				
Post-Disaster Recovery		No	No	Yes	No
Comment:	Chapter 8- Flood Damage Reduction Regulations; Ordinance No. 1979, effective 12-2-14 and Ordinance No. 2151 effective 4-2-19 addresses multiple methods of reducing flood loss including establishing areas of special flood hazard, levee standards, and control over the alteration of natural floodplains. Article III- Emergency Management; Ordinance No. 1371 effective 10-1-02 and Ordinance No. 1577 effective 8-1-06 authorizes the mayor to declare a local disaster. Texas Disaster Act of 1975 effective 9-1-87 established State Level Government Code 4.b.414.a, which includes emergency management provisions including sections on disaster mitigation, preparedness, response and recovery. At the State Level also see Government Code chapters 418 (Emergency Management), 421 (Homeland Security), 433 (State of Emergency), 791 (Inter-local Cooperation Contracts), 778 (Emergency Management Assistance Compact), Executive Order of the Governor Relating to Emergency Management, Administrative Code, Title 37, Part 1, Chapter 7 (Division of Emergency Management), State of Texas Emergency Management Plan. At the Federal level see Robert T. Stafford Disaster Relief & Emergency Assistance Act 42 U.S.C. 5121				
Real Estate Disclosure		No	No	Yes	No
Comment:	Texas Property Code Section 5.008, effective 1/1994 Requires property sellers to disclose flooding, water damage and insurance claims due to flooding, and location within a floodplain, floodway, flood pool or reservoir, and history of FEMA assistance.				
Growth Management		No	No	No	No

		Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Comment:	City of Sugar Land, Texas Land Development Code, Article III Zoning Districts and Land Uses; Ordinance No. 2149 effective 2-19-19 stipulates allowable lot size, coverage, density and dimensional standards per zone, which effectively control type and volume of growth in the City.				
Site Plan Review		Yes	No	No	Yes
Comment:	City of Sugar Land, Texas Land Development Code, Chapter 2 – Zoning Regulations Article 1 Part 1 Section 2-7 Development Review Committee ***Integration Opportunity:*** Multimodal connections are recommended by Comprehensive Plan to be required in site plans as a tool to limit the amount of automobile traffic and thereby limit amount of greenhouse gas emissions produced within the City of Sugar Land.				
Environmental Protection		Yes	Yes	Yes	No
Comment:	The code does not broadly address environmental protection outside of the code sections already mentioned in this assessment. There are additional regional environmental legal and regulatory requirements through EPA Region 6 and Texas Commission on Environmental Quality ***Integration Opportunity:*** Recommended projects from this HMP must comply with the environmental regulations.				
Emergency Management		Yes	No	Yes	No
Comment:	City of Sugar Land, Texas Code of Ordinances Chapter 3 Article III- Emergency Management enacted by Ordinance 1371 10/2002 and Ordinance 1577 8/2006 grants the City Manager authority to appoint one or more persons to administer the city's emergency management plan (required by state law) and stipulates duties. ***Integration Opportunity:*** The City of Sugar Land Emergency Management Division is an integral part of the multi-agency emergency operations organization described in the Emergency Management Plan and is the lead department for developing this hazard mitigation plan.				
Climate Change		No	No	No	No
Comment:	The City does not have a climate change ordinance.				
Planning Documents					
General Plan (Comprehensive Plan)		Yes	No	No	Yes
Comment:	Consists of a framework last adopted in 2012 and 11 citywide elements. Related goals in the Comprehensive Plan focus on safety, hazard preparation and post-disaster recovery, water quality, and stormwater management/drainage to enhance quality of surface water and protect neighborhoods. Specific hazards referenced in the plan include dwindling groundwater resources and plans to diversify drinking water sources in the near future, as well as flooding along Brazos River, Oyster Creek, and Ditch "H" (Bullhead Slough). Nine levee improvement districts (LIDs) exist in Sugar Land provide flood protection and storm water management services. ***Integration Opportunity:*** Based on directives from the plan's Goal A: Safe Community Objective 5, the City will fully integrate this mitigation plan by preparing for all hazards, disaster and post disaster recovery including coordination with local, regional and state resources. The City has secured contracts to shift from ground water to surface water through the Plan's Groundwater Reduction strategy, thereby reducing hazards associated with drought.				
Capital Improvement Plan		Yes	No	No	Yes
Capital facilities the plan addresses:	Recent capital improvement program projects that relate to hazard mitigation include Oyster Creek Maintenance Bridge Replacement, US90A Drainage improvement for Airport Taxiway, Covington Woods Drainage Improvements – Jess Pirtle Side Streets, Covington Woods Drainage Improvements – Sugar Land MS/Sugar Mill, Outfall Structure Improvements with FBC LID No. 2, Riverbend Weir Structure Modifications at Dulles Ave., Riverbend Inlets and Pipes Replacement (2019 GO), Settlers Park Drainage Improvements, Emergency Generators, Emergency Operations Center/Public Safety Dispatch Building (2019 GO), Brazos River Park PH II (Mid-Lake), Wastewater Treatment Plants Improvements, Lift Station Assessment, Oyster Creek Siphon Replacement, Easement Acquisition - FM from North WWTP to West WWTP, Lift Station Rehabilitation, Utility Security - PH III, Distribution System Water Main Rehabilitation Program, Well Rehabilitation, Distribution System Water Main Rehabilitation Program, Ground Storage Tank Rehabilitation, Ground Water Plant Rehabilitation, SH99 and US90A Waterline Relocation and other Capital Improvement Program Projects.				
Comment:	City of Sugar Land Capital Improvement Program has estimated prior funding of $61.5 million worth of projects completed through 2019. New funding ($263.8 million) for projects are on schedule to be				

		Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
	completed by 2024. Future projects are categorized by project type: airport, drainage, municipal, parks, streets, surface water, traffic, wastewater, and water. Specific project types that relate to hazard mitigation include drainage improvements, emergency generators and other emergency equipment, and surface water conversion infrastructure. ***Integration Opportunity:*** This integration is ongoing. In the development of the action plan for this planning process, the City reviewed its capital improvement plan to identify actions that are eligible for FEMA grant funding. All future revisions to the City's capital improvement plans will look to this plan to potentially leverage FEMA grant funding for implementation.				
Floodplain Management Plan		Yes	Yes	Yes	Yes
Comment:	City of Sugar Land Flood Management Plan works with Levee Improvement Districts (LID) located within the city and neighboring communities to improve flood response capabilities. The document includes response and operation plans for flooding events, identifying areas of concern, identifying critical river elevations, and utilizing the National Management System (NIMS). Within the NIMS System, the City of Sugar Land enforces their own incident command system (ICS) for each LID, so that in an event of flooding, the City can work to return normal operating conditions and preserve property and business operations. When the Brazos River United States Geological Survey (USGS) Richmond gauge is at 48 feet or above, patrolling of levees commences and continues throughout the course of flood events. ***Integration Opportunity:*** Integration is ongoing. Throughout the course of flood events, the City of Sugar Land Public Works and Engineering provides local organization, operations, responsibilities, and procedures to coordinate activities during flooding events. They take actions to protect government facilities, equipment, and supplies prior to the onset of hazardous conditions for slowly developing emergency situations.				
Stormwater Plan (Master Drainage Plan)		Yes	No	Yes	Yes
Comment:	The 2015 Master Drainage Plan (MDP) is one of the City's eight official master plans and is a component of the Comprehensive Plan. The Master Drainage Plan identifies a work plan to achieve drainage-related goals and objectives identified in the Comprehensive Plan. Projects are prioritized by annual, high priority (1-2 years), medium priority (3-5 years), and low priority (6-10 years). ***Integration Opportunity:*** A Capital Improvement Program for drainage projects consists of a collection of projects proposed for implementation to address drainage and flood control problems. Some remaining projects could be identified for FEMA grant funding.				
Habitat Conservation Plan (Gulf-Houston Regional Conservation Plan)		No	No	No	Yes
Comment:	The City of Sugar Land currently has no habitat conservation plan of its own, however the Gulf-Houston Regional Conservation Plan (Gulf-Houston RCP) is a long-term collaborative of environmental, business, and governmental entities working together to implement an ecosystem resilience plan for the Eight-County Gulf-Houston region: Brazoria, Chambers, Galveston, Fort Bend, Harris, Liberty, Montgomery and Waller Counties. Regional conservation zones are demarcated; the City of Sugar Land is within the Bayou/Riparian Zone and features upland and bottomland forests and prairies as landscape features of regional significance. The plan recommends a habitat restoration project led by the City of Sugar Land and the Cullinan Park Conservancy as a way to improve water quality, enhance recreational opportunities, and reduce nutrient loads in the Brazos River watershed. It is not yet fully funded. ***Integration Opportunity:*** This integration is ongoing. All future revisions to the habitat conservation plan should look to this hazard mitigation plan to potentially leverage grant funding for implementation.				
Economic Development Plan		Yes	No	No	Yes
Comment:	The 2011 Economic Development Plan 5-Year Strategic Road Map serves to strengthen Sugar Land as a business center of excellence through the attraction and expansion of targeted businesses that provide high quality jobs for residents. ***Integration Opportunity:*** This integration is ongoing. All future revisions to the City's economic development plans should look to this hazard mitigation plan to potentially leverage grant funding for implementation. Tourism funds are used within the Capital Improvement plan towards projects that may also relate to hazard areas, such as recreational trails.				
Community Wildfire Protection Plan (Texas Wildfire Protection Plan)		No	Yes	Yes	Yes

		Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Comment:	The City of Sugar Land does not have a local Wildfire Protection Plan (WPP), however, the State WPP addresses generalized fire response issues for regions across the state. Key fire response concerns in the Houston region, which includes the City of Sugar Land, include its forested terrain and dense population centers. ***Integration Opportunity:*** This integration is ongoing. Wildfires are not a high risk for the City of Sugar Land, however, if the City decides to develop a local WPP, it should be integrated with the Hazard Mitigation Plan.				
Transportation Plan (2012 Master Thoroughfare Plan Update)		Yes	Yes	No	Yes
Comment:	The Thoroughfare Plan identifies an ultimate roadway network to accommodate future growth and expansion of the City and its extraterritorial jurisdiction (ETJ). The Major Roadway Plan map is a component of the Thoroughfare Master Plan and identifies all existing and future roadways within the City. The Thoroughfare Plan identifies an ultimate roadway network to accommodate future growth and expansion of the City and its ETJ. As a separate but concurrent effort to the update, analyses and recommendations of implementing Complete Streets policies are included. ***Integration Opportunity:*** Future transportation planning should consider updates or changes to ponding maps or other changes to development guidelines due to the Atlas 14 forecasting.				
Response/Recovery Planning					
Emergency Operations Plan (Basic Plan)		Yes	Yes	Yes	Yes
Comment:	In partnership with the Texas Division of Emergency Management, the Emergency Operations Plan provides general guidance for Emergency Management activities and an overview of methods of mitigation, preparedness, response, and recovery. This plan describes emergency response organization and assigns responsibilities for various emergency tasks. This plan is intended to provide a framework for more specific functional responses. This plan applies to all local officials, departments, and agencies. ***Integration Opportunity:*** Integration is ongoing. Risk and vulnerability information in the hazard mitigation plan can inform future updates to the Emergency Operation Plan.				
Emergency Action Plans for Levee Improvement Districts (LID)		Yes	Yes	Yes	Yes
Comment:	The purpose of LID Emergency Action Plans generally is to describe the field operations to be undertaken by LID personnel and consultants during events outside of the normal operational parameters of the LIDs' Operations and Maintenance (O&M) manuals. The plans identify emergency situations and present plans for expedited responses to prevent the failure of levees and warn residents within the levee and surrounding areas of impending dangers. The plans also contain communication plans and definitions of roles for coordinating between the LIDs, City of Sugar Land and Fort Bend County. LIDs falling entirely or partially within the City of Sugar Land include the following: First Colony (FC) LID, FC LID 2, and Fort Bend County LIDs 2, 7, 10, 11, 14, 15, and 17. All LIDs have an Emergency Action Plan (sometimes called an Emergency Operations Plan), and all have been updated since 2018. ***Integration Opportunity:*** Integration is ongoing. Risk and vulnerability information in the hazard mitigation plan can inform future updates to each Emergency Action Plan.				
Threat & Hazard Identification & Risk Assessment (FEMA Lower Brazos Watershed Flood Risk Report)		No	Yes	No	Yes
Comment:	The City of Sugar Land is profiled in the 2015 FEMA Lower Brazos Watershed Flood Risk Report (FRR). This summary presents flood risk data for the City of Sugar Land, which host the First Colony LID, the Fort Bend LID #2, and the Fort Bend LID #7. Special Flood Hazard Area (SFHA) boundaries within the Lower Brazos Watershed were updated due to new engineering analysis performed within the Flood Risk Project; however new or revised modeling was not completed for streams within this community. The FRR is not intended to be regulatory or the final authoritative source of all flood risk data in the project area. Rather, it should be used in conjunction with other data sources to provide a comprehensive picture of flood risk within the project area. ***Integration Opportunity:*** Opportunities exist for increasing community flood and erosion risk awareness. Evidence of actual flood losses can be one of the most compelling factors for increasing a community's flood risk awareness. One indicator is flood insurance claims through the NFIP. Census blocks that have an increased flood insurance claim history have been indicated on the Flood Risk Map as Past Claim Hot Spots of the FRR.				

		Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Terrorism Plan (Annex V Terrorist Incident Response of Emergency Operations Plan)		Yes	Yes-	Yes	Yes
Comment:	The 2016 City of Sugar Land Terrorist Incident Response outlines operational concepts and tasks and to assign responsibilities for preparing for and responding to terrorist incidents that may occur while describing state and federal assistance that may be available to help in the response to a terrorist incident (e.g., FBI, Governor's Division of Emergency Management, other state and federal agencies). ***Integration Opportunity:*** Integration is ongoing. A successful response to a terrorist incident will depend upon the coordination of efforts between local, state, and federal government agencies and the health care community.				
Post-Disaster Recovery Plan (Annex J Recovery of Emergency Operations Plan)		Yes	No	Yes	Yes
Comment:	The purpose of this annex within the Emergency Operations Plan is to define the operational concepts, organizational arrangements, responsibilities, and procedures to accomplish the tasks required for the local government and its citizens and businesses to recover from a major emergency or disaster. The plan was last updated in 2016. ***Integration Opportunity:*** Integration is ongoing.				
Continuity of Operations Plan (COOP Basic Plan)		Yes	Yes	Yes	Yes
Comment:	The purpose of the City of Sugar Land COOP Basic Plan (Basic Plan) is to provide the framework for departments within the City to restore mission essential functions to their employees and citizens in the event of an emergency that affects their operations. It also provides policy and guidance to implement actions to continue mission essential functions within the recovery priority time frames established by the COOP steering committee and establishes procedures that City leadership can use to strategically minimize risk to its employees, operations, and facilities. This COOP plan will facilitate the department's ability to perform its essential functions despite incidents that may impact operations, including IT system outages, reduced staffing, or any incident that requires the department to relocate. ***Integration Opportunity:*** This integration is ongoing. The COOP plan was developed in accordance with the April 2004 Department of Homeland Security (DHS) COOP Guidance Document, which provides a structure for formulating a COOP plan; the February 2008 Federal Continuity Directive – 1; Federal Emergency Management Agency (FEMA) Continuity Guidance Circular 1, January 2009; the National Response Framework; and the operational guidelines outlined in the National Incident Management System (NIMS).				
Public Health Plan (Disease Control and Response Annex)		Yes	Yes	Yes	Yes
Comment:	This recently updated (December 2018) plan features security sensitive information that is confidential in nature and restricted from public access in accordance with the provisions of the Texas Government Code, Chapter 418 Emergency Management (Sections §418.177 and §418.181). It serves to outline methods to prevent and/or control the spread of infectious disease through the community. It identifies the facilities, personnel, and defines the procedures necessary to successfully distribute services to the general population. It also examines the use of isolation and quarantine measures to prevent or control the spread of disease. This plan was developed in a partnership between Fort Bend County Department of Health and Human Services (HHS), Texas Department of State Health Services (DSHS). ***Integration Opportunity:*** This integration is ongoing. A successful response to a disease event will depend upon the coordination of efforts between local, state, and federal government agencies and the health care community.				

Table 5-2. Development and Permitting Capability

Indicate if your jurisdiction implements the following	Response Yes/No; Provide further detail
Development Permits. If yes, what department?	Yes – building safety department
Permits are tracked by hazard area. For example, floodplain development permits.	Yes
Buildable land inventory If yes, please describe If no, please quantitatively describe the level of buildout in the jurisdiction.	Yes, development permits are reviewed through site plan review

5.3 ADMINISTRATIVE AND TECHNICAL CAPABILITY

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers.

Table 5-3. Administrative and Technical Capabilities

Resources	Available? (Yes or No)	Department/ Agency/Position
Administrative Capability		
Planning Board	Yes	Planning and Zoning Commission – the purpose of this commission is to make recommendations to City Council concerning the use of land and other planning functions pursuant to state law and to promote orderly development; to serve as advisory concerning master plans and changes to the zoning plan; and to protect the general welfare and interest of the people concerning physical changes in the city and in the extraterritorial jurisdiction.
Mitigation Core Planning Team	Yes	The Core Planning Team working on developing the 2021 Update
Environmental Board/Commission	Yes	Parks, Art, Recreation, Culture, and Streetscapes (PARCS) Board – provides input, feedback and advice on projects and programs to enrich the visual and aesthetic environment of the City and to advise on other matters relating to long term goals and objectives for parks, recreation and cultural activities, streetscape and urban forestry programs, to ensure an environment where all citizens could share and enjoy the full diversity and vitality
Open Space Board/Committee	Yes	See PARCS description above.
Economic Development Commission/Committee	Yes	The Sugar Land Development Corporation is a “Type A” economic development corporation governed by a Board of Directors and authorized under Texas law to levy an economic development sales tax to promote, assist and enhance economic development activities for the benefit of the City. As part of these responsibilities, the Board of Directors is charged with overseeing the SLDC’s Direct Incentive policy and program, as well as making recommendations on the City Economic Development Strategic Plan. The corporation utilized a .25 cent sales tax approved by voters for the purpose of funding economic development activities. Sugar Land 4B Corporation is managed by a board of directors responsible for developing and preparing an Economic Development Plan in accordance with policies or directives established by the City Council. The plan, which is submitted to City Council for approval, includes short- and long-term objectives of the corporation and guidelines on the use of sales tax funds received, which may include municipal facilities, parks, museums, stadiums, parking facilities, and other facilities both private and public.
Technical/Staffing Capability		
Planners or engineers with knowledge of land development and land management practices	Yes	Planning Department, Engineering Department, Environmental and Neighborhood Services, Public Works Department, Fire-EMS Department
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Yes	Public Works Department, Engineering Department, Environmental and Neighborhood Services, Building Safety Department,

Resources	Available? (Yes or No)	Department/ Agency/Position
Planners or engineers with an understanding of natural hazards	Yes	Department of Public Works, Engineering Department, Environmental and Neighborhood Services, Fire- Emergency Management Services Department
Floodplain manager	Yes	Engineering Department; Flood Management Engineer
Surveyors	Yes	Engineering Department
Personnel skilled or trained in GIS Applications	Yes	GIS Division of Information Technology; Engineering Department, Public Works Department, Fire Department, Planning Department
Scientist familiar with local natural hazards	Yes	Engineering Department along with hired consultants
Emergency manager	Yes	Fire- Emergency Management Services Department; Emergency Management Coordinator
Grant writers	Yes	Public Works; Grants Officer
Staff with expertise or training in benefit/cost analysis	Yes	Finance Department

5.4 FISCAL CAPABILITY

Assessing a jurisdiction’s fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees.

Table 5-4. Fiscal Capabilities

Financial Resources	Accessible or Eligible to Use (Yes/No)
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes

5.5 EDUCATION AND OUTREACH CAPABILITY

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement. The following table describes the education and outreach capabilities in the City of Sugar Land.

Table 5-5. Education and Outreach Capabilities

Indicate if your jurisdiction has the following resources	Yes/No; Please describe
Do you have a Public Information Officer or Communications Office?	Yes - The City has a Communications and Community Engagement Office.
Do you have personnel skilled or trained in website development?	Yes
Do you have hazard mitigation information available on your website? If yes, please briefly describe.	Yes - The City has information on the website about area hazards, planning and response to hazards, and hazard mitigation plan updates.
Do you utilize social media for hazard mitigation education and outreach? If yes, please briefly describe.	Yes - The City uses Facebook, Twitter, NextDoor, YouTube, LinkedIn, and Instagram for social media updates
Do you have any resident boards or commissions that address issues related to hazard mitigation? If yes, please briefly describe.	Yes - Resident boards or commissions that address issues relating to hazard mitigation include the Planning and Zoning Commission, Building Standards Commission, the City/Home Owner Associations (HOA) Maintenance Responsibilities Citizens Task Force, and the Zoning Board of Adjustment.
Do you have any other programs already in place that could be used to communicate hazard-related information? If yes, please briefly describe.	Yes - The City has a 2014 Hazard Mitigation Plan available to the public, as well as several webpages with information on hazard risk reduction of various sorts.
Do you have any established warning systems for hazard events? If yes, please briefly describe.	Yes - Through a partnership with Harris County, the City participates in a Flood Warning System, which sends out alerts via email or text for specific waterbodies.

5.6 COMMUNITY CLASSIFICATIONS

Table 5-6. Community Classifications

Program	Participating? (Yes/No)	Classification (if applicable)	Date Classified (if applicable)
Community Rating System	Yes	Class 7	November 2019
ISO Building Code Effectiveness Grading Schedule	Yes	Class 3 (commercial), Class 4 (residential)	July 2018
Public Protection	Yes	Rating of 2	11/01/2013
Firewise	No	N/A	N/A
StormReady	Yes	StormReady Site	FY2020

Note:
N/A Not applicable
NP Not participating
\- *Unavailable*

5.7 NATIONAL FLOOD INSURANCE PROGRAM

Flooding is the costliest natural hazard in the United States and, with the promulgation of recent federal regulation, homeowners throughout the country are experiencing increasingly high flood insurance premiums. Community participation in the NFIP provides opportunity for additional grant funding associated specifically with flooding issues. Assessment of the City's current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities. The following table provides the assessment of the NFIP program in the City.

Table 5-7. NFIP in the City of Sugar Land

Criterion	Response
What local department is responsible for floodplain management?	Engineering Department

Criterion	Response
Who is your floodplain administrator? (name, department/position)	Flood Management Engineer
Are any certified floodplain managers on staff in your jurisdiction?	Yes
What is the date that your flood damage prevention ordinance was last amended?	Originally adopted in 1998; Ord. No. 1661 in 2007; Ord. No. 1950 in 2014; Ord. No. 2151 in 2019
When was the most recent Community Assistance Visit or Community Assistance Contact?	August 14, 2019
Do your flood hazard maps adequately address the flood risk within your jurisdiction? -If no, state why.	Yes - FEMA is in the process of updating the maps; the City uses their own data and mapping which are more updated
Does your floodplain management staff need any assistance or training to support its floodplain management program? - If so, what type of assistance/training is needed?	No; however, City floodplain management personnel always seek opportunities to enhance their floodplain management capabilities.
Does your jurisdiction participate in the Community Rating System (CRS)? -If yes, is your jurisdiction interested in improving its CRS Classification? -If no, is your jurisdiction interested in joining the CRS program?	Yes – the City of Sugar Land participates in CRS and is listed as a Class 7 community as of May 1, 2010. Properties located in the SFHA receive a 15% discount on their flood insurance premiums.

5.8 ADAPTIVE CAPACITY

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or respond to consequences" (IPCC 2014). In other words, it describes a jurisdiction's current ability to adjust to, protect from, or withstand a hazard event. This term is often discussed in reference to climate change; however, adaptive capacity also includes an understanding of local capacity for adapting to current and future risks and changing conditions. The following table outlines the City's adaptive capacity for climate change.

Table 5-8. Adaptive Capacity for Future Conditions

Adaptive Capacity Assessment Questions	Jurisdiction Rating
TECHNICAL CAPACITY	
Jurisdiction-level understanding of potential climate change impacts	**High**
Comment: The 2014 Hazard Mitigation Plan adopted by the City features a profile of how climate change is expected to impact EPA Region 6 of the state of Texas. The City is accounting for climate change in infrastructure planning.	
Jurisdiction-level monitoring of climate change impacts	**Medium**
Comment: Historical rainfall, a local impact from climate change, is monitored by the Regional Flood Warning System accessible in partnership with the Harris County Flood Warning System.	
Technical resources to assess proposed strategies for feasibility and externalities	**High**
Comment: The City is accounting for climate change in infrastructure planning using technical resources to inform development proposals or assess externalities.	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	**Low**
Comment: The City has not developed a greenhouse gas emissions inventory.	
Capital planning and land use decisions informed by potential climate impacts	**High**
Comment: The City is accounting for climate change in infrastructure planning. The City also considers greenhouse gas mitigation by requiring multi-modal transportation infrastructure in new development.	
Participation in regional groups addressing climate risks	**Low**
Comment: The City has not participated in regional groups to address climate risks.	

Adaptive Capacity Assessment Questions	Jurisdiction Rating
IMPLEMENTATION CAPACITY	
Clear authority/mandate to consider future impacts during public decision-making processes	**Low**
Comment: The City considers future precipitation impacts considers in development code and design standards.	
Identified strategies for greenhouse gas mitigation efforts	**Medium**
Strategies for greenhouse gas mitigation efforts in City of Sugar Land's include Initiative 2A in the City Comprehensive Plan which recommends adopting Complete Streets policies and design standards that will improve bicycle, pedestrian and transit safety and functionality. Initiative 2B requires multimodal connections in site plans, general plans and Traffic Impact Analyses.	
Identified strategies for adaptation to impacts	**Medium**
Comment: Strategies for the City of Sugar Land's adaptation to future conditions are included in the City's risk assessments for critical infrastructure and land use regulations regarding drainage system capacities.	
Champions for action in local government departments for adaptation strategies for future conditions	**High**
Comment: Recently, the City held virtual town hall meeting to inform residents how the city is accounting for future conditions in infrastructure planning.	
Financial resources devoted to adaptation to future conditions	**Medium**
Comment: The City is accounting for future conditions in infrastructure planning through the mitigation of increased rainfall forecasted by the Atlas 14 Study conducted by the National Weather Service.	
Local authority over sectors likely to be negative impacted	**High**
Comment: The city is proposing an interim Atlas 14 100-year floodplain regulations until floodplain maps can be redrawn by FEMA in a few years.	
Clear authority/mandate to consider future impacts during public decision-making processes	**Low**
Comment: The City considers future precipitation impacts considers in development code and design standards.	
PUBLIC CAPACITY	
Residents' knowledge and understanding of risk from future conditions	**Medium**
Comment: The City's website provides information about weather related risks such as coastal storms, disease and outbreaks, drought conditions, extreme cold, extreme heat, flooding, and tornadoes, however, these are not specifically linked to future forecasting. Recently, the City has held virtual town hall meeting to inform residents how the city is accounting for future conditions in infrastructure planning.	
Residents' support of adaptation efforts	**High**
Comment: Recently, the City held virtual town hall meeting to inform residents how the city is accounting for future conditions in infrastructure planning. The virtual town hall had about 1,400 views, and feedback was largely positive.	
Residents' capacity to adapt to impacts from future conditions	**Medium**
Comment: The City has developed an emergency preparedness guide that can be accessed on the City's website.	
Local economy current capacity to adapt to impacts from future conditions	**Medium**
Comment: Investment in adaptation projects today should create less burden on the local economy in the future. Regionally, the Gulf Houston Regional Conservation Plan recommends an increase in 24% nature-based infrastructure, which will reduce flooding and hurricane damage and increase resiliency to storm surges and sea level rise. Every mile of marsh reduces inland storm surge by 1 foot, and the 24% goal will build up more than 20 feet of shoreline surge protection through living shorelines.	
Local ecosystems capacity to adapt to impacts from future conditions	**Medium**
Comment: Regionally, the Gulf Houston Regional Conservation Plan recommends an increase in 24% nature-based infrastructure by 2040, which will enhance ecosystem services for flood mitigation, erosion control, air and water quality, carbon sequestration, and nature-based recreation.	

5.9 PLAN INTEGRATION

Described earlier in this section, the City of Sugar Land identified integration of hazard risk management into their existing planning, regulatory, and operational/administrative framework ("integration capabilities") and intended integration promotion (integration actions).

5.9.1 Integration Process

Hazard mitigation is a sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The City of Sugar Land Steering Committee was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms.

A key step under this phase of the planning process was a "core capability" exercise facilitated with the Steering Committee by the CPT. During the second Steering Committee meeting, on January 16, 2020, 30 statements of core capabilities within the planning area were presented. Steering Committee members were asked to review each statement and rank each statement one through five (1 = agree; 2 = somewhat agree; 3 = neutral; 4 = somewhat disagree; 5 = disagree). The primary objective for this exercise was to identify the steering committee's perceived strengths and weaknesses for the planning area; and to inform the identification and prioritization of actions that could increase the core capabilities of the planning partnership, as well as identify limitations in capability to implement mitigation actions. Table 5-9 summarizes the results, which were provided to the Steering Committee via project bulletins.

Table 5-9. Core Capability Exercise

Capability Description	Ranking
Roles and responsibilities for emergency management within the City clearly defined.	1
Emergency response functions for the City are clearly defined and are effective.	2
City staff are knowledgeable about hazards and their impacts and are willing to share that knowledge with the public.	2
All relevant stakeholders are engaged in the City's risk management efforts.	2
Emergency management is provided by a unified authority or program	2
City staff members with emergency management functions are adequately trained.	2
The City currently has a variety of regulatory and non-regulatory strategies to reduce risk.	2
There is political support for risk management within the planning area.	2
The enforcement of Codes and Standards within the planning area is strong.	2
There is a coordinated program to maintain drainage systems free of debris.	2
There is a good understanding of the risk posed by hazards the planning area is susceptible to.	2
Strong collaboration and coordination exist between the City, neighboring jurisdictions, the County and state and federal agency partners.	2
There is strong public support for risk reduction within the planning area.	2
Information on flood insurance is readily available within the planning area.	2
The City development regulations for new development within identified hazards zones are adequate to address that risk.	2
Existing flood control systems are effective and well maintained.	2
The capability to assess and mitigate risk from natural hazards is high.	2
Appropriate and timely warning systems are in place.	2
The City currently has adopted policies that encourage development to be located outside of high-risk areas.	2
Coordinated public outreach regarding risk from all hazards convey clear, consistent messaging to the public.	2
The planning area risk management programs are fair and equitable.	2
Risk from natural hazards within the planning area is adequately mapped and regulated.	2
As a citizen of the City, I feel confident that I am prepared for the impacts from any natural hazard that my impact my property.	2
Current land uses within identified hazard areas are appropriate for the risk posed by each hazard.	3
Areas that provide natural resource protection are identified and protected.	3
The planning area is prepared for the probable impacts on natural hazards due to the impacts from a changing climate.	3
Members of the public know where to find information about hazards and risk.	3
Citizens have a good understanding of natural hazard exposure and risk.	3
Real Estate professionals adequately disclose risk exposure from natural hazards at the time of sale of real property	3
The funding to support risk reduction within the planning area is adequate.	4

The Steering Committee representatives will continue to incorporate mitigation planning as an integral component of daily government operations. Steering Committee representatives will continue to work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Table 5-10 identifies mitigation actions that improve or enhance capabilities for the City of Sugar Land.

Table 5-10. Mitigation Actions to Enhance the City's Capabilities

Project Number	Project Name	Description of Project
City of Sugar Land-6 (previous action)	CRS Program	Develop a program to lower the Community Rating System (CRS) number from 7 to 6.
City of Sugar Land-12 (previous action)	Update City Policy for Threat Assessments	Revise city policy to include threat assessment form is a standard part of any special event action plan.
City of Sugar Land-15 (previous action)	Develop Training and Planning for Top Terrorism Targets in City	Work with the management of high risk facilities on planning and training in response to the threat of terrorism.
City of Sugar Land-18 (previous action)	Review and Update the Hazardous Materials and Oil Spill Response Annex	Coordinate with Fort Bend County Office of Emergency Management to review and update the Hazardous Materials and Oil Spill Response Annex.
City of Sugar Land-19 (previous action)	Identify primary and alternate fuel sources and add them to the City Continuity of Operations Plan	Identify primary and alternate fuel sources and add them to the City Continuity of Operations Plan.
City of Sugar Land-26 (previous action)	General Public and First Responders Planning	Coordinate with Fort Bend County Health and Human Services in planning and exercises for vaccination and prophylaxis of the general public and first responders.
City of Sugar Land-31	City-wide Benchmark System Update	Survey and installation of the benchmarks. Implement flood protection plan (describe additional benefits and applications) modeling to construction.
City of Sugar Land-38	Stormwater Needs Assessment	City-wide Flood Prevention and Drainage Needs Assessment to identify drainage projects and additional flood mapping needs.
City of Sugar Land-40	Development Code Changes - Impervious Surface	Limiting the percentage of allowable impervious surface for new development and re-developed sites city-wide.
City of Sugar Land-41	Development Code Changes - Water Retention	Coordinating with developers to construct on-site retention basins for excessive stormwater and a firefighting water source.
City of Sugar Land-49	Hurricane Sheltering and Evacuation Needs Assessment and Outreach Program	Hurricanes evacuation routes and Shelters of Last Resort - needs assessment and education and outreach program to identify and accommodate sheltering people who are stalled in traffic on a main evacuation route from the coastal communities and to communicate designated shelters and evacuation routes as a result of the study.
City of Sugar Land-50	Lightning/ Severe Weather protocols for outside events.	Schools & parks- update and develop lightning protocols for all outdoor city events to ensure all attendees at outside events are aware of safety precautions.
City of Sugar Land-52	Lightning Prevention Needs Assessment	Needs Assessment to evaluate if City's critical facilities are up to code on lightning and identify projects for facilities that are not in compliance.
City of Sugar Land-53	Update Erosion Study	Update the 2017 Brazos River Erosion Study.
City of Sugar Land-54	Erosion Management Plan	Develop an erosion management plan for the Brazos River.
City of Sugar Land-56	Design Standards Update for Soil Stabilization	Update design standards for development and redevelopment projects to incorporate soil stabilization techniques.
City of Sugar Land-58	Drought Conservation Plan Update	Update 2017 Drought Conservation Plan.
City of Sugar Land-59	Update Integrated Water Resource Plan	Update 2018 Integrated Water Resource Plan.
City of Sugar Land-60	Update Landscape Ordinance	Incorporating drought tolerant or xeriscape practices into landscape ordinances to reduce dependence on irrigation in City of rights-of-way.
City of Sugar Land-63	Development Code Changes - Green Space Requirements	Establishing a "green infrastructure" program to link, manage, and expand existing parks, preserves, greenways, etc. (easements)
City of Sugar Land-64	Vulnerable Population/ Critical Facilities Database	Update/ Develop data base to define and identify critical facilities for vulnerable populations such as Nursing homes and medical service providers.
City of Sugar Land-72	ETJ Code Update	Develop and establish consistent code requirements and enforcement between the City's building codes and development in the ETJ.
City of Sugar Land-76	Brazos River Initiative	Increase coordination efforts with the Texas Water Development Board to update information on the Brazos River and increase multi-agency coordination.
City of Sugar Land-77	Update Design Standards utilize native species in construction	Further conservation efforts to encourage more natural and native grasses and plants in construction through increased design standards.

Further, the sample adoption resolution presented in Appendix A (Plan Adoption) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Steering Committee anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts.
2. The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of City residents.

Section 7 (Plan Maintenance) provides for additional information on the implementation of the mitigation plan through existing programs.

SECTION 6. MITIGATION STRATEGY

This section presents the process by which the City of Sugar Land will reduce or eliminate potential losses from the natural hazards identified in Section 4.2 (Hazard Identification) of this HMP. The mitigation strategy focuses on existing and potential future mitigation actions to alleviate the effects of hazards on the City's population, economy, environment and general building stock.

This section provides a summary of the 2021 HMP update process, outlines the mitigation goals and objectives set forth in the 2021 HMP update, describes the process for identifying and analyzing mitigation techniques, and provides the mitigation action plan.

Hazard mitigation reduces the potential impacts of, and costs associated with, emergency and disaster-related events. Mitigation actions address a range of impacts, including impacts on the population, property, the economy, and the environment.

Mitigation actions can include activities such as: revisions to land-use planning, training and education, and structural and nonstructural safety measures.

6.1 UPDATE PROCESS SUMMARY

The goals and objectives listed in the City of Sugar Land HMP were first examined by the Steering Committee at the January 16th 2020 Steering Committee meeting and confirmed at the June 17th 2020 meeting. The Steering Committee compared the goals and objectives from the 2015 HMP as well as the 2018 State Hazard Mitigation Plan while considering the general project types that could be funded through various grant programs. The Steering Committee provided feedback and confirmed the goals in-person at the January 16th meeting. An online survey was completed by the Steering Committee members to identify objectives that aligned with the confirmed goals. The survey results were compiled prior to the June 17th meeting. The results of the survey were presented at the meeting and the final objectives were confirmed. During the five-year review, the Steering Committee had the opportunity to comment on the goals, objectives, and mitigation actions that were listed in the current HMP.

The overall approach used to update the City's hazard mitigation strategies is based on FEMA and State of Texas regulations and guidance regarding local mitigation plan development, including the following:

- DMA 2000 regulations, specifically 44 CFR 201.6 (local mitigation planning).
- FEMA Local Mitigation Planning Handbook, March 2013.
- FEMA Local Mitigation Plan Review Guide, October 1, 2011.
- FEMA Integrating Hazard Mitigation into Local Planning, March 1, 2013.
- FEMA Plan Integration: Linking Local Planning Efforts, July 2015.
- FEMA Mitigation Planning How-To Guide #3, Identifying Mitigation Actions and Implementing Strategies (FEMA 386-3), February 2013.
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, January 2013.

This section summarizes past mitigation goals and past mitigation action status and provides an update of mitigation strategies and additional past mitigation accomplishments.

6.1.1 Review of the Past Mitigation Mission Statement, Goals, and Objectives

This section documents the City's efforts to develop hazard mitigation goals and objectives that are established to reduce or avoid long-term vulnerabilities to the identified hazards.

Mission Statement

Per FEMA guidance (386-1), a mission statement or guiding principle describes the overall duty and purpose of the planning process and serves to identify the principle message of the plan. It focuses or constrains the range of goals and objectives identified. This is not a goal because it does not describe outcomes.

The 2015 HMP mitigation strategy, inclusive of the 2015-identified mission statement was examined and revised at the October 17, 2019 Steering Committee meeting. The mission statement for the 2021 Update is as follows:

The purpose of the City of Sugar Land HMP is to identify risks and vulnerabilities and to formulate a plan of action to reduce loss of life and damage from natural and non-natural disasters. This plan shall serve as a benchmark for future mitigation activities and will identify mitigation goals and objectives for the City of Sugar Land. The plan will also identify and prioritize potential risks and vulnerabilities in an effort to minimize the effects of disasters in the community.

The implementation of the plan and its components is vital to achieve a community that is resilient to the effects of disaster. The implementation of the plan will reduce loss of life and property and allow the whole community to prosper with minimal disruption to of vital services to its citizens. The plan provides a risk assessment of the hazards the City of Sugar Land is exposed to and puts forth several mitigation goals and objectives that are based on that risk assessment.

Goals And Objectives

According to CFR 201.6(c)(3)(i): "The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards." The mitigation goals were developed based on the risk assessment results, discussions, research, and input from the Steering Committees, existing authorities, polices, programs, resources, stakeholders, and the public.

As previously noted, the Steering Committee reviewed and updated the goals and objectives at the January 16th and June 17th 2020 meetings, in consideration of the hazard events and losses since the 2015 plan, the goals and objectives established in the updated State HMP, Fort Bend County, and City risk management plans, as well as direct input on how the Steering Committee (representing the City) recognized the need to move forward to best manage their hazard risk.

For the purposes of this plan, goals and objectives are defined as follows:

Goals are general guidelines that explain what is to be achieved. They are broad, long-term, policy-type statements that represent global visions. Goals help define the benefits that the plan is trying to achieve. The success of the plan, once implemented, should be measured by the degree to which its goals have been met (that is, by the actual benefits in terms of hazard mitigation).

Objectives are short-term aims, which when combined form a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

The goals and objectives update provides clear guidelines for how the City can move forward to best manage their hazard risk. Amendments include additions and edits to goals and objectives to express the plan participants' interests in integrating this plan with other planning mechanisms/programs and to support mitigation through the protection and preservation of natural systems, incorporate resilience of lifelines, and integrate green infrastructure.

6.1.2 Past Mitigation Action Status and Update of Mitigation Strategies

In the 2015 HMP, the City of Sugar Land identified 52 actions and initiatives to support an approved understanding of hazard risk and vulnerability, to enhance mitigation capabilities, and/or to reduce vulnerability of infrastructure. Progress on the 2015 mitigation actions was evaluated during the 2021 update process by the Steering Committee and Core Planning Team. Table 6-1 provides the evaluation.

Table 6-1. Past Mitigation Action Status

Action	Action / Project Description	Completed	Remove; No Longer Feasible	Carried Over to Plan Update	
				Check if Yes	Action # in Update
1.1.1	Purchase and install a generator at the Fire Administration Building.	X			
Comment: The generator was installed in 2018.					
1.1.2	Purchase and install a generator for Imperial Park Recreation Center for use as a shelter location.			X	City of Sugar Land-1
Comment: No progress in the last five years; to be include in the 2021 update.					
1.1.3	Purchase and install a generator for T.E. Harman Center for use as a community shelter location.			X	City of Sugar Land-2
Comment: No progress in the last five years; to be include in the 2021 update.					
1.2.1	Install emergency power system in Kempner High School to ensure continuous supply during power outages.	X			
Comment: The generator was installed in 2018; however, it only powers the emergency systems at the high school.					
2.1.1	Purchase and install emergency notification systems at all City of Sugar Land schools to ensure they have the newest technology, including integrated siren and strobes and alert beacons.			X	City of Sugar Land-3
Comment: No progress in the last five years; to be include in the 2021 update.					
2.2.1	Purchase of a command vehicle for the City of Sugar Land's needs. Purchase it.	X			
Comment:					
2.3.1	Install lightning rods on existing and future communication infrastructure and other critical facilities.	X		X	
Comment:					
2.3.2	Purchase and install new electric equipment to protect equipment against power surges.			X	City of Sugar Land-4
Comment: No progress in the last five years; to be include in the 2021 update.					
3.1.1	Apply security window film to existing windows in Fort Bend ISD City of Sugar Land schools to protect students from wind-borne debris during high winds situations such as thunderstorms and tornadoes.			X	City of Sugar Land-5
Comment: No progress in the last five years; to be include in the 2021 update.					
3.2.1	Not identified	-	-	-	-
Comment:					
3.2.2	Install Armor Glass®, tinting all windows in fifteen buildings in the City of Sugar Land.	X			
Comment: Windows were installed at all 15 buildings in the City.					
4.1.1	Create a program to inform individuals of potential flood hazards and planning initiatives.	X – Ongoing Capability			
Comment: This is an ongoing capability for the City and part of their day-to-day operations.					

Action	Action / Project Description	Completed	Remove; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Action # in Update
4.1.2	Develop a program to lower the Community Rating System (CRS) number from 7 to 6.			X	City of Sugar Land-6
Comment: No progress in the last five years; to be include in the 2021 update.					
5.1.1	Design and construct an offline pond in the western portion of the existing detention basin in Covington Woods to reduce storm event peak and mitigate downstream impacts.	X		X	
Comment: Project is currently underway					
5.1.2	Design and construct new reinforced concrete boxes south on Longview Drive to divert flow to East Sugar Creek and new storm inlets along Longview Drive to reduce backwater surcharging.	X			
Comment: New boxes were installed in 2017					
5.1.3	Design and construct a new efficient storm water outfall and new trunk line to extend north from Ditch A-22 along Bournewood Dr. to Bramblebury Dr. to mitigate subdivision and street flooding impacts.	X			
Comment: The new stormwater outfall and trunk line was constructed in 2018.					
6.1.1	Assist an existing position to actively participate in FBI JTTF investigations part-time.			X	City of Sugar Land-7
Comment: No progress in the last five years; to be include in the 2021 update.					
6.2.1	Submit and disseminate information as it relates to terrorism to the Department of Homeland Security's Fusion Center.			X	City of Sugar Land-8
Comment: No progress in the last five years; to be include in the 2021 update.					
7.1.1	Schedule formalized training on conducting threat assessments.			X	City of Sugar Land-9
Comment: No progress in the last five years; to be include in the 2021 update.					
7.1.2	Conduct in-house training for SLPD supervisors and designated city departments.			X	City of Sugar Land-10
Comment: No progress in the last five years; to be include in the 2021 update.					
7.2.1	Design a threat assessment form for special events.			X	City of Sugar Land-11
Comment: No progress in the last five years; to be include in the 2021 update.					
7.2.2	Revise city policy to include threat assessment form is a standard part of any special event action plan.			X	City of Sugar Land-12
Comment: No progress in the last five years; to be include in the 2021 update.					
7.3.1	Identify the top five potential targets for terrorism in the City of Sugar Land.			X	City of Sugar Land-13
Comment: No progress in the last five years; to be include in the 2021 update.					
7.3.2	Conduct a planned response for those listed.			X	City of Sugar Land-14
Comment: No progress in the last five years; to be include in the 2021 update.					
7.3.3	Work with the management of those facilities on planning and training.			X	City of Sugar Land-15

Action	Action / Project Description	Completed	Remove; No Longer Feasible	Carried Over to Plan Update Check if Yes	Carried Over to Plan Update Action # in Update
Comment: No progress in the last five years; to be include in the 2021 update.					
8.1.1	Install security vestibules with electronic door controllers at the following schools: • Clement High School • Dulles High School • Kempner High School • M.R. Wood Technical Education Center • First Colony Middle School • Fort Settlement Middle School • Sugar Land Middle School • Barrington Place Elementary School • Colony Meadows Elementary School • Commonwealth Elementary School • Dulles Elementary School • Highlands Elementary School • Lakeview Elementary School	X			
Comment: Completed with the exception of Lakeview Elementary School which will be demolished and rebuilt. The new design of the school will include a security vestibule.					
8.1.2	Not identified	-	-	-	-
Comment:					
8.1.3	Install electronic access controls on exterior doors on all Fort Bend ISD City of Sugar Land schools, including access controls at front doors, as well as kitchen, security vestibule, staff, custodial, athletic, fine arts, bus loading, commons, and all other exterior corridor doors.	X			
Comment: This action was completed in 2019 when controls were installed.					
8.2.1	Install video intercom systems that allow schools to grant access to selected doors at their facilities, thus increasing student mobility and school security for the following schools: • Clements High School • Dulles High School • M.R. Wood Technical Education Center • Dulles Middle School • First Colony Middle School • Fort Settlement Middle School • Sugar Land Middle School • Austin Parkway Elementary School • Barrington Place Elementary Place • Colony Bend Elementary School • Colony Meadows Elementary School • Commonwealth Elementary School • Cornerstone Elementary School • Dulles Elementary School • Highlands Elementary School • Lakeview Elementary School • Settlers Way Elementary School • Sugar Mill Elementary School	X			
Comment: This action was completed in 2019; the systems were installed					
8.2.2	Update security cameras from analog systems to centralized network camera solutions by replacing all				

Action	Action / Project Description	Completed	Remove; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Action # in Update
	digital video recorders with encoders and ensuring all replacement cameras are network IP cameras.				
Comment:					
9.1.1	Prepare and implement an extreme heat plan. Outline when alerts are to be issued and what actions will be taken.				
Comment: This is an ongoing capability for the City as they maintain an extreme heat plan and update as needed.					
9.1.2	Develop an extreme heat outreach program for City of Sugar Land citizens.			X	City of Sugar Land-16
Comment: No progress in the last five years; to be include in the 2021 update.					
9.1.3	Create a program with non-profit organizations to distribution of fans and portable air conditioning units to vulnerable Sugar Land residents.			X	City of Sugar Land-17
Comment: No progress in the last five years; to be include in the 2021 update.					
9.2.1	Not identified				
Comment:					
9.3.1	Co-host a conference for businesses on water irrigation systems.		X		
Comment: At the time of the 2020 plan update, this action is not a priority for the City and will not be included in the 2021 update.					
9.3.2	Conduct a program on an annual basis to inform the public of the Texas Smart Scape Program.		X		
Comment: At the time of the 2020 plan update, this action is not a priority for the City and will not be included in the 2021 update.					
9.3.3	Install low water fixtures in city facilities.		X		
Comment: At the time of the 2020 plan update, this action is not a priority for the City and will not be included in the 2021 update.					
9.4.1	Develop and implement emergency dam plans and procedures.	X			
Comment: The emergency dam plans and procedures were completed in 2017.					
9.4.2	Retrofit Dam #3 to safely pass 75% of the PMF.			X	City of Sugar Land-18
Comment: No progress in the last five years; to be include in the 2021 update.					
9.4.3	Develop and implement a procedure to ensure dam/levee inundation maps are current.				
Comment: Ongoing capability for the City					
9.4.4	Implement an inspection maintenance, and enforcement program to help ensure continued structural integrity of dams and levees.	X			
Comment: Project is complete; it is part of the FBC program					
9.4.5	Educate the public regarding dam and levee and mitigation actions being taken by the city and actions they can take to protect their lives and property, including the purchase of flood insurance, in the event of a dam or levee branch.	X			
Comment: This is an ongoing capability for the City; the City conducts educational programs regarding dam and levee safety/mitigation.					
9.5.1	Review and update COOP plan succession of leadership procedures.	X			
Comment: This is an ongoing capability for the City; the COOP is updated each year.					

Action	Action / Project Description	Completed	Remove; No Longer Feasible	Carried Over to Plan Update Check if Yes	Carried Over to Plan Update Action # in Update
9.6.1	Coordinate with Fort Bend County Office of Emergency Management to review and update the Hazardous Materials and Oil Spill Response Annex.			X	City of Sugar Land-19
Comment: No progress in the last five years; to be include in the 2021 update.					
9.7.1	Identify primary and alternate fuel sources and add them to the City Continuity of Operations Plan.			X	City of Sugar Land-20
Comment: No progress in the last five years; to be include in the 2021 update.					
9.8.1	Purchase an airport fire truck to mitigate the effects of an aircraft crash at the airport.			X	City of Sugar Land-21
Comment: No progress in the last five years; to be include in the 2021 update.					
9.8.2	Develop a system to be alerted when an incident might be developing such as an airplane in trouble.			X	City of Sugar Land-22
Comment: No progress in the last five years; to be include in the 2021 update.					
10.1.1	Provide guidance to the public regarding prevention of damage and injuries from lightning.			X	City of Sugar Land-23
Comment: No progress in the last five years; to be include in the 2021 update.					
10.1.2	Educate the public on the importance of water conservation and steps the public can take to limit water waste.			X	City of Sugar Land-24
Comment: No progress in the last five years; to be include in the 2021 update.					
10.1.3	Provide guidance to the public in shelter in place procedures.			X	City of Sugar Land-25
Comment: No progress in the last five years; to be include in the 2021 update.					
10.1.4	Develop a severe winter storm outreach program for City of Sugar Land citizens.			X	City of Sugar Land-26
Comment: No progress in the last five years; to be include in the 2021 update.					
11.1.1	Coordinate with Fort Bend County Health and Human Services in planning and exercises for vaccination and prophylaxis of the general public and first responders.			X	City of Sugar Land-27
Comment: No progress in the last five years; to be include in the 2021 update.					

6.1.3 Past Mitigation Accomplishments

In accordance with the requirements of the DMA 2000, a discussion regarding past mitigation activities and an overview of past efforts is provided as a foundation for understanding the mitigation goals, objectives, and activities outlined in this plan update. The City of Sugar Land, through previous and ongoing hazard mitigation activities, has demonstrated that it is proactive in protecting its physical assets and citizens against losses from natural hazards. Examples of previous and ongoing actions and projects include the following:

- The City installed 44 mm extruded shutters and metal hurricane straps to City Hall. This provides increased protection from high wind/hurricane winds to exterior windows and roof.
- The City installed galvanized metal hurricane straps to the police/courts building to secure the roof from high winds/hurricanes. Additionally, roof mounted equipment was fastened including: (3) Carrier package units 5 tons each, (2) Liebert package units 3 tons each, and (2) outside air fans.

- Galvanized metal hurricane straps were installed at the Sugar Land Regional Airport Tower to secure the roof from high winds and hurricanes. They also fastened roof-mounted equipment including (2) Trane XL 1200/Model #TTX048D100A0 condensers and (2) disconnects supplying power to the units.
- Generators were installed at several critical facilities in the City including: City Hall Annex and Public Works. HMGP funds were used to purchase and install.

6.2 MITIGATION GOALS AND OBJECTIVES

This section describes the mitigation goals and objectives set forth in the 2021 HMP update.

6.2.1 2020 Mitigation Goals and Objectives

The City of Sugar Land's Steering Committee reviewed the 2015 goals to determine their continuing applicability to City mitigation needs and decided to update them. During the January 16, 2020 meeting, the Steering Committee updated and finalized the goals and objectives for the 2021 HMP update. The 2020 City HMP goals are in line with State mitigation goals, embody the overarching needs and concerns of the City and address both natural and non-natural hazard risk reduction. The 2020 City HMP goals are listed below:

- **Goal 1: Warning** — Enhance predictive measure including the expansion and protection of warning systems and supporting technologies.
- **Goal 2: Data Collection/Studies/Planning** — Enhance the quality of assessments, analysis and planning through the development and collection of data.
- **Goal 3: Public Outreach** — Develop and enhance communications and education capabilities to the public regarding hazards, including the steps that can be taken to mitigate their impact.
- **Goal 4: Mitigate Structures/Protect Lives** — Implement protective measures to reduce the effect of natural, technological and human caused hazards including measures that enhance public safety and reduce the risk of damage to public and private property.
- **Goal 5: Protect Natural Resources** — Reduce adverse environmental, natural resource, and economic impacts from natural, technological, and human-caused hazard events.
- **Goal 6: Code Enforcement** — Review update, adopt and enforce local, state and federal plans, codes and regulations to reduce the impacts of natural hazards.
- **Goal 7: Coordination** — Enhance coordination between private sector, local, state, tribal, and federal agencies to improve mitigation capabilities and reduce the risk of natural, technological and human caused hazard events.
- **Goal 8: Continuity of Operations** — Support continuity of operations pre-, during, and post- hazard events including the support of community lifelines.

6.2.2 2020 Mitigation Objectives

The goals listed above were used to develop relevant objectives. The objectives address the results of the vulnerability assessment in more specific terms and reflect the possible effects that can be mitigated for the identified hazards, as well as existing limitations in available data and information. The objectives that were originally identified during the 2015 HMP update process were reviewed by the Steering Committee and updated to reflect changes in City priorities and capabilities since the HMP was written in 2015. During the January 16, 2020 meeting, the Steering Committee updated and finalized the goals and objectives for the 2021 HMP update. Objectives related to each of the goals are listed below, and Table 6-2 summarizes the evaluation of all goals and objectives from the 2015 HMP.

Table 6-2. 2020 Mitigation Objectives and Corresponding Goals

Objective	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8
Obj 1: Improve systems that provide warning and emergency communications.	X							
Obj 2: Increase public awareness of risk.	X	X	X				X	
Obj 3: Research, develop, and promote adoption of cost-effective building and development laws, regulations, and ordinances.		X		X		X		
Obj 4: Improve hazard information databases and maps and increase accessibility to those resources.	X	X	X				X	X
Obj 5: Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.	X	X	X	X	X			X
Obj 6: Manage development in geologically hazardous areas and floodplains to protect life and property.					X	X	X	
Obj 7: Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of natural hazards.		X		X	X	X	X	
Obj 8: Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.	X	X	X	X	X		X	X
Obj 9: Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life safety and health.		X	X	X	X		X	
Obj 10: Consider risk reduction in long-term planning.		X		X		X	X	
Obj 11: Minimize impacts of hazard events to key employers.	X	X	X	X			X	X
Obj 12: Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.	X	X	X	X	X		X	X
Obj 13: Identify projects that simultaneously reduce risk while increasing operational area resilience and sustainability.	X	X	X	X	X	X	X	X
Obj 14: Establish a partnership among all levels of government and the business community to improve and implement methods to protect property.		X	X	X	X		X	X
Obj 15: Reduce risks that may impact critical business operations.	X	X	X	X	X		X	X
Obj 16: Promote and enhance outreach and education efforts by state, regional and local agencies with hazard mitigation plans and programs to actively encourage engagement of stakeholder groups such as homeowners, private sector businesses, and nonprofit community organizations.		X	X	X	X		X	X
Obj 17: Inform the public on the risk exposure to natural hazards and ways to increase the public's capability to prepare, respond, recover and mitigate the impacts of these events.	X	X	X	X	X	X	X	
Obj 18: Modify structures, as necessary, to meet life safety standards.			X	X		X	X	X
Obj 19: Encourage the incorporation of mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.		X	X	X	X	X	X	
Obj 20: Retrofit, purchase, or relocate structures in high hazard areas, especially those known to be repetitively damaged.		X	X	X	X	X	X	
Obj 21: Encourage hazard mitigation measures that promote and enhance natural processes and minimize adverse impacts on the ecosystem.		X	X	X	X	X	X	
Obj 22: Promote enforcement of relevant state regulations and local ordinances that significantly reduce life loss and injuries.		X	X	X	X	X	X	

Objective	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8
Obj 23: Strengthen local building code enforcement.		X	X	X		X	X	
Obj 24: Ensure continuity of operations of essential county government services.		X	X	X	X		X	X
Obj 25: Protect rare, endangered, unusual, or educationally important natural resources.		X	X		X	X	X	
Obj 26: Provide incentives for development and land use techniques that reduce risks.		X	X	X	X	X	X	

6.3 2021 HMP MITIGATION ACTION PLAN

Representatives from the Core Planning Team with input from the Steering Committee selected mitigation strategies and initiatives to pursue until the next plan update. These actions also include some actions identified during the 2015 update that are still relevant or in progress. This section describes 2020 mitigation initiatives, mitigation strategy prioritization and implementation, and prioritization of mitigation actions.

6.3.1 2020 Mitigation Initiatives

Table 6-3 summarizes the updated mitigation strategies identified by the City, including the following information:

- Mitigation actions for individual and multiple hazards
- Mitigation action type
- Department or agency primarily responsible for project initiation and/or implementation
- Estimated cost for the mitigation action and identification of known or potential sources of funding
- Implementation schedule
- Implementation priority

During the June 17, 2020 Steering Committee meeting, mitigation actions were identified and prioritized. Specific mitigation actions were identified to prevent future losses; however, current funding is not identified for all of these actions at present. Section 5 of this HMP indicates potential funding sources to support future implementation. The implementation of these mitigation actions is dependent on the approval of the local elected governing body and the ability of the jurisdiction to obtain funding from local or outside sources. Table 6-3 provides the mitigation strategies developed for the 2021 update and Table 6-4 provides the prioritization of each strategy.

Table 6-3. Hazard Mitigation Strategy

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-1 (previous action)	Imperial Park Generator	Purchase and install a generator for the Imperial Park Recreation Center. This center serves as an emergency shelter for residents.	Existing	8	Energy/Fuel Shortage, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Severe Winter Storm	City Emergency Management	$250,000	FEMA HMGP and PDM/BRIC; City Budget	Within 2 years
City of Sugar Land-2 (previous action)	T.E. Harman Center Generator	Purchase and install a generator for the T.E. Harman Center. This center serves as an emergency shelter for residents.	Existing	8	Energy/Fuel Shortage, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Severe Winter Storm	City Emergency Management	$250,000	FEMA HMGP and PDM/BRIC; City Budget	Within 2 years
City of Sugar Land-3 (previous action)	Emergency Notification System for City Schools	Purchase and install emergency notification systems at all City of Sugar Land schools to ensure they have the newest technology, including integrated siren and strobes and alert beacons.	Existing	1, 8	Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Severe Winter Storm	Fort Bend ISD	$400,000	Fort Bend ISD	One Year
City of Sugar Land-4 (previous action)	New Electric Equipment to Protect Against Power Surges	Purchase and install new electric equipment to protect equipment against power surges.	Existing	8	Lightning, Thunderstorm Wind	City Emergency Management	$25,000	City Budget	One Year
City of Sugar Land-5 (previous action)	Install Security Window Film in Fort Bend ISD City Schools	Apply security window film to existing windows in Fort Bend ISD City of Sugar Land schools to protect students from wind-borne debris during high winds situations such as thunderstorms and tornadoes.	Existing	4, 8	Thunderstorms Wind, Tornadoes, Hurricane	Fort Bend ISD	$500,000	Fort Bend ISD	One Year
City of Sugar Land-6 (previous action)	CRS Program	Develop a program to lower the Community Rating System (CRS) number from 7 to 6.	New and Existing	2, 6	Flood	City Emergency Management	$10,000+	City Budget	Within 5 years
City of Sugar Land-7 (previous action)	Participation in FBI JTTE	Assign an existing position to actively participate in FBI JTTF investigations part-time.	N/A	7	Terrorism	City Police Department	$30,000	City Budget	Within 5 years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-8 (previous action)	Terrorism Information to Fusion Center	Submit and disseminate information as it relates to terrorism to the Department of Homeland Security's Fusion Center.	Existing	7	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 5 years
City of Sugar Land-9 (previous action)	Training for Threat Assessments	Schedule formalized training on conducting threat assessments.	New and Existing	2, 7	Terrorism	City Police Department	<$10,000	City Budget, HSGP, SHSP	Within 2 years
City of Sugar Land-10 (previous action)	Police Department Training for Supervisors	Conduct in-house training for SLPD supervisors and designated city departments.	N/A	2, 7	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-11 (previous action)	Design Threat Assessment	Design a threat assessment form for special events.	New and Existing	2, 7	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-12 (previous action)	Update City Policy for Threat Assessments	Revise city policy to include threat assessment form is a standard part of any special event action plan.	New and Existing	2, 6, 7	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-13 (previous action)	Identify Top Targets for Terrorism Events	Identify the top five potential targets for terrorism in the City of Sugar Land.	New and Existing	2, 7, 8	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-14 (previous action)	Develop Terrorism Response Plans for Top Targets in City	Conduct a planned response plan for top identified targets in the city at risk of terrorism.	New and Existing	2, 7, 8	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-15 (previous action)	Develop Training and Planning for Top Terrorism Targets in City	Work with the management of high risk facilities on planning and training in response to the threat of terrorism.	Existing	2, 7, 8	Terrorism	City Police Department	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-16 (previous action)	Extreme Heat Education and Outreach Program	Education/outreach for homeless or vulnerable populations sensitive to extreme heat conditions on mitigation techniques to avoid heat related illness.	New and Existing	3	Extreme Temperature	Emergency Management	$20,000	FEMA HMGP, FMA/BRIC, CDBG	Within 1 year

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-17 (previous action)	Fan and Air Conditioning Program	Create a program with non-profit organizations to distribution of fans and portable air conditioning units to vulnerable Sugar Land residents.	New and Existing	3, 7	Extreme Temperature	City Emergency Management	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-18 (previous action)	Review and Update the Hazardous Materials and Oil Spill Response Annex	Coordinate with Fort Bend County Office of Emergency Management to review and update the Hazardous Materials and Oil Spill Response Annex.	New and Existing	2, 7, 8	Hazardous Material Spills	City Emergency Management with support from Fort Bend County OEM	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-19 (previous action)	Identify primary and alternate fuel sources and add them to the City Continuity of Operations Plan	Identify primary and alternate fuel sources and add them to the City Continuity of Operations Plan.	New and Existing	2, 7, 8	Energy/Fuel Shortage	City Emergency Management	<$10,000	City Budget, Staff Time	Within 2 years
City of Sugar Land-20 (previous action)	Purchase an airport fire truck	Purchase an airport fire truck to mitigate the effects of an aircraft crash at the airport.	New and Existing	8	Transportation Accidents	City Emergency Management	$1 million	UASI, HSGP, SHSP	Within 5 years
City of Sugar Land-21 (previous action)	Emergency Alert System for Aircrafts	Develop a system to be alerted when an incident might be developing such as an airplane in trouble.	New and Existing	1	Transportation Accidents	City Emergency Management	<$10,000	City Budget, Staff Time	Within 5 years
City of Sugar Land-22 (previous action)	Outreach Materials for Lightning Injuries	Provide guidance to the public regarding prevention of damage and injuries from lightning.	Existing	3	Lightning, Thunderstorm Wind	City Emergency Management	<$10,000	City Budget, Staff Time	1 year
City of Sugar Land-23 (previous action)	Water Conservation Public Outreach	Educate the public on the importance of water conservation and steps the public can take to limit water waste.	New and Existing	3, 5	Drought	City Emergency Management	<$10,000	City Budget, Staff Time	1 year
City of Sugar Land-24 (previous action)	Shelter-in-place procedures	Provide guidance to the public in shelter in place procedures.	New and Existing	3, 8	Tornado, Hurricane, Flood	City Emergency Management	<$10,000	City Budget, Staff Time	1 year
City of Sugar Land-25	Winter Storm Outreach Program	Develop a severe winter storm outreach program for City of Sugar Land citizens.	New and Existing	3	Severe Winter Storm	City Emergency Management	<10,000	City Budget, Staff Time	2 years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
(previous action)									
City of Sugar Land-26 (previous action)	General Public and First Responders Planning	Coordinate with Fort Bend County Health and Human Services in planning and exercises for vaccination and prophylaxis of the general public and first responders.	N/A	7, 8	Pandemic	City Emergency Management	Staff Time	City Budget	1 year
City of Sugar Land-27	Project Brazos	Project consists of 13 sites – 4 are in City of Sugar Land. Project includes design and construction to prevent additional erosion along the Brazos River that is compromising stability of the Levees.	New and Existing	4, 5	Erosion, Flood	Fort Bend County	>$100,000	CDBG-MIT; TWDB FIF; HMGP; PDM	5+ years
City of Sugar Land-28	Austin Park/Chimneystone Drainage Project	Design and construct a new channel to connect to LID#2. This will help reduce or eliminate flooding to 250+ homes in this area.	New and Existing	4	Flood	City of Sugar Land	$60.5 million	HMGP; TWDB Loan; CDBG-MIT	Within 3 years
City of Sugar Land-29	Covington Woods West	Improve and upgrade drainage in the Covington Woods West area of the City. This will help reduce street ponding.	New and Existing	4	Flood	City of Sugar Land	$3 million	CDBG-MIT	Within 3 years
City of Sugar Land-30	Oyster Creek Diversion Channel and Storage Facility in Tract 2	The proposed project includes the design and construction of a drainage solution (diversion channel and wet detention pond) to reduce the risk of flooding and associated damages to the Oyster Creek area and reduce the economic impact to critical facilities. The proposed project will remove the City of Sugar Land Airport, the Police Training Academy and the Central Unit Prison properties from the 100-year (Atlas 14) floodplain while minimizing any adverse downstream impacts. The project includes the construction of a 95 acres wet detention pond that will enhance and protect wetlands and park land in the project area.	Existing	4	Flood, Thunderstorm Wind	City Engineering	$27.4 million	TWDB	5+ years
City of Sugar Land-31	City-wide Benchmark System Update	Survey and installation of the benchmarks. Implement flood protection plan (describe additional	New and Existing	1, 2, 4	Flood	City Engineering	$20,000	HMGP	Within 3 years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
		benefits and applications) modeling to construction.							
City of Sugar Land-32	New Emergency Operations Center	Construct new EOC and Dispatch Center – The current EOC and Dispatch Center is over 25 Years old. Due to increased growth of the City and risk over the past 25 years, a larger facility is needed to address capacity needs. The new facility will be located on property directly behind the current Police Station within the flood plain.	New	1,4, 7, 8	Extreme Temperatures, Hail, Hazmat Spill, Lightning, Pandemic, Thunderstorm Wind, Tornadoes, Transportation, Hurricane, Erosion, Dam and Levee, Energy Shortage, Severe Winter Storm, Terrorism, Flood	City Engineering and Public Works	$11.5 million	UASI, HSGP	Within 5 years
City of Sugar Land-33	New Territory WWTP Road Elevation	During heavy rainfall events, the roads to the WWTP become flooded and access to the facility can only be obtained by boat. The projects propose is to elevate the access roads to the WWTP	Existing	4	Flood	City Engineering and Public Works	$230,000	TWDB, HMGP	5+ years
City of Sugar Land-34	New Territory WWTP Flood Protection	Purchase and install flood walls to protect chemical storage facilities at the WWTP that store hazardous materials utilized in the treatment process	Existing	4	Flood, Hazardous Material Spills	City Engineering and Public Works	$250,000	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-35	Structural Elevation & Acquisition Program	Develop a home elevation and/or acquisition program to prioritize the reduction of flood risk for severe repetitive loss properties and those structures in the SHFA	Existing	4	Flood	City Engineering/Emergency Management	TBD	FEMA HMGP, FMA/BRIC, CDBG	5+
City of Sugar Land-36	Flood/Dry-proofing critical facilities	Develop a program to prioritize the Flood/dry proofing of critical facilities in the SHFA	Existing	4	Flood	City Engineering/Emergency Management	TBD	FEMA HMGP, FMA/BRIC, CDBG	5+
City of Sugar Land-37	Elevation of WWTP Critical Assets	Elevate lift stations, critical assets and electrical components out of risk to flooding.	Existing	4	Flood	City Engineering and Public Works	$1,000,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-38	Stormwater Needs Assessment	City-wide Flood Prevention and Drainage Needs Assessment to identify drainage projects and additional flood mapping needs.	New and Existing	2	Flood	City of Sugar Land Engineering and Public Works	$600,000	HMGP, TWDB Loan	5+ years
City of Sugar Land-39	Stormwater impact fee	Conduct feasibility study to determine and implement a Stormwater impact fee program.	New and Existing	2, 6	Flood	City Engineering	100,000	FEMA HMGP, FMA/BRIC, CDBG	Within 3 years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-40	Development Code Changes - Impervious Surface	Limiting the percentage of allowable impervious surface for new development and re-developed sites city-wide.	New and Existing	4, 6, 7	Flood	City Engineering	Staff Time	City Budget	5+ years
City of Sugar Land-41	Development Code Changes - Water Retention	Coordinating with developers to construct on-site retention basins for excessive stormwater and a firefighting water source.	New and Existing	4, 6,7	Flood	City Engineering	Staff Time	City Budget	5+ years
City of Sugar Land-42	High Water Rescue Vehicle	High Water Rescue Vehicle to be deployed during emergency events to support first responder efforts and residents with rescue & evacuation.	New and Existing	7, 8	Flood	Emergency Management	20,000	FEMA HMGP, FMA/BRIC, CDBG	Within 1 year
City of Sugar Land-43	Updated LIDAR Data	Update 2014 city-wide LIDAR to update the City's flooding and ponding models.	New and Existing	2	Flood	City Engineering	50,000	FEMA, TWDB	3+ years
City of Sugar Land-44	Waste Water Treatment Back-up Power Supply	Installing back-up generators for pumping and lift stations in sanitary sewer systems along with other measures (e.g., alarms, meters, remote controls, and switchgear upgrades)	New and Existing	8	Energy/Fuel Shortage, Flood, Hail, Hurricane, Lightning, Thunderstorm Wind, Tornado, Severe Winter Storm	City Engineering/Public Works	$5,000,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-45	Power supply hardening to critical facilities	Bury power lines to critical facilities hospital, school, WWTP to ensure uninterrupted power	New and Existing	4, 8	Thunderstorm Wind, Tornado, Hurricane	City Engineering	$10,000,000	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-46	Window Hardening	Ballistic Resistant glass/Film for Critical Facilities	New and Existing	4	Thunderstorm Wind, Tornado, Hurricane, Hail	Public Works	$25,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-47	Critical Facility Hardening	Installing hardening measures for Critical facilities – Emergency Operations Center, fire stations, police, City Hall, WWTP to be more resistant wind, hurricane and hail.	New and Existing	4	Thunderstorm Wind, Tornado, Hurricane, Hail	City Engineering/Emergency Management	$10,000,000	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-48	Traffic Light Hardening	Traffic Lights- stabilizer, minimize cracking in mast arms and increase damage resistance in high wind events.	New and Existing	4	Thunderstorm Wind, Tornado, Hurricane, Transportation Accident	Public Works	$800,000	FEMA HMGP, FMA/BRIC, CDBG	3+ years
City of Sugar Land-49	Hurricane Sheltering and Evacuation Needs Assessment and Outreach Program	Hurricanes evacuation routes and Shelters of Last Resort - needs assessment and education and outreach program to identify and accommodate sheltering people who are stalled in traffic on a main	New and Existing	2, 3, 7, 8	Thunderstorm Wind, Tornado, Hurricane, Transportation Accident	Emergency Management	$50,000	FEMA HMGP, FMA/BRIC, CDBG, UASI, HSGP,	3+ years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
		evacuation route from the coastal communities and to communicate designated shelters and evacuation routes as a result of the study.							
City of Sugar Land-50	Lightning/ Severe Weather protocols for outside events.	Schools & parks- update and develop lightning protocols for all outdoor city events to ensure all attendees at outside events are aware of safety precautions.	New and Existing	1, 7	Lightning	ISD/Parks Department	$25,000	FEMA HMGP, FMA/BRIC, CDBG, UASI, HSGP	2+ years
City of Sugar Land-51	Update Lightning Alert and Severe Storm Monitoring and warning capabilities	Implement a service to detect lightning strikes within a certain mile radius. Warning for fires, and for any outdoor activities. Establish warning thresholds that indicate when not operate, utility preparation, and overall protection of public safety.	New and Existing	1, 7	Lightning	Public Works	$50,000	FEMA HMGP, FMA/BRIC, CDBG	Within 1 year
City of Sugar Land-52	Lightning Prevention Needs Assessment	Needs Assessment to evaluate if City's critical facilities are up to code on lightning and identify projects for facilities that are not in compliance.	New and Existing	2, 4, 6	Lightning	City Engineering/ Environmental and Neighborhood Services	$75,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-53	Update Erosion Study	Update the 2017 Brazos River Erosion Study.	New and Existing	2	Erosion	City Engineering	$100,000	FEMA HMGP, FMA/BRIC, CDBG	3+ years
City of Sugar Land-54	Erosion Management Plan	Develop an erosion management plan for the Brazos River.	New and Existing	2, 5	Erosion	City Engineering	$100,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-55	Project Brazos	Monitor annual erosion to the Brazos River (Drone/ LIDAR capability).	New and Existing	1, 2, 5	Erosion	City Engineering and Fort Bend County	$50,000	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-56	Design Standards Update for Soil Stabilization	Update design standards for development and redevelopment projects to incorporate soil stabilization techniques.	New and Existing	4, 6	Erosion	City Engineering	Staff Time	City Budget	5+ years
City of Sugar Land-57	SCADA Update for Dams	Update SCADA system to include data on dams located within the City.	New and Existing	1, 2, 7	Drought, Flood, Dam & Levee Failure	Public Works	$100,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-58	Drought Conservation Plan Update	Update 2017 Drought Conservation Plan.	New and Existing	2, 5, 7, 8	Drought	Public Works	$100,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-59	Update Integrated Water Resource Plan	Update 2018 Integrated Water Resource Plan.	New and Existing	2, 7, 8	Drought	Public Works	$500,000	FEMA HMGP, FMA/BRIC, CDBG	3+ years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-60	Update Landscape Ordinance	Incorporating drought tolerant or xeriscape practices into landscape ordinances to reduce dependence on irrigation in City of rights-of-way.	New and Existing	5, 6	Drought	Public Works	Staff Time	City Budget	Within 1 year
City of Sugar Land-61	WWTP Reclaim Systems	Expanding reclaim systems at south WWTP plant from 1/mgd to 2/mgd. For the North pant installing a new reclaim system for additional capacity up to 2/mgd.	New and Existing	4, 5	Drought	City Engineering/Public Works	$25,000,000	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-62	Purchase Advanced Metering Infrastructure System	Purchase and install Advanced Metering Infrastructure (AMI) which is an integrated system of customer water meters, communication networks and data management systems that provide real time water use information to the city and its residents.	New and Existing	2, 3, 7	Drought	Public Works	$20,000,000	FEMA HMGP, FMA/BRIC, CDBG	3+ years
City of Sugar Land-63	Development Code Changes - Green Space Requirements	Establishing a "green infrastructure" program to link, manage, and expand existing parks, preserves, greenways, etc. (easements)	New and Existing	3, 4, 5 7	Drought, Erosion, Flood	City Engineering	Staff Time	City Budget	5+ years
City of Sugar Land-64	Vulnerable Population/ Critical Facilities Database	Update/ Develop data base to define and identify critical facilities for vulnerable populations such as Nursing homes and medical service providers.	New and Existing	2, 8	Extreme Temperatures, Hail, Hazmat Spill, Lightning, Pandemic, Thunderstorm Wind, Tornadoes, Transportation, Hurricane, Erosion, Dam and Levee, Energy Shortage, Severe Winter Storm, Terrorism, Flood	Emergency Management	$50,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-65	Homeowner Outreach Program	Develop quarterly program to inform homeowners of hazard risk, hazard reducing materials, techniques, and funding opportunities [Water saving techniques (rain barrels, appliance/ rebate programs for smart meters) and Hail resistance materials and insurance incentives]	New and Existing	3	Extreme Temperatures, Hail, Lightning, Pandemic, Thunderstorm Wind, Tornadoes, Hurricane, Severe Winter Storm, Flood	Emergency Management	$50,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-66	Drone Purchase	Purchase a drone with the appropriate camera to perform regular assessments of impacted areas for data collection related to mitigation efforts	New and Existing	1, 2, 7, 8	Hail, Hazmat Spill, Lightning, Thunderstorm Wind, Tornadoes, Transportation, Hurricane, Erosion, Dam and Levee, Severe Winter Storm, Terrorism, Flood	Communications	$50,000	FEMA HMGP, FMA/BRIC, CDBG	Within a year
City of Sugar Land-67	Software Purchase	Purchase and install software to manage and analyze collected drone data in relation to mitigation efforts	New and Existing	1, 2, 7, 8	Hail, Hazmat Spill, Lightning, Thunderstorm Wind, Tornadoes, Transportation, Hurricane, Erosion, Dam and Levee, Severe Winter Storm, Terrorism, Flood	Communications	$50,000	FEMA HMGP, FMA/BRIC, CDBG	Within a year
City of Sugar Land-68	Establish Design Standards for Channel Repair	All parties (county, city, LID's) to establish design standards to address sloughing and repair of the channel for Ditch H	New and Existing	4, 6, 7	Flood	City Engineering	$500,000	FEMA, TWDB	3+ years
City of Sugar Land-69	Surface Water Treatment Plant Access Road Elevation	During flooding events, the roadway between the Surface Water Treatment Plant and the fore bay/intake area become flooded, preventing access to the fore bays and intake for operations and maintenance. The City will elevate roadway between the SWTP main area and fore bays to deter flooding	New and Existing	4, 8	Flood	City Engineering and Public Works	$1,000,000	TWDB	5+ years
City of Sugar Land-70	Back-up power for Homeward Way Production Plan	Upgrade/Replace generator with an appropriately sized generator at Homeward Way Groundwater Production Plant. Current generator capacity is insufficient to power plant during utility power loss.	New and Existing	8	Energy/Fuel Shortage, Flood, Hail, Hurricane, Lightning, Tornado, Thunderstorm Wind, Severe Winter Storm	Public Works	$350,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-71	SWTP Hurricane Shutters	Add hurricane shutters to Surface Water Treatment Plant control room has windows covering the South and East walls to protect personnel and critical equipment.	New and Existing	4, 8	Hurricane	Public Works	20,000	FEMA HMGP, FMA/BRIC, CDBG	2+ years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land-72	ETJ Code Update	Develop and establish consistent code requirements and enforcement between the City's building codes and development in the ETJ.	New and Existing	6, 7	Hail, Lightning, Thunderstorm Wind, Tornadoes, Transportation, Hurricane, Erosion, Dam and Levee, Flood	Code Enforcement Division	Staff Time	FEMA HMGP, FMA/BRIC, CDBG	3+ years
City of Sugar Land-73	SWTP Surge Protection	Install surge protection at the SWTP to incoming power supply due to power surges cause by severe weather events.	New and Existing	8	Thunderstorm Wind	Public Works	$200-500K	FEMA HMGP, FMA/BRIC, CDBG	2+ years
City of Sugar Land-74	Update City's Warning System Update	Enhance City warning system (Reverse 911) to include additional hazards and alert capabilities, especially tornado/ high winds with more city focus on informing public.	New and Existing	1, 3	Thunderstorm Wind, Tornado	Emergency Management/ 911-Dispatch	$100K	FEMA HMGP, FMA/BRIC, CDBG, UASI, HSGP	Within 1 year
City of Sugar Land-75	Implement Stone toe protection for Brazos River	Implement proposed USACE stone toe protection plans for sample area due to stabilize and reduce Brazos River erosion and encroachment to levees.	New and Existing	5	Erosion, Dam and Levee Failure	City Engineering	$100M	FEMA HMGP, FMA/BRIC, CDBG	3+ years
City of Sugar Land-76	Brazos River Initiative	Increase coordination efforts with the Texas Water Development Board to update information on the Brazos River and increase multi-agency coordination.	New and Existing	5, 7	Erosion	City Engineering and Fort Bend County	Staff Time	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-77	Update Design Standards utilize native species in construction	Further conservation efforts to encourage more natural and native grasses and plants in construction through increased design standards.	New and Existing	3, 5, 6	Drought	City Engineering	$50,000	TWDB	5+ years
City of Sugar Land-78	Water Systems Update	Construct emergency interconnections between the main city and New Territory water systems, main city and Greatwood water systems, and RiverPark and New Territory water systems due to lack of emergency interconnections between city water systems.	New and Existing	4, 8	Drought	Public Works	$40,000,00	FEMA HMGP, FMA/BRIC, CDBG	5+ years
City of Sugar Land-79	Back-up Generators at New Territory (West); Greatwood; North Plant; South Plant WWTP	Install and replace generators to increase capacity of available back-up power at all 4 WWTP that services the City.	New and Existing	8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$6,000,000	FEMA HMGP, FMA/BRIC, CDBG	1 years

Project Number	Project Name	Description of Project	Applies to New or Existing Assets	Goals Met	Hazard(s) Mitigated	Lead and Support Agencies	Estimated Costs	Potential Funding Sources	Estimated Timeline
City of Sugar Land -80	South Plant WWTP Shelter	Purchase and construct shelter for WWTP staff who must remain at the facility during disaster events to ensure continuous operations at the facility.	New and Existing	4, 8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$500,000	FEMA HMGP, FMA/BRIC, CDBG	2 years
City of Sugar Land -81	Remote well right angle drive and generator	Purchase and install right angle drives and generators at 6 remote well locations that provide water supply, located throughout the City.	New and Existing	8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$6,000,000	FEMA HMGP, FMA/BRIC, CDBG	1 years
City of Sugar Land -82	Surface Water Plant Generator	Purchase and install (3) 750kw generators at the surface water treatment plant which provides water supply to the City.	New and Existing	8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$10,000,000	FEMA HMGP, FMA/BRIC, CDBG	1 years
City of Sugar Land -83	Generators for City's Wireless System	Purchase and install generators at 10 high sites around the City to support communications and IT infrastructure during disaster events.	New and Existing	8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$200,000	FEMA HMGP, FMA/BRIC, CDBG	1 years
City of Sugar Land -84	Back-up Power supply for traffic signals.	Purchase 45 portable generators for traffic signals.	New and Existing	8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$150,000	FEMA HMGP, FMA/BRIC, CDBG	1 year
City of Sugar Land -85	Fuel Trailer	Purchase 1000-gallon fuel trailer to provide fuel service to various generator sites located throughout the City.	New and Existing	7, 8	Winter Storm; Hurricane; Flood; Tornado; Thunderstorm Wind	Public Works	$40,000	FEMA HMGP, BRIC, CDBG	1 year

Notes:
Not all acronyms and abbreviations defined below are included in the table.

Acronyms and Abbreviations:

CAV Community Assistance Visit
CRS Community Rating System
FEMA Federal Emergency Management Agency
HMA Hazard Mitigation Assistance
N/A Not applicable
NFIP National Flood Insurance Program

Potential FEMA HMA Funding Sources:

FMA Flood Mitigation Assistance Grant Program
HMGP Hazard Mitigation Grant Program
PDM Pre-Disaster Mitigation Grant Program
BRIC Building Resilient Infrastructure and Communities

Timeline:

The time required for completion of the project upon implementation

Mitigation Category:

- *Local Plans and Regulations (LPR) – These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.*
- *Structure and Infrastructure Project (SIP) - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.*
- *Natural Systems Protection (NSP) – These are actions that minimize damage and losses and preserve or restore the functions of natural systems.*

- *Education and Awareness Programs (EAP) – These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady and Firewise Communities*

CRS Category:

- *Preventative Measures (PR) - Government, administrative or regulatory actions, or processes that influence the way land and buildings are developed and built. Examples include planning and zoning, floodplain local laws, capital improvement programs, open space preservation, and storm water management regulations.*
- *Property Protection (PP) - These actions include public activities to reduce hazard losses or actions that involve (1) modification of existing buildings or structures to protect them from a hazard or (2) removal of the structures from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.*
- *Public Information (PI) - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and educational programs for school-age children and adults.*
- *Natural Resource Protection (NR) - Actions that minimize hazard loss and preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.*
- *Structural Flood Control Projects (SP) - Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include dams, setback levees, floodwalls, retaining walls, and safe rooms.*
- *Emergency Services (ES) - Actions that protect people and property during and immediately following a disaster or hazard event. Services include warning systems, emergency response services, and the protection of essential facilities*

6.3.2 Mitigation Strategy Prioritization and Implementation

Table 6-4 lists the priority of each mitigation strategy identified for the City of Sugar Land. A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

Implementation Priority

- High Priority—An action that meets multiple objectives, has benefits that exceed costs, and has a secured source of funding. Action can be completed in the short term (1 to 5 years).
- Medium Priority—An action that meets multiple objectives, has benefits that exceed costs, and is eligible for funding though no funding has yet been secured for it. Action can be completed in the short term (1 to 5 years), once funding is secured. Medium-priority actions become high-priority actions once funding is secured.
- Low Priority—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no secured source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions are generally “wish-list” actions. They may be eligible for grant funding from programs that have not yet been identified.

Grant Pursuit Priority

- High Priority—An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium implementation priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.
- Medium Priority—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low implementation priority; local funding options are unavailable.
- Low Priority—An action that has not been identified as meeting any grant eligibility requirements.

Table 6-4. Summary of Prioritization of Actions

Project Number	# of Goals Met	Benefit	Cost	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded Under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
City of Sugar Land-1 (previous action)	1	High	Low	Yes	Yes	No	Medium	Medium
City of Sugar Land-2 (previous action)	1	High	Low	Yes	Yes	No	Medium	Medium
City of Sugar Land-3 (previous action)	2	Medium	Low	Yes	Yes	Yes	High	Low
City of Sugar Land-4 (previous action)	1	Medium	Low	Yes	Yes	Yes	High	Low
City of Sugar Land-5 (previous action)	2	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-6 (previous action)	2	High	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-7 (previous action)	1	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-8 (previous action)	1	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-9 (previous action)	2	Medium	Low	Yes	Yes	Yes	Medium	Medium
City of Sugar Land-10 (previous action)	2	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-11 (previous action)	2	Medium	Low	Yes	No	Yes	Medium	Low

Project Number	# of Goals Met	Benefit	Cost	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded Under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
City of Sugar Land-12 (previous action)	3	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-13 (previous action)	3	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-14 (previous action)	3	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-15 (previous action)	3	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-16 (previous action)	1	High	Low	Yes	Yes	Yes	Medium	Low
City of Sugar Land-17 (previous action)	2	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-18 (previous action)	3	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-19 (previous action)	3	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-20 (previous action)	1	Medium	High	Yes	Yes	No	Medium	Medium
City of Sugar Land-21 (previous action)	1	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-22 (previous action)	2	High	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-23 (previous action)	2	High	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-24 (previous action)	2	High	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-25 (previous action)	1	High	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-26 (previous action)	2	Medium	Low	Yes	No	Yes	Medium	Low
City of Sugar Land-27	2	High	High	Yes	Yes	Yes	High	High
City of Sugar Land-28	1	High	High	Yes	Yes	Yes	High	High
City of Sugar Land-29	1	High	High	Yes	Yes	Yes	High	High
City of Sugar Land-30	1	High	High	Yes	Yes	Yes	High	High
City of Sugar Land-31	3	High	High	Yes	Yes	Yes	Medium	Medium
City of Sugar Land-32	4	High	High	Yes	Yes	Yes	High	High
City of Sugar Land-33	1	High	Medium	Yes	Yes	No	High	Medium
City of Sugar Land-34	1	High	Medium	Yes	Yes	No	Medium	Low
City of Sugar Land-35	1	High	TBD	Yes	Yes	No	Low	Low
City of Sugar Land-36	1	High	TBD	Yes	Yes	No	Medium	Low
City of Sugar Land-37	1	High	Medium	Yes	Yes	No	High	Medium
City of Sugar Land-38	1	High	Medium	Yes	Yes	No	High	High
City of Sugar Land-39	2	Medium	Low	Yes	Yes	No	Low	Low
City of Sugar Land-40	3	Medium	Low	Yes	Yes	Yes	Low	Low
City of Sugar Land-41	3	Medium	Low	Yes	No	Yes	Low	Low

Project Number	# of Goals Met	Benefit	Cost	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded Under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
City of Sugar Land-42	2	Low	Low	Yes	Yes	No	High	Medium
City of Sugar Land-43	1	High	Low	Yes	Yes	Yes	Medium	Medium
City of Sugar Land-44	1	High	Medium	Yes	Yes	No	Medium	Medium
City of Sugar Land-45	2	High	High	Yes	Yes	No	Low	Low
City of Sugar Land-46	1	Low	Low	Yes	Yes	Yes	Low	Low
City of Sugar Land-47	1	High	High	Yes	Yes	No	High	Medium
City of Sugar Land-48	1	Medium	Medium	Yes	Yes	No	Low	Low
City of Sugar Land-49	4	High	Low	Yes	Yes	Yes	High	High
City of Sugar Land-50	2	Low	Low	Yes	Yes	Yes	Low	Low
City of Sugar Land-51	2	Low	Low	Yes	Yes	No	Low	Low
City of Sugar Land-52	3	Medium	Low	Yes	Yes	No	Low	Low
City of Sugar Land-53	1	High	Low	Yes	Yes	Yes	High	High
City of Sugar Land-54	2	High	Low	Yes	Yes	Yes	High	High
City of Sugar Land-55	3	Medium	Low	Yes	Yes	Yes	High	High
City of Sugar Land-56	2	Low	Low	Yes	Yes	Yes	Medium	Low
City of Sugar Land-57	3	High	Low	Yes	Yes	No	Medium	Medium
City of Sugar Land-58	4	High	Low	Yes	Yes	No	High	High
City of Sugar Land-59	3	High	Low	Yes	Yes	No	High	High
City of Sugar Land-60	2	Low	Low	Yes	Yes	Yes	Low	Low
City of Sugar Land-61	2	High	High	Yes	Yes	No	High	High
City of Sugar Land-62	3	High	High	Yes	Yes	No	Medium	High
City of Sugar Land-63	4	Low	Low	Yes	Yes	No	Low	Low
City of Sugar Land-64	2	Medium	Low	Yes	No	No	Medium	Low
City of Sugar Land-65	1	Low	Low	Yes	Yes	No	Low	Low
City of Sugar Land-66	4	Medium	Low	Yes	Yes	No	Medium	Medium
City of Sugar Land-67	4	High	Low	Yes	Yes	No	Medium	Medium
City of Sugar Land-68	3	High	Low	Yes	Yes	No	Medium	Medium
City of Sugar Land-69	2	High	Medium	Yes	Yes	No	High	High
City of Sugar Land-70	1	High	Medium	Yes	Yes	No	High	High

Project Number	# of Goals Met	Benefit	Cost	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded Under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
City of Sugar Land-71	2	High	Low	Yes	Yes	Yes	Medium	Medium
City of Sugar Land-72	2	Low	Low	Yes	Yes	Yes	Low	Low
City of Sugar Land-73	1	Medium	Medium	Yes	Yes	No	Medium	Medium
City of Sugar Land-74	2	High	Low	Yes	Yes	No	High	High
City of Sugar Land-75	1	High	High	Yes	Yes	No	High	High
City of Sugar Land-76	2	Medium	Low	Yes	Yes	Yes	Medium	Medium
City of Sugar Land-77	3	Low	Low	Yes	Yes	No	Low	Low
City of Sugar Land-78	2	High	High	Yes	Yes	Yes	High	High
City of Sugar Land-79	1	High	High	Yes	Yes	No	High	High
City of Sugar Land-80	2	High	Medium	Yes	Yes	No	High	High
City of Sugar Land-81	1	High	High	Yes	Yes	No	High	High
City of Sugar Land-82	1	High	High	Yes	Yes	No	High	High
City of Sugar Land-83	1	High	Medium	Yes	Yes	No	High	High
City of Sugar Land-84	1	High	Medium	Yes	Yes	No	High	High
City of Sugar Land-85	2	High	Low	Yes	Yes	Yes	High	High

6.3.3 Classification of Mitigation Actions

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Please note that this plan is using the 6 mitigation categories defined under activity 510 of the Community Rating System (CRS) program. Please note that the CRS program is considered to be a higher standard than those specified by FEMA for compliance with the provisions of 44CFR, section 201.6. The CRS program criteria was a big driver for this planning effort, as 16 of the municipal planning partners in this effort participate in the CRS program. This classification expands upon the 4 mitigation categories defined by FEMA. Table 6-5 shows these classifications.

Mitigation types used for this categorization are as follows:

- Prevention—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- Property Protection—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.

- Public Education and Awareness—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- Natural Resource Protection—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.
- Emergency Services—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- Structural Projects—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- Climate Resiliency—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea level rise or urban heat island effect.
- Community Capacity Building—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

Table 6-5. Analysis of Mitigation Actions

	Actions that Address the Hazard, by Mitigation Type							
Hazard	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilience	Community Capacity Building
Dam and Levee Failure	X							X
Drought	X		X	X		X		X
Energy/Fuel Shortage			X		X			X
Erosion	X	X	X	X		X		X
Extreme Temperature			X					X
Flood	X	X	X	X	X	X		X
Hail			X		X	X		
Hazardous Material Spills	X		X			X		X
Hurricane		X	X		X			
Lightning	X	X	X		X	X		
Pandemic	X							X
Severe Winter Storm	X		X		X			X
Terrorism	X				X			X
Thunderstorm Wind	X	X	X		X	X		X
Tornadoes	X	X	X		X	X		X
Transportation Accidents			X		X			

SECTION 7. PLAN ADOPTION, IMPLEMENTATION, AND MAINTENANCE

This section details the formal process that will ensure that the HMP remains an active and relevant document and that the Steering Committee maintains their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. In addition, this section describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategies outlined in this plan update will be incorporated into existing planning mechanisms and programs, such as comprehensive land use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

7.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted.

This plan update was submitted to the City of Sugar Land 2020 Hazard Mitigation Plan Update Steering Committee and Core Planning Team, as well as the general public for review and comments. The Core Planning Team incorporated all appropriate edits in response to comment. Once finalized, it was presented to City of Sugar Land City Council for approval to submit to the Texas Division of Emergency Management. This plan will be submitted for a pre-adoption review to Texas Division of Emergency Management and FEMA Region VI prior to adoption. Once pre-adoption approval has been provided, the City of Sugar Land will adopt the plan. DMA compliance and its benefits cannot be achieved until the plan is adopted. A copy of the City's resolution adopting this plan can be found in Appendix A of this plan.

7.2 PLAN MAINTENANCE PROCEDURES

The plan maintenance matrix shown in Table 7-1 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Table 7-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	September or upon major update to Comprehensive Plan or major disaster	HMP point of contact identified in Section 2 (Planning Process)	HMP lead identified in Section 2 (Planning Process)
Integration	In order for integration of mitigation principles action to become an organic part of the ongoing municipal activities, the City will incorporate the distribution of the safe growth worksheet (see 7.3.4 below) for annual review and update by the City.	September each year with interim email reminders to address integration in municipal activities.	HMP Coordinator identified in Section 2 (Planning Process)	HMP Coordinator

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan; compile and finalize the Annual Progress Report	Finalized progress report completed by August 14 of each year	Steering Committee; Plan Maintenance element	HMP point of contact identified in Section 2 (Planning Process)
Update	Reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years or upon major update to Comprehensive Plan or major disaster	City of Sugar Land HMP Coordinator	HMP point of contact identified in Section 2 (Planning Process)

7.3 MONITORING, EVALUATING AND UPDATING THE PLAN

The procedures for monitoring, evaluating, and updating the plan are provided below.

The HMP Coordinator is assigned to manage the maintenance and update of the plan during its performance period. The HMP Coordinator will chair the Steering Committee and be the prime point of contact for questions regarding the plan and its implementation as well as to coordinate incorporation of additional information into the plan. The Steering Committee shall fulfill the monitoring, evaluation and updating responsibilities identified in this section which is comprised of a representative from the City.

Regarding the composition of the committee, it is recognized that individual commitments change over time, and it shall be the responsibility of the City to inform the HMP Coordinator of any changes in representation. The HMP Coordinator will strive to keep the committee makeup as a uniform representation of planning partners and stakeholders within the planning area.

Currently, the City of Sugar Land HMP Coordinator is designated as:

Patrick K. Hughes, TEM, EMC | Assistant Fire Chief
2700 Town Center Blvd. North | Sugar Land, Texas 77478
phughes@sugarlandtx.gov
Phone: (281) 275- 2860

7.3.1 Monitoring

The Steering Committee will be responsible for monitoring progress on, and evaluating the effectiveness of, the plan, and documenting annual progress. Each year, beginning one year after plan development, the City of Sugar Land will collect and process information from the departments, agencies and organizations involved in implementing mitigation projects or activities identified in Section 6 (Mitigation Strategy) of this plan, by contacting persons responsible for initiating and/or overseeing the mitigation projects.

In addition to progress on the implementation of mitigation actions, including efforts to obtain outside funding; and obstacles or impediments to implementation of actions, the information that Steering Committee representatives shall be expected to document, as needed and appropriate include:

- Any grant applications filed on behalf of the City,
- Hazard events and losses occurring in their jurisdiction,
- Additional mitigation actions believed to be appropriate and feasible, and
- Public and stakeholder input.

7.3.2 Evaluating

The evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, if the HMP goals are being achieved, and whether changes are needed. The HMP will be evaluated on an annual basis to determine the effectiveness of the programs, and to reflect changes that could affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting of the Steering Committee, to be held either in person or via teleconference approximately one year from the date of local adoption of this update, and successively thereafter. At least two weeks before the annual plan review meeting, the City of Sugar Land HMP Coordinator will advise Steering Committee members of the meeting date, agenda and expectations of the members.

The City of Sugar Land HMP Coordinator will be responsible for calling and coordinating the annual plan review meeting and Soliciting input regarding progress toward meeting plan goals and objectives.. These evaluations will assess whether:

- Goals and objectives address current and expected conditions.
- The nature or magnitude of the risks has changed.
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available.
- Actions were cost effective.
- Schedules and budgets are feasible.
- Implementation problems, such as technical, political, legal or coordination issues with other agencies are presents.
- Outcomes have occurred as expected.
- Changes in city resources impacted plan implementation (e.g., funding, personnel, and equipment)
- New agencies/departments/staff should be included, including other local governments as defined under 44 CFR 201.6.

Specifically, the Steering Committee will review the mitigation goals, objectives, and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Under/over spending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Steering Committee will evaluate how other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions ("Implementation of Mitigation Plan through Existing Programs" subsection later in this section discusses this process). Other programs and policies can include those that address:

- Economic development
- Environmental preservation
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public education and outreach
- Transportation

The Steering Committee should refer to the evaluation forms, Worksheets #2 and #4 in the FEMA 386-4 guidance document, to assist in the evaluation process (see Appendix E – Plan Review Tools). Further, the Steering Committee should refer to any process and plan review deliverables developed by the City as a part of the plan review processes established for prior or existing local HMPs within the City.

The City of Sugar Land HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report for each year of the performance period, based on the information provided by the local Steering Committee members, information presented at the annual Steering Committee meeting, and other information as appropriate and relevant. These annual reports will provide data for the five-year update of this HMP and will assist in pinpointing any implementation challenges. By monitoring the implementation of the HMP on an annual basis, the Steering Committee will be able to assess which projects are completed, which are no longer feasible, and what projects should require additional funding.

The Annual HMP Progress Report shall be posted on the City of Sugar Land's website to keep the public appraised of the plan's implementation (at https://www.sugarlandtx.gov/HMPAdditionally, the website provides details on the HMP update planning process. As a community in the CRS program, the City of Sugar Land can use this report to meet annual CRS recertification requirements. To meet this recertification timeline, the Steering Committee will strive to complete the review process and prepare an Annual HMP Progress Report by October 14th of each year.

The HMP will also be evaluated and revised following any major disasters, to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 4.3 (Hazard Profiles) of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's disaster resistance and build a better and stronger community.

7.3.3 Updating

44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised as appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under DMA 2000. It is the intent of the City of Sugar Land HMP Steering Committee to update this plan on a five-year cycle from the date of initial plan adoption.

Plan Amendment

At any time, minor technical changes can be made to update the City of Sugar Land HMP. Material changes to mitigation actions or major revisions to the overall content of the HMP must be subject to formal adoption by the City of Sugar Land. The City will review the proposed changes and vote to accept, reject, or amend the modifications. Upon adoption, the amendment will be transmitted to TDEM.

Five Year Review

To facilitate the update process, the City of Sugar Land HMP Coordinator, with support of the Steering Committee, shall use the second annual Steering Committee meeting to develop and commence the implementation of a detailed plan update program. The City of Sugar Land HMP Coordinator shall invite representatives from TDEM to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish who shall be responsible for managing and completing the plan update effort, what needs to be included in the updated plan, and a detailed timeline with milestones to assure that the update is completed according to regulatory requirements.

At this meeting, the Steering Committee shall determine what resources will be needed to complete the update. The City of Sugar Land HMP Coordinator shall be responsible for assuring that needed resources are secured.

Following each five-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all planning group members and the Texas State Hazard Mitigation Officer.

7.3.4 Integration Process of the HMP into Municipal Planning Mechanisms

Hazard mitigation is sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do no increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The City of Sugar Land Steering Committee was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Refer to Section 5 (Capability Assessment) for how this is done for the City. During this process, the City recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes.

The Steering Committee representatives will incorporate mitigation planning as an integral component of daily government operations. Steering Committee representatives will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Steering Committee anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts;
2. The Hazard Mitigation Plan, Comprehensive Plan, Emergency Management Plan and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of City residents.

During the HMP annual review process, each participating municipality will be asked to document how they are utilizing and incorporating the City of Sugar Land HMP into their day-to-day operations and planning and regulatory processes. Additionally, the City will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report. The following checklist was adapted from FEMA's Local Mitigation Handbook (2013), Appendix A, Worksheet 4.2. This checklist will help a community analyze how hazard mitigation is integrated into local plans, ordinances, regulations, ordinances, and policies. By completing the checklist, it will help the City identify areas that integrate hazard mitigation currently and where to make improvements and reduce vulnerability to future development. In this manner, the integration of mitigation into municipal activities will evolve into an ongoing culture within the City.

Table 7-2. Safe Growth Check List

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
Operating, Municipal and Capital Improvement Program Budgets			
• When constructing upcoming budgets, hazard mitigation actions will be funded as budget allows. Construction projects will be evaluated to see if they meet the hazard mitigation goals.			
• Annually, during adoption process, the municipality will review mitigation actions when allocating funding.			
• Do budgets limit expenditures on projects that would encourage development in areas vulnerable to natural hazards?			
• Do infrastructure policies limit extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards?			
• Do budgets provide funding for hazard mitigation projects identified in the City HMP?			
Human Resource Manual			
• Do any job descriptions specifically include identifying and/or implementing mitigation projects/actions or other efforts to reduce natural hazard risk?			
Building and Zoning Ordinances			
• Prior to, zoning changes, or development permitting, the municipality will review the hazard mitigation plan and other hazard analyses to ensure consistent and compatible land use.			
• Does the zoning ordinance discourage development or redevelopment within natural areas including wetlands, floodways, and floodplains?			
• Does it contain natural overlay zones that set conditions			
• Does the ordinance require developers to take additional actions to mitigate natural hazard risk?			
• Do rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use?			
• Do the ordinances prohibit development within, of filling of, wetlands, floodways, and floodplains?			
Subdivision Regulations			
• Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
• Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
• Do the regulations provide for conservation subdivisions or cluster subdivisions in order to conserve environmental resources?			

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
• Do the regulations allow density transfers where hazard areas exist?			
Comprehensive Plan			
• Are the goals and policies of the plan related to those of the City HMP?			
• Does the future land use map clearly identify natural hazard areas?			
• Do the land use policies discourage development or redevelopment with natural hazard areas?			
• Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Land Use			
• Does the future land use map clearly identify natural hazard areas?			
• Do the land use policies discourage development or redevelopment with natural hazard areas?			
• Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Transportation Plan			
• Does the transportation plan limit access to hazard areas?			
• Is transportation policy used to guide growth to safe locations?			
• Are transportation systems designed to function under disaster conditions (e.g. evacuation)?			
Environmental Management			
• Are environmental systems that protect development from hazards identified and mapped?			
• Do environmental policies maintain and restore protective ecosystems?			
• Do environmental policies provide incentives to development that is located outside protective ecosystems?			
Grant Applications			
• Data and maps will be used as supporting documentation in grant applications.			
Municipal Ordinances			
• When updating municipal ordinances, hazard mitigation will be a priority			
Economic Development			
• Local economic development group will take into account information regarding identified hazard areas when assisting new businesses in finding a location.			
Public Education and Outreach			
• Does the municipality have any public outreach mechanisms / programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

7.4 IMPLEMENTATION OF MITIGATION PLAN THROUGH EXISTING PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the City there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those existing plans and programs.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county and local) that support hazard mitigation within the City. Additionally, the City identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("existing integration"), and how they intend to promote this integration ("opportunities for future integration").

It is the intention of Steering Committee representatives to incorporate mitigation planning as an integral component of daily government operations. Steering Committee representatives will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Steering Committee anticipates that:

1) Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts;
2) The Hazard Mitigation Plan, Comprehensive Plan, Emergency Management Plan and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of City residents.

Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans
- Training and exercise of emergency response plans
- Debris management plans
- Recovery plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community Wildfire Protection Plans
- Comprehensive Flood Hazard Management Plans
- Resiliency plans
- Community Development Block Grant-Disaster Recovery action plans
- Public information/education plans

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

During the annual plan evaluation process, the Steering Committee representatives will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report.

7.5 CONTINUED PUBLIC INVOLVEMENT

The City of Sugar Land is committed to the continued involvement of the public in the hazard mitigation process. This HMP update will continue to be posted on-line (https://www.sugarlandtx.gov/HMPIn addition, public outreach and dissemination of the HMP will include:

- Continued utilization of existing social media outlets (Facebook, Twitter) to inform the public of natural hazard events, such as floods and severe storms. Educate the public via the jurisdictional websites on how these applications can be used in an emergency situation.
- Development of annual articles or workshops on flood hazards to educate the public and keep them aware of the dangers of flooding.

Steering Committee representatives and the HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan via the hazard mitigation website at any time. The HMP Coordinator will maintain this website, posting new information and maintaining an active link to collect public comments.

The public can also provide input at the annual review meeting for the HMP and during the next five-year plan update. The City of Sugar Land HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. Additional meetings might also be held as deemed necessary by the planning group. The purpose of these meeting would be to provide the public an opportunity to express concerns, opinions, and ideas about the mitigation plan.

The Steering Committee representatives shall be responsible to assure that:

- Public comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan (or draft in the case that the five-year update effort is underway) are available for review, along with instructions to facilitate public input and comment on the Plan.
- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during Plan update cycles.

The City of Sugar Land HMP Coordinator shall be responsible to assure that:

- Public and stakeholder comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- The City of Sugar Land HMP website is maintained and updated as appropriate.
- Copies of the latest approved plan are available for review at appropriate City facilities along with instructions to facilitate public input and comment on the plan.

- Public notices, including media releases, are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.

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APPENDIX A. ADOPTION RESOLUTIONS

City of Sugar Land adoption resolution will be included in this appendix upon receipt of the Federal Emergency Management Agency (FEMA) Approval Pending Adoption (APA) status. This appendix also includes an example resolution to be submitted by City of Sugar Land authorizing adoption of the Sugar Land Hazard Mitigation Plan Update.

RESOLUTION NO. XXXX-XX

A RESOLUTION OF THE Governing Body OF THE Jurisdiction Name

AUTHORIZING THE ADOPTION OF THE

2020 CITY OF SUGAR LAND, TX HAZARD MITIGATION PLAN UPDATE

WHEREAS, all jurisdictions within Sugar Land, Texas have exposure to natural hazards that increase the risk to life, property, environment, and the City and local economy; and

WHEREAS; pro-active mitigation of known hazards before a disaster event can reduce or eliminate long-term risk to life and property; and

WHEREAS, The Disaster Mitigation Act of 2000 (Public Law 106-390) established new requirements for pre and post disaster hazard mitigation programs; and

WHEREAS; a coalition of City of Sugar Land stakeholders with like planning objectives has been formed to pool resources and create consistent mitigation strategies within Sugar Land; and

WHEREAS, the coalition has completed a planning process that engages the public, assesses the risk and vulnerability to the impacts of natural hazards, develops a mitigation strategy consistent with a set of uniform goals and objectives, and creates a plan for implementing, evaluating and revising this strategy;

NOW, THEREFORE, BE IT RESOLVED that the [**jurisdiction name]**:

1) Adopts in its entirety, the 2020 City of Sugar Land, TX Hazard Mitigation Plan Update (the "Plan") as the jurisdiction's Natural Hazard Mitigation Plan, and resolves to execute the actions identified in the Plan that pertain to this jurisdiction.
2) Will use the adopted and approved portions of the Plan to guide pre- and post-disaster mitigation of the hazards identified.
3) Will coordinate the strategies identified in the Plan with other planning programs and mechanisms under its jurisdictional authority.
4) Will continue its support of the Mitigation Planning Committee as described within the Plan.
5) Will help to promote and support the mitigation successes of all participants in this Plan.
6) Will incorporate mitigation planning as an integral component of government and partner operations.
7) Will provide an update of the Plan in conjunction with the County no less than every five years.

PASSED AND ADOPTED on this Xst, Xnd, Xrd, Xth day of MONTH, YEAR, by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

____

Mayor, Town/Village of ______________

ATTEST: ___________________________

Clerk, Town/Village of ________

APPENDIX B. PARTICIPATION MATRIX

The matrix in Appendix B is intended to give a broad overview of FEMA, the State of Texas, county, municipal and stakeholder personnel that participated in the Sugar Land, TX HMP update planning process. Meeting attendees and input provided are also included.

Table B-1. Jurisdictions Notified of the Mitigation Plan Development and Invited to Participate

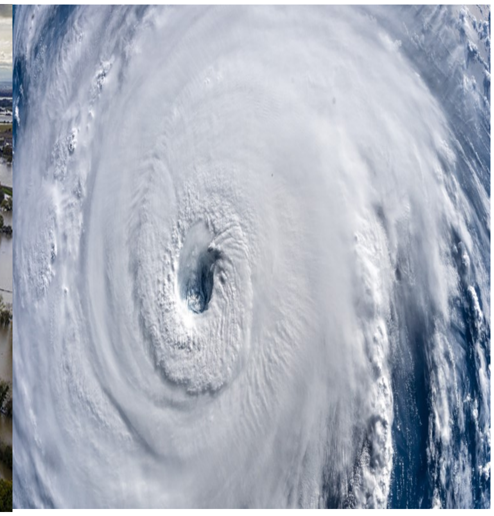
Jurisdiction	Name	Title / Position	Email	Invited to Participate	Date of Invitation	Method of Invitation	Agreed to Participate	Attended Meetings	Provided Feedback	Steering Committee Member	Designated Project Point of Contact
City of Sugar Land	Pat Hughes	Assistant Fire Chief/ EMC	phughes@sugarlandtx.gov					X		X	X
Police Department	Scott Schultz	Assistant Police Chief	sschultz@sugarlandtx.gov					X		X	X
Planning	Doug Schomburg	City Planner	dschomburg@sugarlandtx.gov					X		X	X
Public Works	Rob Valenzuela	Public Works Director	rvalenzuela@sugarlandtx.gov					X		X	X
Public Works	Brian Butscher	Assistant Public Works Director	bbutscher@sugarlandtx.gov					X		X	
Public Works	Eric Oscarson	Assistant Public Works Director	eoscarson@sugarlandtx.gov					X		X	
Public Works	Danica Mueller	Facility Ops Manager	dmueller@sugarlandtx.gov					X		X	X
Animal Services	Stacey Henderson	ENS Director	shenderson@sugarlandtx.gov					X		X	X
Animal Services	Dennis Winchell	Assistant ENS Director	dwinchell@sugarlandtx.gov					X		X	
Animal Services	Kathryn Ketchm	Animal Services Manager	kkatchm@sugarlandtx.gov					X		X	
Communications	Doug Adolph	Assistant Communications Director	dadolph@sugarlandtx.gov					X		X	X
Engineering	Jessie Li	City Engineer	jli@sugarlandtx.gov					X		X	X
Engineering	Jorge Alba	Flood Management Engineer	jalba@sugarlandtx.gov					X		X	X
N/A	Dr. Joe Anzaldua	Health Authority/ Medical Director	drjoe_anzaldua@comecast.net					X		X	X
Public Works	John Bailey	Surface Water Treatment Manager	jbailey@sugarlandtx.gov					X		X	X

Jurisdiction	Name	Title / Position	Email	Invited to Participate	Date of Invitation	Method of Invitation	Agreed to Participate	Attended Meetings	Provided Feedback	Steering Committee Member	Designated Project Point of Contact
Traffic Engineering	James Turner	Traffic Engineer	jturner@sugarlandtx.gov					X		X	X
Sugar Land Dispatch	Shannon Price	Director	sprice@sugarlandtx.gov					X		X	X
Sugar Land Dispatch	Amy Patin	Dispatch Ops Manager	apatin@sugarlandtx.gov					X		X	
Sugar Land Dispatch	Larry Hunter	Dispatch Manager	lhunter@sugarlandtx.gov					X		X	
Fort Bend County OEM	Alan Spears	Deputy EMC	alan.spears@fortbendcounty.tx.gov					X		X	X
TDEM	Ed Norman	District Coordinator 16D	edward.norman@dps.texas.gov					X		X	X
Nalco/ Champion	Scott Schawalder	Plant Manager	sschawalder@ecolab.com					X		X	X
Sugar Land Regional Airport	Cassie Slater	Operations Manager	cslater@sugarlandtx.gov					X		X	X
Sugar Land Methodist Hospital	Pete Munoz		PMunoz@houstonmethodist.org					X		X	X
Sugar Land Methodist Hospital	Sean Sevy		SXSevy@houstonmethodist.org					X		X	X
Saint Luke's Hospital Sugar Land	Eric Tauber	Emergency Services Director	etauber@stlukeshealth.org					X		X	
Saint Luke's Hospital Sugar Land	Jason	Facilities Manager						X		X	X
Memorial Hermann Hospital Sugar Land	Kord Quintero	Operations Manager	Kord.Quintero@memorialhermann.org					X		X	X
Army Corps of Engineers	Kalli Clark-Egan	Regional Business Tech	Kalli.clark-egan2@usace.army.mil					X		X	X
Brazos River Authority	Jay Webster	Chief of Law Enforcement/ EMC	jay.webster@brazos.org					X		X	X
Brazos River Authority	Don Naylor		don.naylor@brazos.org					X		X	X
Fort Bend Independent School District	Judy Lefevers	EMC	judy.lefevers@fortbendisd.com					X		X	X

Jurisdiction	Name	Title / Position	Email	Invited to Participate	Date of Invitation	Method of Invitation	Agreed to Participate	Attended Meetings	Provided Feedback	Steering Committee Member	Designated Project Point of Contact
NWS Houston Galveston	Dan Rilley	Warning Cood. Meteorologist	dan.rilley@noaa.gov					X		X	X
National Weather Service	Katie Landry-Guyton	Senior Service Hydrologist	katie.landry@noaa.gov					X		X	X

APPENDIX C. MEETING DOCUMENTATION

Appendix C includes meeting agendas, sign-in sheets and minutes (where applicable and available) for meetings convened during the development of the Sugar Land Hazard Mitigation Plan Update.



City of Sugar Land

Hazard Mitigation Plan

Informational Bulletin
November 2019

Core Planning Team

Chairperson
Rob Valenzuela
Rvalenzuela@sugarlandtx.gov

Vice-Chairperson
Pat Hughes
Phughes@sugarlandtx.gov

Project Manager
Chrissie Angeletti, JD
Chrissie.Angeletti@tetratech.com

Planner
Brian Rutherford
Brian.Rutherford@tetratech.com

Next Steering Committee Meeting
January, 16 2020
11:00 am to 1:00 pm

Up-coming Deliverables

- **Confirm Primary and Alternate point of Contact (e-mailed).**
  E-mail responses to Chrissie.angeletti@tetratech.com before December 20, 2019.

- **Review the 2018 State of Texas Hazard Mitigation Plan.**
  Become familiar with the hazards, goals and objectives.

- **Review the 2014 City of Sugar Land Hazard Mitigation Plan.**

- **Complete Goals Exercise (Handout/e-mailed).**
  Results to be discussed at next meeting.

- **Provide Feedback on Sample Survey (e-mailed).**
  E-mail responses to Chrissie.angeletti@tetratech.com before December 20, 2019

We understand this is a busy time of year and the first time many of you have been involved in a hazard mitigation planning process. We hope you are making progress on completing these deliverables, and know that some of you may have questions. Please contact a member of the Core Planning Team for assistance with any issue, we can work with you to finished the required deliverables!

October 17, 2019 Steering Committee Meeting Re-cap

On October 17, 2019, the Core Planning Team hosted the 1st Steering Committee Meeting for the City of Sugar Land Hazard Mitigation Plan Update with forty-nine persons in attendance. The Steering Committee established the following:

- Ground rules for future meetings and overall planning process.
- Bi-monthly meetings set for the third Thursday of the month beginning with the January 2020 Steering Committee meeting:

January 16, 2020
*** Risk Assessment Public Workshop - TBD**
March 19, 2020
May 21, 2020

First Steering Committee Bulletin

City of Sugar Land Hazard Mitigation Plan Update

October 17, 2019 Steering Committee Meeting Re-cap Cont'd

- Hazard Mitigation Plan Update planning process overview and Planning Area defined.
- Identified hazards of concern and conducted hazard prioritization exercise.

Natural Hazard Ranking Exercise - Results	
Flooding (*Inland, Riverine, and Severe Coastal Flooding)*	1
Hurricanes / Tropical Storms, Depressions	2
Severe Thunderstorms	3
Dam & Levee Failure	4
Tornadoes; Lightning	5
Erosion (Coastal, Inland)	*6*
Drought	7
Extreme Temperatures (Cold/Heat)	8
Hailstorms	9
Severe Winter Storms	10
Land Subsidence	*11*
Expansive Soils	*12*
Wildfire	*13*
Earthquakes	*14*

Non-Natural Hazard Ranking Exercise - Results	
Hazardous Material Spill	1
Aircraft Incidents/Transportation	2
Energy/Fuel Shortage	3/4
Terrorism	3/4
Cyber Attack	Write-In

- Definition of Critical Facilities presented, discussed, and confirmed.
- Public Involvement Strategy presented and discussed.
- Mission Statement reviewed and confirmed.

WISHING YOU

HAPPY AND SAFE HOLIDAYS

City of Sugar Land Hazard Mitigation Plan

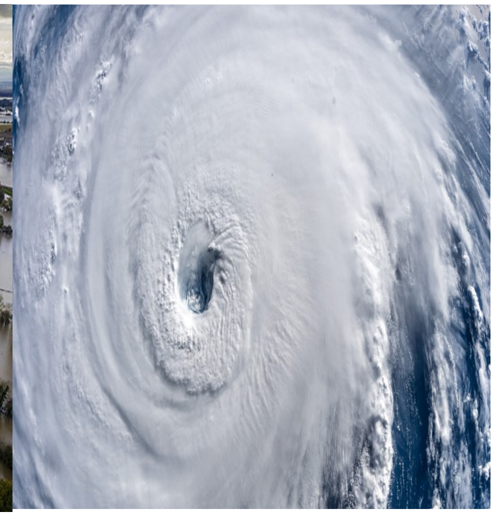
City of Sugar Land
2700 Town Center Blvd N.
Sugar Land, TX 77479

TETRA TECH

The City of Sugar Land is committed to creating and sustaining communities that are more resilient to disasters. To fulfill this pledge, the City is in the process of updating the Hazard Mitigation Plan (HMP) in partnership with local, state and federal stakeholders. Federal rules require the HMP to be updated every five years.

The Steering Committee is comprised of representatives from various City departments, local, state, and federal regulatory agencies, special districts, higher education, hospitals, private sector and members of the general public. The Steering Committee is collaborating with Tetra Tech Incorporated - the contractor leading the hazard assessment and HMP development. Decisions regarding HMP elements, such as specific hazards to include, are made by the Steering Committee.

http://www.sugarlandtx.gov/HMP



Up-coming Deliverables

- **Complete Objectives Exercise located at:** https://www.surveymonkey.com/r/CSLHMP_ObjExc
- **Distribute Public Survey** (email–Public Release Packet) https://www.surveymonkey.com/r/CSLHMP_PubSurvey

January 16, 2019 Steering Committee Meeting Re-cap

On January 16, 2019, the Core Planning Team hosted the 2nd Steering Committee Meeting for the City of Sugar Land Hazard Mitigation Plan Update. The Steering Committee established the following:

- Risk Assessment—Risk Assessment Public Workshop February 26, 2020 6-8pm
- Capability Assessment—Underway
- Capability Exercise—See results pg. 2)
- Goal Setting Exercise—The following goals were developed and adopted:

Warning—Enhance predictive measure including the expansion and protection of warning systems and supporting technologies.

Data Collection/Studies/Planning—Enhance the quality of assessments, analysis and planning through the development and collection of data.

Public Outreach—Develop and enhance communications and education capabilities to the public regarding hazards, including the steps that can be taken to mitigate their impact.

Mitigate Structures/Protect Lives—Implement protective measures to reduce the effect of natural, technological and human caused hazards including measures that enhance public safety and reduce the risk of damage to public and private property.

Protect Natural Resources—Reduce adverse environmental, natural resource, and economic impacts from natural, technological, and human-caused hazard events.

Code Enforcement—Review update, adopt and enforce local, state and federal plans, codes and regulations to reduce the impacts of natural hazards.

Coordination—Enhance coordination between private sector, local, state, tribal, and federal agencies to improve mitigation capabilities and reduce the risk of natural, technological and human caused hazard events.

Continuity of Operations—Support continuity of operations pre-, during, and post-hazard events including the support of community lifelines.

CITY OF SUGAR LAND
Hazard Mitigation Plan

Informational Bulletin
February 2020

Core Planning Team

Chairperson
Rob Valenzuela
Rvalenzuela@sugarlandtx.gov

Vice-Chairperson
Pat Hughes
Phughes@sugarlandtx.gov

Project Manager
Chrissie Angeletti, JD
Chrissie.Angeletti@tetratech.com

Planner
Brian Rutherford
Brian.Rutherford@tetratech.com

Next Steering Committee Meeting
March 26, 2020
11:00 am to 1:00 pm

First Steering Committee Bulletin

City of Sugar Land Hazard Mitigation Plan Update

Capabilities Exercise Results

Capability Description	Ranking
Roles and responsibilities for emergency management within the City clearly defined.	1
Emergency response functions for the City are clearly defined and are effective.	2
City staff are knowledgeable about hazards and their impacts and are willing to share that knowledge with the public.	2
All relevant stakeholders are engaged in the City's risk management efforts.	2
Emergency management is provided by a unified authority or program	2
City staff members with emergency management functions are adequately trained.	2
The City currently has a variety of regulatory and non-regulatory strategies to reduce risk.	2
There is political support for risk management within the planning area.	2
The enforcement of Codes and Standards within the planning area is strong.	2
There is a coordinated program to maintain drainage systems free of debris.	2
There is a good understanding of the risk posed by hazards the planning area is susceptible to.	2
Strong collaboration and coordination exist between the City, neighboring jurisdictions, the County and state and federal agency partners.	2
There is strong public support for risk reduction within the planning area.	2
Information on flood insurance is readily available within the planning area.	2
The City development regulations for new development within identified hazards zones are adequate to address that risk.	2
Existing flood control systems are effective and well maintained.	2
The capability to assess and mitigate risk from natural hazards is high.	2
Appropriate and timely warning systems are in place.	2
The City currently has adopted policies that encourage development to be located outside of high-risk areas.	2
Coordinated public outreach regarding risk from all hazards convey clear, consistent messaging to the public.	2
The planning area risk management programs are fair and equitable.	2
Risk from natural hazards within the planning area is adequately mapped and regulated.	2
As a citizen of the City, I feel confident that I am prepared for the impacts from any natural hazard that my impact my property.	2
Current land uses within identified hazard areas are appropriate for the risk posed by each hazard.	3
Areas that provide natural resource protection are identified and protected.	3
The planning area is prepared for the probable impacts on natural hazards due to the impacts from a changing climate.	3
Members of the public know where to find information about hazards and risk.	3
Citizens have a good understanding of natural hazard exposure and risk.	3
Real Estate professionals adequately disclose risk exposure from natural hazards at the time of sale of real property	3
The funding to support risk reduction within the planning area is adequate.	4

City of Sugar Land Hazard Mitigation Plan

City of Sugar Land
2700 Town Center Blvd N.
Sugar Land, TX 77479

TETRA TECH

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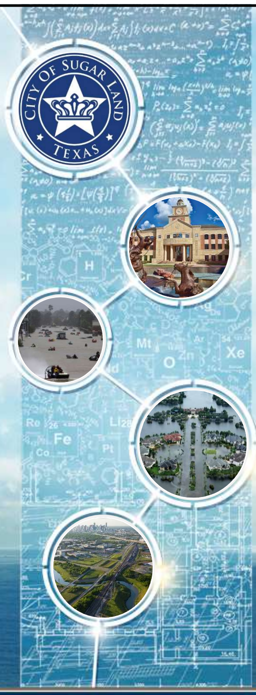
http://www.sugarlandtx.gov/HMP



TETRA TECH

City of Sugar Land, TX
Hazard Mitigation Plan 2020 Update

Project Kick-off Meeting

August 12, 2019

1

Speaker

TETRA TECH

Chrissie Angeletti- Tetra Tech, Inc.

Project Manager

- Licensed attorney in the State of Texas - TCEQ in Air and Water Permitting Division.
- Public Assistance (PA) including 406 Mitigation - State of Texas from Ike through Harvey.
- 428 under the Sandy Recovery Improvement Act (SRIA) – Sandy
- 404 Hazard Mitigation Grant Program (HMGP) grant application development and monitoring – FEMA HMTAP Harvey
- Hazard Mitigation Action Plans

2

Today's Discussion

TETRA TECH

- Introductions
- Overview of Project Planning Process
- Project Organization
- Administrative
- Public Involvement Strategy
- Action Items & Next Steps

3

The Core Planning Team

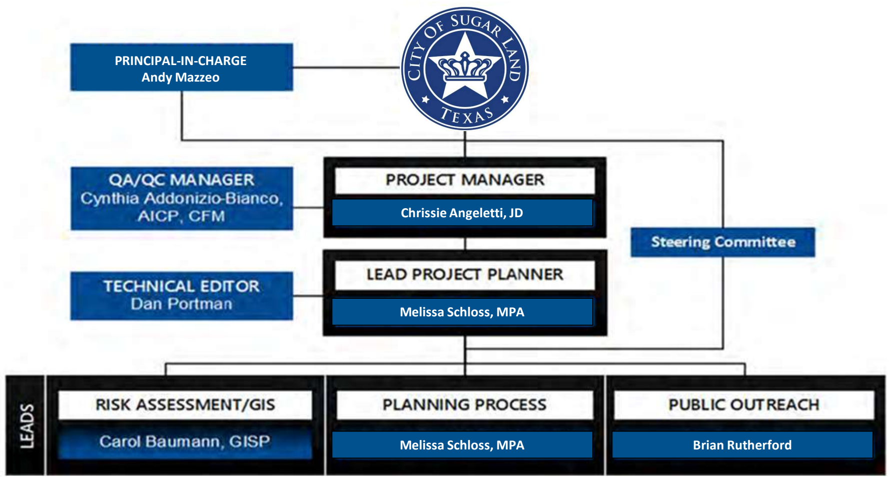
TETRA TECH

- The Core Planning Team (CPT) is made up of discipline leads from the Tetra Tech team as well as key staff from City of Sugar Land.
- The CPT is primarily responsible for overall project management, facilitating meetings/workshops, and developing the updated hazard mitigation plan (HMP).
- From project inception to completion, bi-weekly project coordination calls will be held by the CPT.

4

The Tetra Tech Team

TETRA TECH



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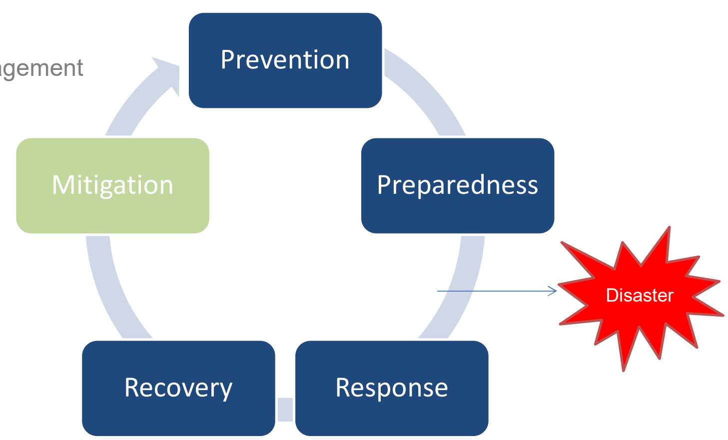
5

What is Mitigation?

TETRA TECH

Five Phases of Emergency Management



"Sustained action taken to reduce or eliminate long-term risk to life and property"

6

Provisions of the Disaster Mitigation Act (DMA)

- Encourages and rewards local and state pre-disaster planning ($$$ for projects)
- Integrates state and local planning
- Results in faster more efficient allocation of funding and more effective risk reduction projects
- Specifies required plan components:
  - risk assessment
  - public outreach and participation
  - process for update
  - formal review State and FEMA review
  - documentation of acceptance by the community seeking approval

7

What is the Disaster Mitigation Act (DMA)?

Federal legislation that establishes a pre-disaster hazard mitigation program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP).

=

Federal $$$ for pre-disaster and post-disaster hazard mitigation projects within the participating jurisdiction.

8

Benefits of Hazard Mitigation Plans

TETRA TECH

- Establish eligibility for grant funds ($$$ for projects)
- Improve understanding of risks and vulnerabilities
- Reduce negative impact of natural hazards – actions save lives, reduce displacement, and speed recovery
- Encourage sustainable actions – builds strong, resilient, and self-sufficient communities
- Foster collaboration between the local jurisdiction and its residents

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Examples of Mitigation Strategies

TETRA TECH

- Drainage projects and studies
- Property elevations or acquisition
- Critical infrastructure hardening
- Education programs to be better informed of risks
- Policies– building codes and zoning
- Incentives – grants or financial assistance for risk reduction at business and household level

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Other Benefits to Hazard Mitigation Planning

TETRA TECH

- Hazard Mitigation Plans contribute to a community's Community Rating System (CRS) score
- What is Community Rating System?
  - *A FEMA/National Flood Insurance voluntary incentive program that encourages floodplain management activities*
  - *Reduces potential flood damages and can decrease flood insurance rates $$*
- Sugar Land currently participates as a Class 7 in the CRS program since 2010

Sugar Land, TX CRS Profile					
Community ID #	CRS Entry Date	Current Effective Date	CRS Class	% Discount for SFHA	% Discount for NON SFHA
480234	5/1/2010	5/1/2010	7	15%	5%

Class	Discount	Class	Discount
1	45%	6	20%
2	40%	7	15%
3	35%	8	10%
4	30%	9	5%
5	25%	10	0%

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Stakeholders

TETRA TECH

- ✓ Police / Fire Departments / Dispatch
- ✓ Public Works / Utilities
- ✓ Animal Services
- ✓ Communications
- ✓ Engineering
- ✓ Health Authority
- ✓ Traffic Engineering
- ✓ Fort Bend County OEM
- ✓ Levy & Drainage Districts
- ✓ Schools/ Higher Education
- ✓ Medical Facilities
- ✓ Environmental Entities
- ✓ Economic Development / Chamber of Commerce
- ✓ Regulatory Agencies

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TETRA TECH

The Work Plan

- Phase 1: CPT & SC Creation
- Phase 2: Update Risk Assessment
- Phase 3: Public Involvement Strategy
- Phase 4: Confirm Goals, Objectives, Capabilities & Actions
- Phase 5: Assemble the Updated Plan
- Phase 6: Plan Review & Adoption

- 6 phase scope of work
- Follow the 10-Step Planning script from FEMA's Community Rating System (CRS Program).
- Centers on a comprehensive risk assessment and active public engagement strategy

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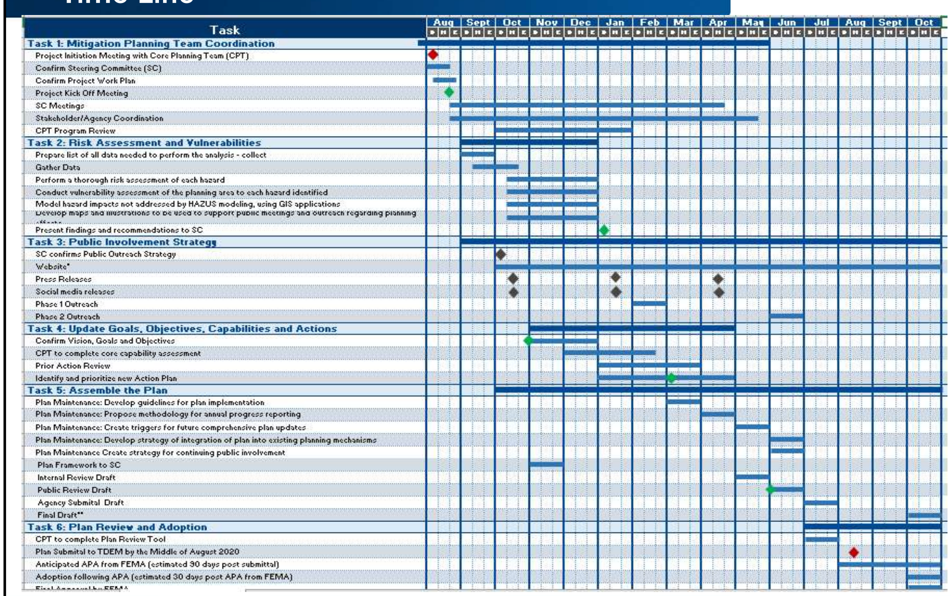
TETRA TECH

Time Line

- Schedule projects a 15-month time frame
- Target for submittal to TDEM would be End October 2020
- *This schedule all depends on you!*



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Steering Committee

TETRA TECH

- Process will be overseen by a stakeholder Steering Committee
- Will strive to meet the CRS Activity 510, step 2 planning requirements
- Multi-disciplined representation
  - General Public
  - Stakeholders (Business, academia, government)
  - Emergency Management
- Will meet bi-monthly through the course of this update process

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The Steering Committee

TETRA TECH

The Steering Committee	Will operate under a set of ground rules
	Will participate in the Public Involvement Strategy
	Will act as spokespersons for the process
	minimum of 2 hours per meeting
	Will oversee plan development

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Steering Committee Engagement

TETRA TECH

- Coordinating Stakeholders will be kept apprised of plan development milestones via bulletin after each SC meeting.
- Additional information to be deployed by the CPT on an as-needed basis.


Cook County Multi-Jurisdictional All Hazards Mitigation Plan
Information Bulletin #4
The Mission Statement and Critical Facilities

What Is a Mission Statement and Why Do We Need One?

The purpose of a mission statement for the Cook County Multi-Jurisdictional All Hazards Mitigation Plan is to identify the principle message of the plan. A mission statement should be broad in scope and help provide direction for the planning process. The mission statement is not a goal or an objective, as it does not describe outcomes or ways to achieve outcomes. The mission statement will be promoted through public outreach as a brief description of what the Multi-Jurisdictional All Hazards Mitigation Plan is about.

Cook County Multi-Jurisdictional All Hazards Mitigation Plan Mission Statement:

Identify risks and sustainable cost-effective actions to mitigate the impact of natural hazards in order to protect the life, health, safety, welfare and economy of the communities of Cook County.

What Is a Critical Facility and Why Is It Important?

Some buildings or places are of such importance to a community that they must remain accessible and able to operate even during a flood, tornado or other natural disaster. For example, hospitals and fire stations need to remain in operation for the rescue and treatment of injured people. Water treatment facilities and wastewater treatment plants are needed to provide potable water and safe living conditions for residents.

Federal regulations require local governments preparing hazard mitigation plans to define which facilities and infrastructure are critical to the community's ability to respond to and recover from the impacts of natural hazards. This definition is then used to create an inventory of all critical facilities in the planning area.

During a disaster, communities need to provide essential services to their residents. To do that, roads and bridges must be accessible, police and fire departments need power and fuel for their vehicles, and shelters need potable water and electricity. Identifying critical facilities within a community helps leaders plan for the impacts and ensure that they will be able to continue providing those services.

Photo courtesy of the Forest View Fire Department

Exhibit 1. Planning Partner Bulletin

17

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Hazards of Concern

TETRA TECH

2016 Plan

- Severe Winter Storms
- Severe Thunderstorms
- Tornadoes
- Lightning
- Extreme Temps
- Hailstorms
- Flooding
- Drought
- Hurricanes / Tropical Storms
- Infectious Disease Outbreak
- Dam & Levee Failure
- Terrorism
- HazMat Spills
- Energy / Fuel Shortage
- Aircraft Incidents

Texas State Plan

- Hurricanes, Tropical Storms & Depressions
- Drought
- Hailstorms
- Severe Coastal Flooding
- Riverine Flooding
- Tornadoes
- Wildfire
- Winter Weather
- Lightning
- Extreme Cold
- Extreme Heat
- Coastal Erosion
- Inland Erosion
- Land Subsidence
- Earthquakes
- Expansive Soils
- Dam/Levee Failure

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18

Goals & Objectives from Previous Plan

- Maximize the use of all resources by promoting intergovernmental coordination and partnerships in the public and private sectors.
- Harden our communities against the effects of disasters through the development of new mitigation strategies and strict enforcement of current regulations that have proved effective.
- Reduce and, where possible, eliminate repetitive damage, loss of life, and property from disasters.
- Bring greater awareness throughout the community about potential hazards and the need for community preparedness.
- Continue city training for City of Sugar Land departments.

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Critical Facilities Definition in Previous Plan

- The City of Sugar Land identified critical facilities as **critical assets.**
- Critical asset is defined as a government asset that provides essential City of Sugar Land services, including government facilities, police departments, fire departments, and emergency medical services.
- *Previous plan also listed the Fort Bend Independent School District Critical Facilities*

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Next Steps

TETRA TECH

- Steering Committee will be organized with their 1st meeting targeted for no later than the end of October.
- CPT to collect new data for development of the risk assessment
- CPT to initiate the bulletin
- Public Engagement strategy

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TETRA TECH

Questions ?

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MEETING SUMMARY

Date/Time of Meeting:	Thursday – October 17, 2019; 11:00am to 1pm
Location:	2700 Town Center Blvd. Sugar Land, TX 77478
Subject:	1st HMP Steering Committee Meeting
Project Name:	City of Sugar Land Hazard Mitigation Plan Update
In Attendance	***Attendees: 49 persons in attendance, see attached*** **Core Planning Team:** Brian Murray, Brian Dunaway, Ashly Schutt, Rob Flaner, Chrissie Angeletti
Summary Prepared by:	Brian Rutherford and Chrissie Angeletti
Quorum – Yes or No	Yes

Welcome and Introductions

- Pat Hughes, the Emergency Management Coordinator (EMC) for the City of Sugar Land, provided an introduction and facilitated group introductions.
- Agenda was reviewed an no modifications were made
- Distributed handouts included: Agenda, Steering Committee Charter, Hazards of Concern, Critical Facilities definitions.

The Steering Committee Role/Ground rules

- The purpose and expectations of the Steering Committee was discussed.
- The Chairperson and Vice Chairperson were named as well as the roles of these positions. Rob Valenzuela, Public Works Director for the City of Sugar Land, serves as the Chairman of the SC. Pat Hughes, will serve as the Vice Chairman.
- Quorum was established as 7 members plus at least 1 of the co-chairs.
- Alternates can be designated in the event a committee member is unable to attend.
- Decision-making – process will seek consensus. If consensus cannot be reached, a decision will be confirmed by a majority vote. A dissenting opinion can be recorded upon request.
- Recommendations from meetings will be recorded in meeting summaries.
- Attendance – if the committee member is unable to attend, they can send their alternate if one has been designated. Repeated no-shows, member or alternate, will be contacted by the Chair to see if they are still able to support the process
- To meet CRS requirements, the City staff must consist of no more than 20 percent of the SC.
- Notes will be taken at each meeting and posted to the City's website. A bulletin will also be developed to highlight planning activities and posted to the website.
- Public Involvement – all meetings are open to the public and will be advertised as such. SC members are encouraged to share the bulletins with their constituents as well as help with public participation, public workshops, and use various media to disburse planning information.

Schedule

- Overview and Milestones of the planning process were discussed
- The following Meeting Schedule was established:
  - October 17, 2019
  - January 16, 2020
  - Risk Assessment Public Workshop TBD
  - March 19, 2020
  - May 21, 2020
- The next SC meeting will be conducted on January 16, 2020 and will involve discussion of the risk assessment and to schedule a public workshop. The risk assessment public workshop provides the public the opportunity to examine the risk assessment data and see how the hazards identified could affect them. SC members do not need to participate in the workshop, but often find it interesting to see the results of the risk assessment.
- A SC meeting will be conducted on March 19, 2020 to develop mitigation strategies.
- The final SC meeting will be conducted on May 21, 2020 to review the draft plan and schedule a public workshop to get feedback on the plan before it is finalized.
- In-kind Tracking - SC members should track the time they spend working on planning process. Sharon Shapiro, Grants Manager for the City, will provide an Excel spreadsheet for City staff to track hours for the City to receive a 25 percent in kind match contribution from FEMA for the planning costs.
- Others can email their activities to Sharon Shapiro, Pat Hughes or Chrissie Angeletti.

Hazard Mitigation Planning and Update Overview

- Overview of the Hazard Mitigation Planning and Update discussed.
- Any taxing entity can develop an HMP including a City, special district, or county.
- The City's HMP will be a single jurisdiction plan.
- The project will include the gathering of hazard data, the development of a hazard risk assessment, a review of the previous plan, establishment of priorities based on the hazard data, and establishment of action items.
- The HMP is a working document that seeks to prevent and minimize damages from disasters.
- The HMP is a prerequisite for funding for hazard mitigation projects and the HMP will provide the City with a better understanding of community hazards. The HMP will list and prioritize projects for implementation when funding is available. When funding is available, an application may be completed and often includes a benefit cost analysis.
- Once approved, the plan is good for 5 years.
- Hazard Mitigation planning can also earn the City Community Rating System (CRS) credits. The CRS is a voluntary program that encourages floodplain management that meet and exceed the National Flood Insurance Program (NFIP). CRS membership by the City also provides discounts to City residents on flood insurance.

Defined Planning Area for the update

- The City will coordinate with the Fort Bend County Office of Emergency Management (OEM) regarding ETJs and how risk data is obtained and utilized in the Risk Assessment.

Critical Facilities/Infrastructure Definition

- Attendees discussed a definition for critical facilities in the City. The definition approved by the SC is:
  - "A critical asset is defined as an asset that provides essential City of Sugar Land services, including government facilities; education facilities; health and medical facilities; transportation systems; emergency services such as police, fire and emergency medical services; historical and cultural sites;

hazardous materials sites; water control facilities including waste water treatment facilities, dams, levees, and diversion facilities. Critical facilities and infrastructure in Sugar Land are all vulnerable to hazards."

The list of critical facilities will include:

- Government facilities
- Education facilities
- Health and Medical facilities
- Transportation systems
  - Airport
  - Union Pacific Railroad
  - Major arterial roads
  - Fort Bend Transit
  - Evacuation Routes
- Emergency Services
- Environmental Areas
- Historical and Cultural Sites
  - Texas Prison System Central State Farm Main Building
  - Sugar Land Auditorium
- Hazardous Material Sites
  - Underground Storage Tanks
  - Noted that NALCO has a list of high risk sites
- Water Control Facilities
- Water Supply Facilities
- Electrical Transfer Stations
  - It was noted that CenterPoint energy maintains a critical asset list.
- NALCO
  - It was noted that NALCO has a list of high hazard risk areas for their facility.

Hazards of Concern

- Hazards from the previous plan were discussed.
- Additional Hazards to comply with the State Plan were reviewed and approved.
- Ms. Angeletti noted that for state purposes the Texas Division of Emergency Management (TDEM) will only review natural hazards in the HMP but the City is free to list and develop actions to address non-natural hazards in the HMP.
- The SC conducted an exercise to rank a list of hazards for the City followed by a discussion regarding the results. Cyberterrorism will be added to the list of Non-Natural hazards. Active shooter was also discussed as a growing concern.

Natural Hazard Ranking Exercise - Results	
Flooding (*Inland, Riverine, and Severe Coastal Flooding)*	1
Hurricanes / Tropical Storms, Depressions	2
Severe Thunderstorms	3
Dam & Levee Failure	4
Tornadoes; Lightning	5
Erosion (Coastal, Inland)	*6*

Drought	7
Extreme Temperatures (Cold/Heat)	8
Hailstorms	9
Severe Winter Storms	10
Land Subsidence	*11*
Expansive Soils	*12*
Wildfire	*13*
Earthquakes	*14*

Non-Natural Hazard Ranking Exercise - Results	
Hazardous Material Spill	1
Aircraft Incidents/Transportation Accidents	2
Energy/Fuel Shortage	3/4
Terrorism	3/4
Cyber Attack	Write-In

Data Collection Status

- Tetra Tech will use spatial analysis to illustrate the type and distribution of hazards in the City. Some of the data to be included in the HMP include:
  - Three scenarios for flood data: 100-year, 500 year, and the Hurricane Harvey flooding event.
  - Two scenarios for hurricanes including 20 year and 100-year probabilistic scenarios.
  - Dam failure risk data. Inundation levels for dams in the City will be needed. The City has 3 dams. They are not large dams and a dam failure is not expected to impact any homes. However, dam inundation data information will be needed calculate risk.
  - Wildfire risks will be examined in the HMP using Texas wildfire risk assessment data.
- Other data that Tetra Tech will need for HMP development will include erosion information, subsidence (tracked by the Fort Bend Subsidence District), soil expansive data, and demographic data.
- It was mentioned that the Planning Department of the City can supplement demographic information from the U.S. Census Bureau. Water meter data may also be helpful information.

Public Involvement Strategy/Tracking

- The City has established a website for the HMP Update - http://www.sugarlandtx.gov/HMP
- The website has information on hazard mitigation planning, public notices, project bulletins, meeting notes, and will provide a link to the public survey. It will also include links to the old plan and state mitigation planning links. SC members are encouraged to link to the site and share information regarding the project on their own websites and through social media.
- Tracking Public Outreach Efforts
  - Email – Chrissie.angeletti@tetratech.com & cc Rob V. and Pat H.
- Media Request - Doug Adolph (281-275-2724/dadolph@sugarlandtx.gov)
- A sample public survey will be developed by Tetra Tech for the SC's review. The purpose of the survey will be to help gauge the public's perception of risk. The number of questions will be limited to less than 20. Using the survey will help pinpoint the public's concerns regarding community hazards. The SC will have any opportunity to provide input on the survey questions. The SC will also set a target goal for completed surveys.

Mission Statement for the Plan

- Participants reviewed the purpose mission statement from the 2014 plan that was provided on a handout.
- A discussion was held, and revisions were approved by the SC.
- The revised Mission Statement will read as follows:

  "The purpose of the City of Sugar Land HMP is to identify risks and vulnerabilities and to formulate a plan of action to reduce loss of life and damage from natural and non-natural disasters. This plan shall serve as a benchmark for future mitigation activities and will identify mitigation goals and objectives for the City of Sugar Land. The plan will also identify and prioritize potential risks and vulnerabilities in an effort to minimize the effects of disasters in the community.

  The implementation of the plan and its components is vital to achieve a community that is resilient to the effects of disaster. The implementation of the plan will reduce loss of life and property and allow the whole community to prosper with minimal disruption to of vital services to its citizens. The plan provides a risk assessment of the hazards the City of Sugar Land is exposed to and puts forth several mitigation goals and objectives that are based on that risk assessment."

Introduced Goal setting exercise (Homework)

- Review the goals from the 2015 HCMHMP
- Compare HCMHMP goals to state plan goals
- Changes or enhancements?

Introduce Objective's exercise

- What is an objective?
- The 2015 HCMHMP did not identify objectives
- The 2019 HCMHMP will identify objectives that will be utilized to support prioritize actions.
- Linear planning components (MS, Goals, Objectives, then actions)

Action Items and Next Steps

- Confirm Objectives for the Plan
- Confirm Public Survey

Homework (before the next SC meeting)

- Review the October 2018 TX State Hazard Mitigation Plan
  - http://tdem.wpengine.com/wp-content/uploads/2019/08/01-Texas-SHMP-FINAL-Adopted-10.17.2018.pdf
- 2016 City of Sugar Land HMP
  - http://www.sugarlandtx.gov/DocumentCenter/View/22831/2014-Hazard-Mitigation-Plan
- Complete Goal Exercise
- Select Questions from Sample Survey

Adjourn

- Meeting was adjourned at 1pm

City of Sugar Land
2020 Hazard Mitigation Plan Meeting #1
August 12, 2019
Sign-In Sheet

Name	Title	Organiation	Phone	Email	Initials
Pat Hughes	Assistant Fire Chief / EMC	City of Sugarland	281-757-2526	phughes@sugarlandtx.gov	
Scott Schultz	Assistant Police Chief	Police Department	281-275-2516	sschultz@sugarlandtx.gov	
Doug Schomburg	City Planner	Planning	281-275-2738	dschomburg@sugarlandtx.gov	
Rob Valenzuela	Public Works Director	Public Works	281-275-2167	rvalenzuela@sugarlandtx.gov	RV
Brian Butscher	Asst. PW Director	Public Works	281-275-22456	bbutscher@sugarlandtx.gov	
Eric Oscarson	Asst. PW Director	Public Works	281-275-2485	eoscarson@sugarlandtx.gov	
Danica Mueller	Facility Ops Mgr.	Public Works	281-275-2164	dmueller@sugarlandtx.gov	
Stacey Henderson	ENS Director	Animal Services	281-275-2172	shenderson@sugarlandtx.gov	
Dennis Winchell	Asst. ENS Director	Animal Services	281-275-2483	dwinchell@sugarlandtx.gov	
Kathryn Ketchm	Animal Services Manager	Animal Services	281-275-2183	kkatchm@sugarlandtx.gov	KK
Doug Adolph	Asst. Communications Dir	Communications	281-275-2724	dadolph@sugarlandtx.gov	
Jessie Li	City Engineer	Engineering	281-275-2780	jli@sugarlandtx.gov	
Jorge Alba	Flood Mgmt. Engineer	Engineering	281-275-2275	jalba@sugarlandtx.gov	
Dr. Joe Anzaldua	Health Authority/Medical Director		281-265-7000	drjoe_anzaldua@comecast.net	
John Bailey	Surface Water Treatment Mgr	Public Works	281-275-2002	jbailey@sugarlandtx.gov	JB
James Turner	Traffic Engineer	Traffic Engineering	281-275-2473	jturner@sugarlandtx.gov	
Shannon Price	Director	Sugar Land Dispatch	281-275 2526	SPRICE@sugarlandtx.gov	
Amy Patin	Dispatch Ops Mgr.	Sugar Land Dispatch	281-275-2989	apatin@sugarlandtx.gov	
Larry Hunter	Diapatch Mgr.	Sugar Land Dispatch	281-275-2989	lhunter@sugarlandtx.gov	
Alan Spears	Deputy EMC	Ft. Bend County OEM	832-473-1071	alan.spears@fortbendcounty.tx.gov	
Ed Norman	Distric Coordinator 16D	TDEM	2713-213-7496	edward.norman@dps.texas.gov	
Bonnie Garnet & Mike Ferrell ~~Scott Schwalader~~	~~Plant Manager~~ Prod. Mgr/SHE	Nalco / Champion	281-263-7401	sschawalder@ecolab.com	BG/MF
Cassie Slater	Operations Manager	Sugar Land Regional Airport	281-275-2058	cslater@sugarlandtx.gov	
Pete Munoz		Sugar Land Methodist Hospital		PMunoz@houstonmethodist.org	
Sean Sevy		Sugar Land Methodist Hospital		SXSevy@houstonmethodist.org	
Eric Tauber	Emergency Services Dir.	Saint Luke's Hospital Sugar Land	281-637-7611	etauber@stlukeshealth.org	
Jason Jetton	Facilities Manager	Saint Luke's Hospital Sugar Land	281-637-8035	jjetton@stlukeshealth.org	JJ
Kord Quintero	Operations Manager	Memorial Herman Hospital SL	979-541-6643	Kord.Quintero@memorialhermann.org	
Kalli Clark-Egan	Regional Business Tech	Army Corps of Engineers		Kalli.clark-egan2@usace.army.mil	
Jay Webster	Chief of Law Enforcement /EMC	Brazos River Authority	915-309-8737	jay.webster@brazos.org	
Don Naylor		Brazos River Authority	254-761-3138	don.naylor@brazos.org	
Judy Lefevers	EMC	Ft. Bend Independent School District		judy.lefevers@fortbendisd.com	
Dan Rilley	Warning Cood. Meterologist	NWS Houston Galveston	281-534-2157	dan.reilly@noaa.gov	

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Katie Landry-Guyton	Sr Service Hydrologist	National Weather Service	281-337-5074	katie.landry@nooa.gov	
Craig Kalkomey	District Engineer	~~FB~~ FBLID 2, 10, 11, 14, 17 ~~and~~ 7 and FBCMUD 121	713.825.1158	ckalkomey@Lja.com	CWK
Taylor Danesi	Environmental Manager	COSL	281-275-2497	tdanesi@sugarlandtx.gov	TD
Lisa Kocich-Meyer	Director of Planning	COSL	281-275-2311	lkocich-meyer@sugarlandtx.go	
Mohamed Bendjemil			281-236-9387	mbendjemil@gmail.com	MB
Sharon Shapiro	grants officer	COSL	281-275-2310	sshapiro@sugarlandtx.gov	
Nicole Solis	Asst. Dir. ENS	COSL	2291	nsolis@sugarlandtx.gov	
Frank Garza	OEM Specialist	COSL	281-275-2805	fgarza@SugarlandTX.gov	
Jeffrey S. Willis	Vice President	PageSoutherland Page, Inc.	281-782-8675	jwillis@pagethink.com	

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Jessie Li	City Engineer	Engineering	281-275-2780	jli@sugarlandtx.gov	
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Larry Hunter	Diapatch Mgr.	Sugar Land Dispatch	281-275-2989	lhunter@sugarlandtx.gov	
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Ed Norman	Distric Coordinator 16D	TDEM	2713-213-7496	edward.norman@dps.texas.gov	
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Sean Sevy		Sugar Land Methodist Hospital		SXSevy@houstonmethodist.org	
Eric Tauber	Emergency Services Dir.	Saint Luke's Hospital Sugar Land	281-637-7611	etauber@stlukeshealth.org	
Jason	Facilities Manager	Saint Luke's Hospital Sugar Land	281-637-8035		
Kord Quintero	Operations Manager	Memorial Herman Hospital SL	979-541-6643	Kord.Quintero@memorialhermann.org	
Kalli Clark-Egan	Regional Business Tech	Army Corps of Engineers		Kalli.clark-egan2@usace.army.mil	
Jay Webster	Chief of Law Enforcement /EMC	Brazos River Authority	915-309-8737	jay.webster@brazos.org	
Don Naylor		Brazos River Authority	254-761-3138	don.naylor@brazos.org	
Judy Lefevers	EMC	Ft. Bend Independent School District		judy.lefevers@fortbendisd.com	
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Name	Title	Organiation	Phone	Email	Initials
Katie Landry-Guyton	Sr Service Hydrologist	National Weather Service	281-337-5074	katie.landry@nooa.gov	

MEETING SUMMARY

Date/Time of Meeting:	Thursday – January 16, 2020; 11:00am to 1pm
Location:	City of Sugar Land City Hall Annex Auditorium 10405 Corporate Drive Sugar Land, TX 77478
Subject:	2nd HMP Steering Committee Meeting
Project Name:	City of Sugar Land Hazard Mitigation Plan Update
Summary Prepared by:	Brian Rutherford and Chrissie Angeletti
Quorum – Yes or No	Yes

Welcome and Introductions

- Rob Valenzuela, the Director of Public Works for the City of Sugar Land, welcomed the Steering Committee members to the meeting at 11:02 a.m.
- Chrissie Angeletti, the Tetra Tech project manager, confirmed that a quorum was present and reviewed the meeting agenda. Mrs. Angeletti then asked the Steering Committee for a vote to approve the meeting minutes from the Steering Committee meeting conducted on October 17, 2019. The minutes were approved.
- Distributed handouts included: Agenda, Goal Setting Exercise, Objectives Definition and Examples, Capabilities Exercise

Data Collection/Risk Assessment Update

- Mrs. Angeletti provided an update on data collection efforts. Data is collected to aid in assessing the risk the City faces from the hazards profiled in the Hazard Mitigation Plan (HMP). Mrs. Angeletti reported that almost all the data needed to develop the risk assessment has been collected.
- As part of the risk assessment data collection process, a public workshop will be conducted to educate the public and get their input on hazards and risk in the City. The initial date scheduled for the public workshop was February 19, 2020 from 6:00 p.m. to 8:00 p.m. However, after reviewing the City calendar, it was determined to move the public workshop date to February 26th to avoid a potential conflict with other meetings scheduled for the 19th. The City will check on room availability for the 26th. It was suggested that the meeting be conducted in the Council Chambers so the meeting can be live streamed from that location. It can be live streamed from other rooms as well, but equipment would have to be brought in to facilitate live streaming.
- A capability assessment will also be conducted as part of the data collection process. Mrs. Angeletti explained that a capability assessment examines the risk assessment data and then compares that data to the City's capabilities for reducing risk to potential hazards. In assessing the City's capabilities, the HMP development team reviews City ordinances, building codes, floodplain management plans, climate action plans, and other factors. The risks are compared to the capabilities to determine if any gaps exist that might prevent the City from adequately addressing risks. Any gaps identified are addressed in the development of mitigation strategies to help alleviate risks from hazards to the City. Final pieces of information are being collected from the levee districts to complete this process.

Public Involvement Strategy/Tracking

- The City has established a website for the HMP Update - http://www.sugarlandtx.gov/HMP
- The website has information on hazard mitigation planning, public notices, project bulletins, meeting notes, and will provide a link to the public survey. It will also include links to the old plan and state mitigation planning links. SC members are encouraged to link to the site and share information regarding the project on their own websites and through social media.
- Media Request - Doug Adolph (281-275-2724/dadolph@sugarlandtx.gov)
- A sample public survey will be developed by Tetra Tech for the SC's review. The purpose of the survey will be to help gauge the public's perception of risk. Using the survey will help pinpoint the public's concerns regarding community hazards. The survey will be widely disseminated and will be available for six to eight months during the planning process to provide the public ample opportunity to respond.
- Steering Committees members are encouraged to distribute the survey, via weblink and/or QR code, to others in the City to collect residents and others input. The goal is to get several hundred responses to the survey.
- Tracking efforts to get the public's input is very important. Mrs. Angeletti asked Steering Committee members that when they do forward the survey or post it on a website, to capture those effort with a screenshot so the City's efforts to get public input can be documented.
    - Email – Chrissie.angeletti@tetratech.com & cc Rob V. and Pat H.

Goal Setting Exercise

- Mrs. Angeletti lead the group in an activity to identify goals for the HMP. After goal selection the group will then select objectives. The plan will receive more points from reviewers for objectives that meet multiple goals. Mrs. Angeletti first led the group in a review of the State HMP goals, then the goals from the 2014 City HMP. The Steering Committee then identified the following goals:

Warning
Enhance predictive measure including the expansion and protection of warning systems and supporting technologies.

Data Collection/Studies/Planning
Enhance the quality of assessments, analysis and planning through the development and collection of data.

Public Outreach
Develop and enhance communications and education capabilities to the public regarding hazards, including the steps that can be taken to mitigate their impact.

Mitigate Structures/Protect Lives
Implement protective measures to reduce the effect of natural, technological and human caused hazards including measures that enhance public safety and reduce the risk of damage to public and private property.

Protect Natural Resources
Reduce adverse environmental, natural resource, and economic impacts from natural, technological, and human-caused hazard events.

Code Enforcement
Review update, adopt and enforce local, state and federal plans, codes and regulations to reduce the impacts of natural hazards.

Coordination
Enhance coordination between private sector, local, state, tribal, and federal agencies to improve mitigation capabilities and reduce the risk of natural, technological and human caused hazard events.

Continuity of Operations
Support continuity of operations pre-, during, and post- hazard events including the support of community lifelines.*

*Community lifelines are defined by the Federal Emergency Management Agency (FEMA) as the most fundamental services in the community that, when stabilized, enable all other aspects of society to function. The concept of lifelines is being used by FEMA and local governments to aid in rapidly stabilizing services and prioritizing response after a disaster.

Objectives Exercise

- Mrs. Angeletti will send out the objective exercise via online survey, so the Steering Committee can vote on potential objectives to align with the goals that have been developed. The survey is to be completed prior to the next steering committee meeting. At the next steering committee meeting, the team will review the results of the survey and adopt the objectives.
  - What is an objective?
  - The 2015 HCMHMP did not identify objectives
  - The 2019 HCMHMP will identify objectives that will be utilized to support prioritize actions.
  - Linear planning components (MS, Goals, Objectives, then actions)

Homework (before the next SC meeting)

- Distribute Public Survey via:
  - Newsletters
  - Meetings
  - Community Groups
  - Social Media
    - Facebook
    - Twitter
    - Nextdoor

*****NOTE: The next Steering Committee meeting will be conducted on March 26th 2020*****
Originally scheduled for March 19th it was rescheduled due to spring break and the rodeo.

Adjourn

- Meeting was adjourned at 1pm

City of Sugar Land Hazard Mitigation Plan Update

Risk Assessment Presentation | February 26, 2020

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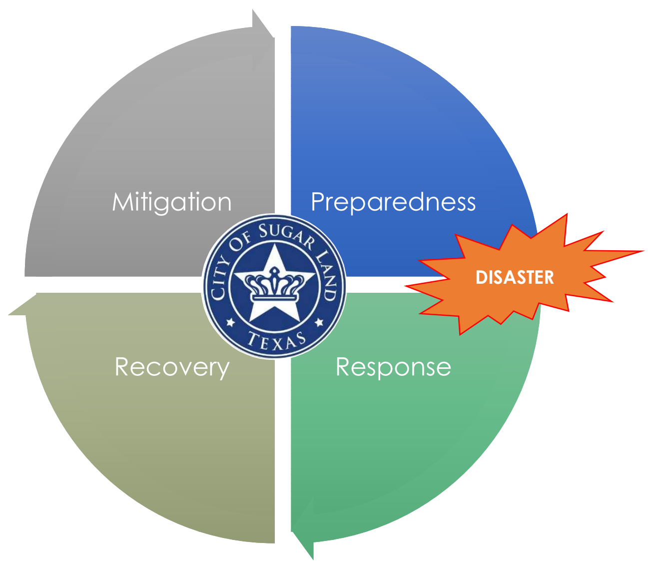
Agenda

- Introductions
- Project Status
- Public Participation
- Risk Assessment Overview
- Hazard Ranking Methodology
- SWOO Overview
- Next Steps



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Hazard Mitigation Plan Update Overview

Why update the plan?

- Goal - minimize or eliminate long-term risk to human life and property from known hazards by identifying and implementing cost-effective mitigation actions.
- FEMA requires a Hazard Mitigation Plan to be federally approved and updated every five years.

What are the benefits?

- Planning process includes development of a Risk Assessment, Capability and Vulnerability Assessment, and Hazard Mitigation Actions (projects).
- Federal funding programs require FEMA approved Hazard Mitigation Plan

What are we focusing on?

- Clear communication of risk
- Connecting risk assessment to mitigation strategy
- Integrating Hazard Mitigation Plan into policies, procedures and decision-making

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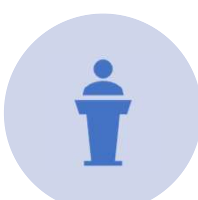
Steering Committee Role and Responsibilities



PROVIDE GUIDANCE AND LEADERSHIP

OVERSEE THE PLANNING PROCESS

POINT OF CONTACT FOR VARIOUS INTEREST GROUPS IN THE PLANNING AREA

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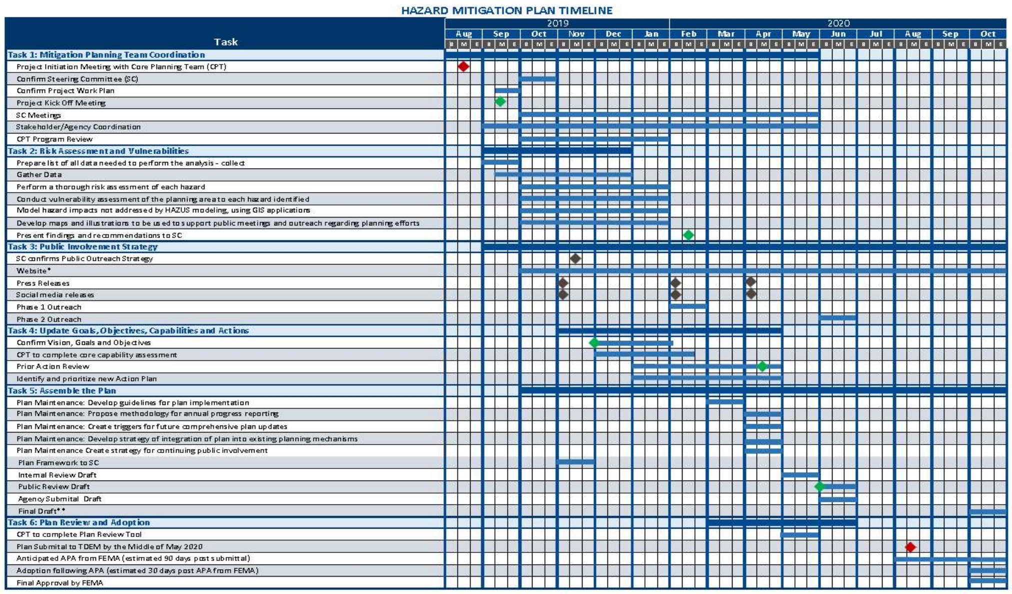
Project Overview and Milestones



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Public Outreach and Engagement

- **City of Sugar Land HMP Update Website**

  https://www.sugarlandtx.gov/1852/Hazard-Mitigation-Plan-Update

- **Steering Committee Meetings**
  - Composition
  - Upcoming Meeting: March 26th 2020, 11am-1pm,
- **Public Survey**
  - City's Website
  - Share with network – Goal 200 Responses!

"An effective planning process is essential in developing and maintaining a good plan."
44 CFR §201.4(b)

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Hazard Mitigation Public Survey

Participate in the City of Sugar Land Hazard Mitigation Update Process by taking the following survey:

https://www.surveymonkey.com/r/LWXQ8GW

Please share with your friends, neighbors and co-workers

- Repost via Facebook
  https://www.facebook.com/SugarLandFireEMS/
- Nextdoor
- Twitter

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Hazards of Concern

2020 Hazard Mitigation Plan Hazards of Concern	
NATURAL HAZARDS	**NATURAL HAZARDS CONT'D**
Dam and Levee Failure	Lightning
Drought	Severe Winter Storm
Earthquake (HAZUS)	Severe Thunderstorms and Wind
Erosion	Tornadoes
Expansive Soils	Wildfire
Extreme Temperatures – heat and cold	**NON-NATURAL HAZARDS**
Flood (HAZUS)	Terrorism (Includes Cyber Attack)
Hail	Hazardous Material Spill
Hurricane and Tropical Storm (HAZUS)	Energy & Fuel Shortage
Land Subsidence	Transportation Accidents

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Hazard Of Concern Exercise

Natural Hazard Ranking Exercise - Results	
Flooding (*Inland, Riverine, and Severe Coastal Flooding)*	1
Hurricanes / Tropical Storms, Depressions	2
Severe Thunderstorms	3
Dam & Levee Failure	4
Tornadoes; Lightning	5
Erosion (Coastal, Inland)	*6*
Drought	7
Extreme Temperatures (Cold/Heat)	8
Hailstorms	9
Severe Winter Storms	10
Land Subsidence	*11*
Expansive Soils	*12*
Wildfire	*13*
Earthquakes	*14*

Non-Natural Hazard Ranking Exercise - Results	
Hazardous Material Spill	1
Aircraft Incidents/Transportation Accidents	2
Energy/Fuel Shortage	3/4
Terrorism	3/4
Cyber Attack	Write-In

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Hazard Ranking Methodology

A risk rating for each hazard was determined by multiplying the assigned probability factor by the sum of the weighted impact factors for people, property and the economy:

Risk Rating = Probability Factor x Weighted Impact Factor [people + property + economy]

Probability:

- Hazard event is likely to occur within 25 years **(Probability Factor = 3)**
- Within 100 years (Probability Factor = 2)
- Not likely to occur within 100 years (Probability Factor = 1)
- If there is no exposure to a hazard, there is no probability of occurrence (Probability Factor = 0)

Impacts on People:

- 25 % or more of the population is exposed to a hazard **(Impact Factor = 3)**
- 10-24 % exposed to hazard (Impact Factor = 2)
- 9 % or less exposed to hazard (Impact Factor = 1)
- None of the population is exposed to a hazard (Impact Factor = 0)

Scores of 30 or greater are rated "High," 15 -30 are rated "Medium," and less than 15 are rated "Low"

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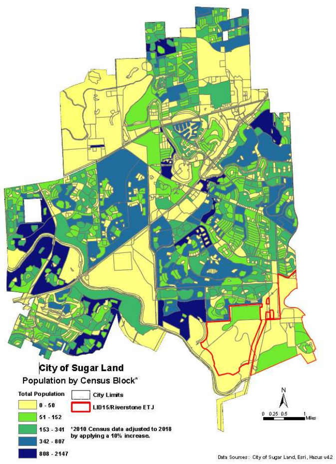
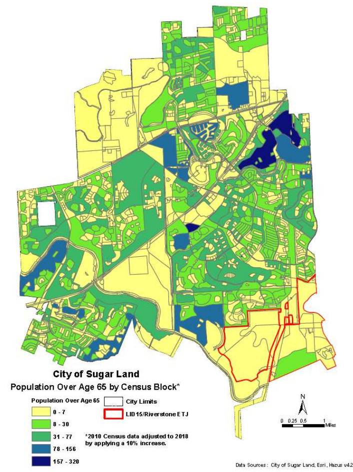
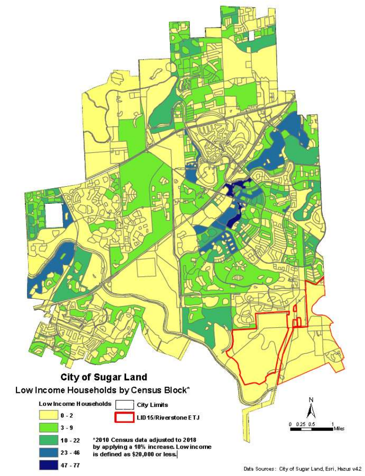
Risk Assessment – Population, Vulnerable Persons







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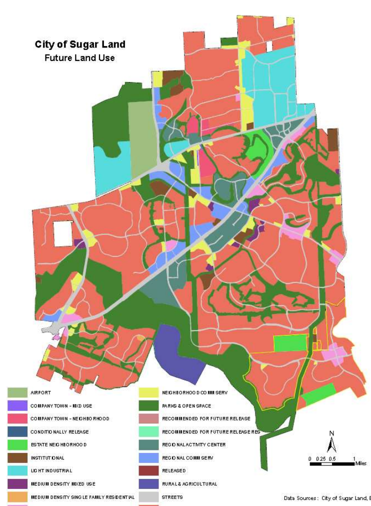
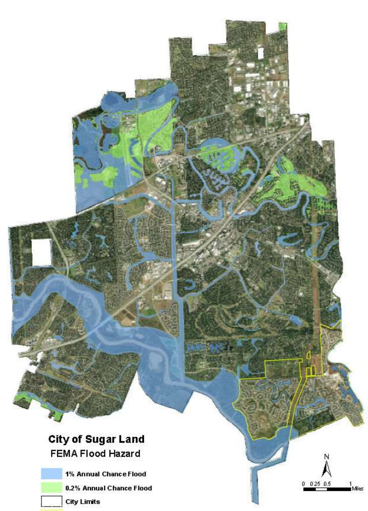
City Overview – Land Use, Flood Extent





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Hurricane 100 Year Example

Jurisdiction	Estimated Exposure					Economic Impact						
	Estimated Population (1)	% Population Exposed	Total Number of Buildings (2)	Total Building Value (Structure and contents in $) (2)	% of Total Value Exposed	Structure Debris (Tons) (3)	Number of Displaced Households (3)	People Requiring Short-Term Shelter (3)	Value Structure in $ Damaged (3)	Value Contents in $ Damaged (3)	Total Value (Structure and Contents in $) Damaged (3)	% of Total Value Damaged
City Limits	119,229	100%	37,060	$47,404,761,657	100%	116,892.06	358	221	$593,932,218	$131,219,077	$725,151,295	1.5%
ETJ - Riverstone/LID 15	537	100%	2,764	$2,038,965,248	100%	8,247.94	25	15	$45,085,542	$10,270,823	$55,356,365	2.7%
TOTAL	**119,766**	100%	**39,824**	**$49,443,726,904**	100%	**125,140.00**	**383**	**236**	**$639,017,760**	**$141,489,900**	**780,507,660**	1.6%

(1) Estimated 2018 population calculated by multiplying 2010 Census block-level population (Hazus v4.2 SP03) by 10% population change from 2010 to 2018 (U.S. Census Bureau Quick Facts website).
(2) Values based off of Fort Bend Central Appraisal District 2019 certified data.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.

RISK RANKING-100-yr Probabilistic Hurricane

	Probability		Impact on People				Impact on Property				Impact on Economy					
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
City Limits	Medium	2	100.00%	High	3	9	100.00%	High	3	6	1.53%	Low	1	1	32	High
ETJ - Riverstone/LID 15	Medium	2	100.00%	High	3	9	100.00%	High	3	6	2.71%	Low	1	1	32	High
TOTAL	Medium	2	100.00%	High	3	9	100.00%	High	3	6	1.58%	Low	1	1	32	High

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Hazard Ranking Results

RISK RANKING-FEMA 100-Year Flood

	Risk Ranking Score	Hazard Risk Rating
City Limits	10	Low
ETJ - Riverstone/LID 15	10	Low
Total	10	Low

RISK RANKING-20-yr Probabilistic Hurricane

	Risk Ranking Score	Hazard Risk Rating
City Limits	32	High
ETJ - Riverstone/LID 15	32	High
TOTAL	32	High

RISK RANKING-FEMA 500-Year Flood

	Risk Ranking Score	Hazard Risk Rating
City Limits	12	Low
ETJ - Riverstone/LID 15	10	Low
Total	12	Low

RISK RANKING-100-yr Probabilistic Hurricane

	Risk Ranking Score	Hazard Risk Rating
City Limits	32	High
ETJ - Riverstone/LID 15	32	High
TOTAL	32	High

RISK RANKING- Hurricane Harvey Flood

	Risk Ranking Score	Hazard Risk Rating
City Limits	34	High
ETJ - Riverstone/LID 15	34	High
Total	34	High

RISK RANKING-500-yr Probabilistic Hurricane

	Risk Ranking Score	Hazard Risk Rating
City Limits	34	High
ETJ - Riverstone/LID 15	36	High
TOTAL	34	High

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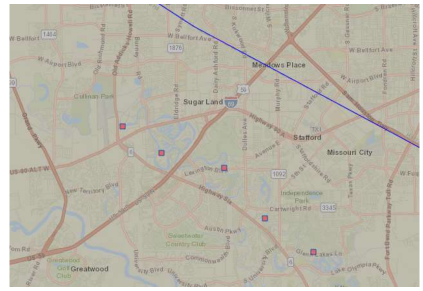
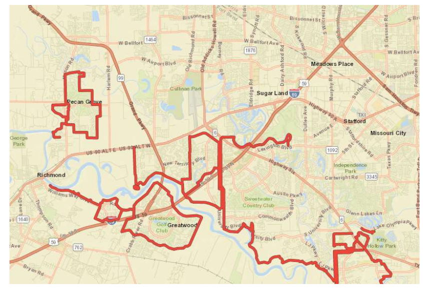
Dam and Levee Failure

- There are 3 dams located within the City of Sugar Land:
    - Dam 1
    - Dam 3
    - Old Second Lift Dam
- There are five Levee Improvement Districts (LID) in the City
- No history of dam or levee failures in the City





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Drought

USDA Disaster Designation History for Fort Bend County

Date(s) of Event	Event Type	USDA Designation Number
April-May 2014	**Drought**	**44 acres damaged; $3,192 in losses**
Starting in August 2019	**Drought**	**Over 6,000 acres damaged; nearly $1 million in losses**

- Minimal exposure to buildings and critical facilities
- Prolong droughts can lead to water supply shortages

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Earthquake

RISK RANKING-500-yr Probabilistic Earthquake

	Probability (High, Medium, Low, None)	Risk Ranking Score	Hazard Risk Rating
City Limits	None	0	Low
ETJ - Riverstone/LID 15	None	0	Low
TOTAL	None	0	Low

Overall City Impacts

Probability - Low

Estimated Exposure

- Entire population of the City is exposed
- All buildings in the City are exposed

Economic Impacts

- $3.5 million in structural/contents damages
- <0.01% of total building value damaged

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Erosion

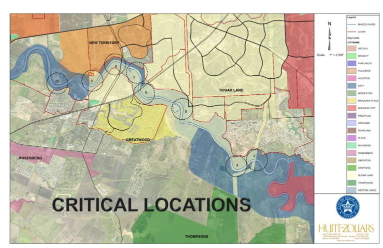
Banks along the Brazos River is the main area of erosion in the City.

Rainfall events upstream from the City can lead to major flood stages, increasing the risk of erosion along the river.

Recent events causing erosion:

- Memorial Day Flood – 2015
- Tax Day Flood – 2016
- Hurricane Harvey – 2017
- May 2019
- Tropical Storm Imelda – 2019

The City contract with a firm to prepare a comprehensive study (completed in August 2018) of erosion along the Brazos River. The study included funding sources to help reduce erosion.



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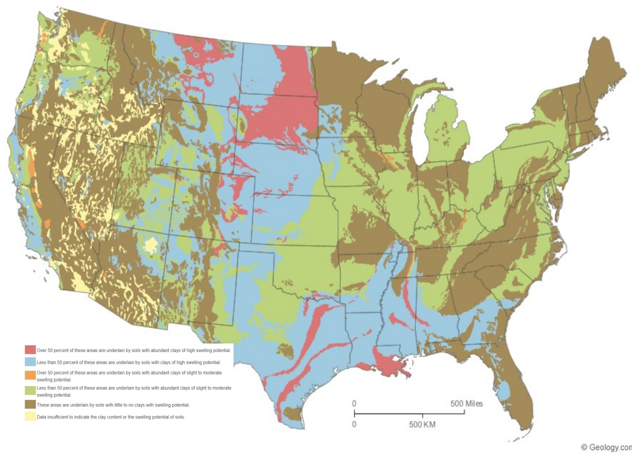
Expansive Soils

- Less than 50% of the soils in the City consist of clay that has high swelling potential
- Damages associated with expansive soils in the City was not found during hazard research.
- Slab-on-grade buildings are the most susceptible to damage from expansive soils.
- The entire population and building stock of the City is exposed to expansive soils. However, probability of occurrence is minimum.



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Extreme Temperature

The entire City is exposed and vulnerable to extreme temperature; however, the main concern is extreme heat.

Between 1997 and 2019, the City had over 100 days of temperatures over 90°F and seven days of temperatures below 32°F. This information was collected from the Houston Sugar Land Memorial Station weather station.

The City has a 100% chance of an extreme temperature event occurring in any given year.

Populations most at risk:

- Persons over 65 – 12,570 in the City
- Persons under 5 – 4,702 in the City
- Population below poverty threshold – 5,213 in the City

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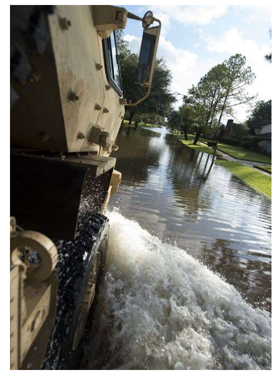
Flood

- History of events
- 7 FEMA Flood Disaster Declarations for Fort Bend County

Date(s) of Incident	Incident Type	FEMA Disaster Number
December 20, 1991-January 14, 1992	Severe Thunderstorms	DR-930
October 14-November 8, 1994	Severe Thunderstorms and Flooding	DR-1041
October 17-November 15, 1998	TX-Flooding	DR-1257
October 24-November 15, 2002	Severe Storms, Tornadoes, and Flooding	DR-1439
May 4-June 22, 2015	Severe Storms, Tornadoes, Straight-Line Winds and Flooding	DR-4223
April 17-30, 2016	Severe Storms and Flooding	DR-4269
May 22-June 24, 2016	Severe Storms and Flooding	DR-4272

- 12 flood events impacting the City between 1991 and 2019 (FEMA, NOAA-NCEI and 2014 City HMP)



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Flood

Hazard Type	Number of Occurrences Between 1991 and 2019	Total Fatalities	Total Injuries	Total Damages
Flash Flood	10	0	5	$1.04 million

Sources: NOAA-NCEI 2020; City of Sugar Land HMP 2014
Notes: The numbers shown here are as reported to NOAA and may not contain all events that occurred in or impacted the City of Sugar Land.

The September 2019 flood event brought 4.5 inches of rain to the City, inundating streets, flooding homes, and stranding vehicles in the roadways.

- ✓ 7 FEMA declarations – 3 since 2014
- ✓ September 2019 most recent event

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Flood – Estimated Exposure

Estimated Exposure

1% annual chance flood
- 6,318 acres in the floodplain
- 313 people (0.3% of total population)
- 103 structures in floodplain (over $175 million)
- Medium probability of occurring

0.2% annual chance flood
- 7,513 acres in the floodplain
- 3,617 people (3% of total population)
- 1,105 structures in floodplain (over $855 million)
- Medium probability of occurring

Hurricane Harvey
- 15,923 acres in floodplain
- 32,044 people (26.8% population)
- 10,741 structures in floodplain (over $14 billion)
- Medium probability of occurring

Estimated Economic Impacts

1% annual chance flood
- 48 people displaced; two people seeking shelter
- 34 buildings impacted; $4.6 million damages

0.2% annual chance flood
- 749 people displaced; 39 seeking shelter
- 801 buildings impacted; $49.4 million damages

Hurricane Harvey
- 16,067 people displaced; 903 seeking shelter
- 10,740 buildings impacted; over $2.7 billion damages

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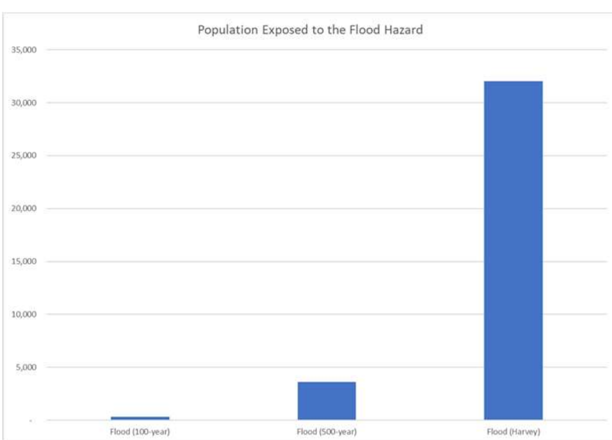
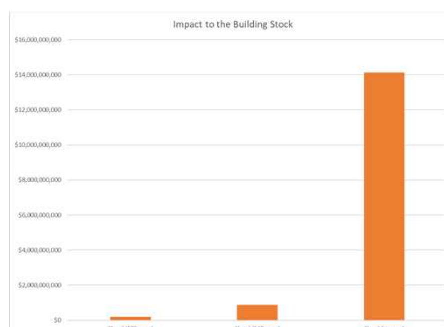
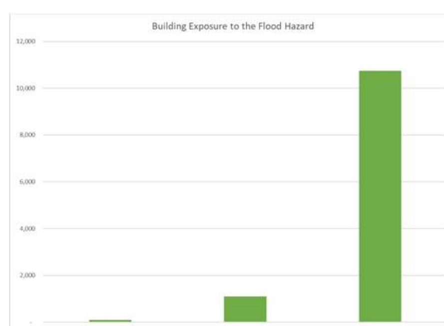
Flood – Estimated Exposure







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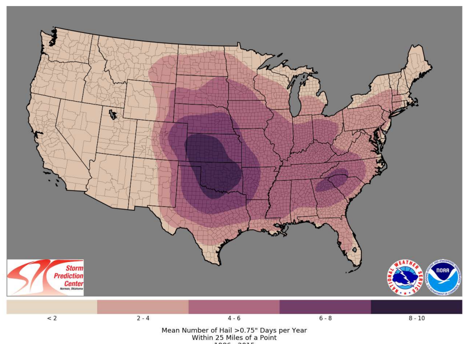
Hail

- Over 120 hail incidents were recorded for Fort Bend County. Of those events, 13 were recorded in the City of Sugar Land, causing $99,000 in property damage. These numbers are based on information reported to NOAA-NCEI and may not include all events or losses.
- Entire population and all buildings are exposed to hail.



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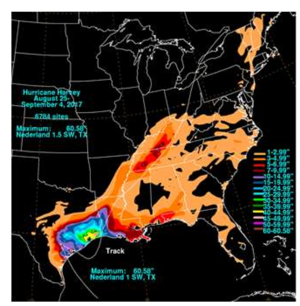
Hurricane and Tropical Storm

Hurricane and Tropical Storm Event History

10 FEMA Hurricane Disaster Declarations for Fort Bend County

Date(s) of Incident	Incident Type	FEMA Disaster Number
August 18-20, 1983	Hurricane Alicia	DR-689
August 22-31, 1998	Tropical Storm Charley	DR-1239
June 5-20, 2001	Tropical Storm Allison	DR-1379
September 20-October 14, 2005	Hurricane Rita	EM-3261 and DR-1606
August 17-September 5, 2007	Hurricane Dean	EM-3277
August 27-September 7, 2008	Hurricane Gustav	EM-3290
September 7-October 2, 2008	Hurricane Ike	EM-3294 and DR-1791
August 23-September 15, 2017	Hurricane Harvey	DR-4332



Six hurricane events between 1996 and 2019 (FEMA, NOAA-NCEI and 2014 City HMP)

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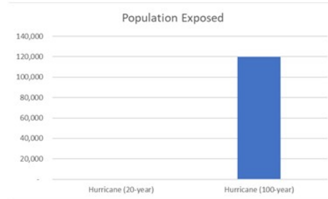
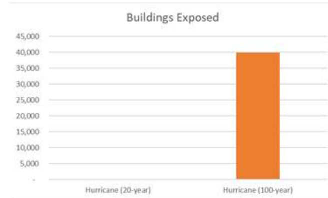
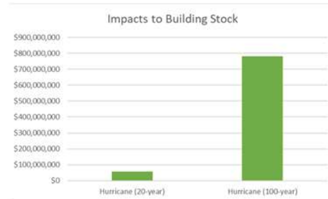
Hurricane and Tropical Storm







Estimated 20-year Probability

- Entire population and all buildings exposed
  - One displaced household; one person seeking shelter
- 9,988 tons of debris generated
- Over $58 million in structure/contents damages
- Medium probability of occurring

Estimated 100-year probability

- Entire population and all buildings exposed
  - 383 displaced households; 236 people seeking shelter
- Over 125,000 tons of debris generated
- Over $780 million in structure/contents damages
- Medium probability of occurring

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Land Subsidence

- Areas along the Texas Gulf Coast are the most susceptible to land subsidence
- While no reports of land subsidence events in the City of Sugar Land, there have been reports in surrounding areas. Sinkholes have occurred in Rosenberg and Kingwood.
- The entire population and building stock of the City is exposed to the land subsidence hazard. However, probability of occurrence is minimum.

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Lightning

Between 1996 and 2019, three lightning strikes were record in the City of Sugar Land.

- This led to $43,000 in damages, one fatality and two injuries.

These numbers are based on information reported to NOAA-NCEI and may not include all events or losses.

The entire population of the City and all buildings are exposed to the lightning hazard.

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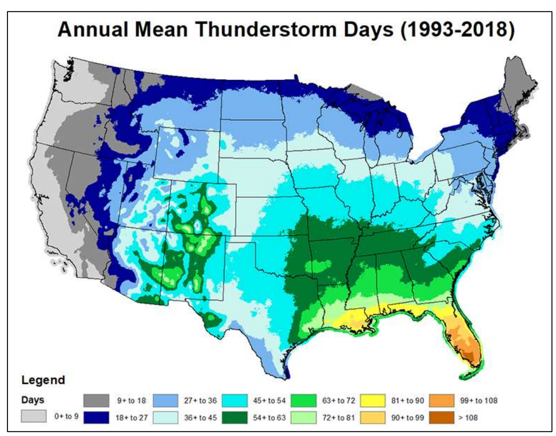
Severe Thunderstorms and Wind

- Between 1991 and 2019, NOAA-NCEI reported 21 thunderstorm/wind events in the City. Many of the events downed trees, caused power outages, and damaged roads and buildings.
- <u>Severe thunderstorms are the most frequent natural hazard in the City.</u>
- The entire population of the City and all buildings are exposed to the thunderstorm and wind hazard.
- Secondary impacts include flash flood, power outages, and property damage.



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Severe Winter Storm

- Between 1950 and 2019, eight winter weather-related events impacted the City of Sugar Land.
- The entire City is exposed and vulnerable to the impacts of winter weather.
- Secondary impacts include: power outages, frost heaving of roads, and downed trees due to weight of snow and ice.

Tornado

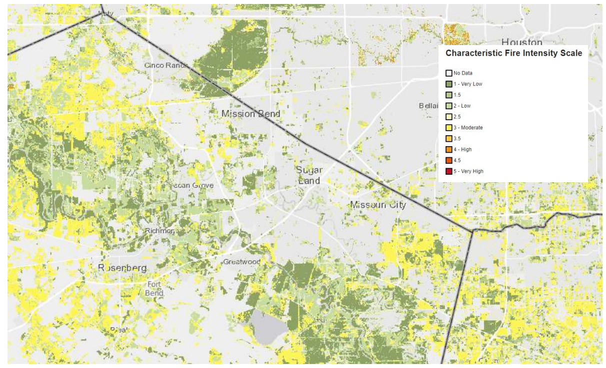
- Two FEMA tornado-related Disaster Declarations for Fort Bend County

Date(s) of Incident	Incident Type	FEMA Disaster Number
October 24, 2002 to November 15, 2002	Severe Storms, Tornadoes, and Flooding	DR-1439
May 4, 2015 to June 22, 2015	Severe Storms, Tornadoes, Straight-Line Winds and Flooding	DR-4223

- Between 1950 and 2019, there have been seven tornadoes and two funnel clouds in the City. These events caused 64 injuries and over $5 million in property damage. These numbers are based on information reported to NOAA-NCEI and may not include all events or losses.
- The most severe tornado to impact the City was on February 16, 1998. An EF3 tornado struck causing four injuries and $3.7 million in property damage.
- The entire City is exposed and vulnerable to a tornado

Wildfire

- According to the Texas Wildfire Risk Assessment Portal, the City of Sugar Land has a very low risk to wildfires.
- Between 2002 and 2019, there have been no reported wildfires in the City of Sugar Land.
- The entire population and building stock of the City is exposed to the wildfire hazard. However, probability of occurrence is minimum.



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Non-Natural Hazards

Hazmat
Frequent occurrence in the City; entire population and building stock (mainly highways and roads) are exposed and vulnerable; we will use the USDOT PHMSA (Pipeline and Hazardous Materials Safety Administration) website to research previous events.

Transportation Accidents
Frequent occurrence in the City; entire population and building stock (mainly highways and roads) are exposed and vulnerable; we will use the USDOT PHMSA (Pipeline and Hazardous Materials Safety Administration) and NTSB websites to research previous events.

Terrorism
Major event has a low likelihood of occurrence; if an event were to occur, the entire population and building stock is exposed and vulnerable.

Energy Shortage
Low probability of occurrence; we will need history of events from the City; if an event were to occur, the entire population and building stock are exposed and vulnerable.

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Next Steps

- Attend Steering Committee Meeting (March 26, 2020,11am-1pm)
- Core Planning Team Review Hazard Profiles
- SWOO Exercise – Steering Committee
- Develop Mitigation Strategy
- Review Draft Plan
- Submit Draft Plan for TDEM/FEMA VI Review
- Adopt FEMA-Approved Plan
- Implement Projects and Maintain the Plan
- Increase Resilience!

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Questions?

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Tetra Tech Project Contacts
Chrissie Angeletti, JD
(512) 917-7513 | Chrissie.Angeletti@tetratech.com
Thank You

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APPENDIX D.PUBLIC AND STAKEHOLDER OUTREACH

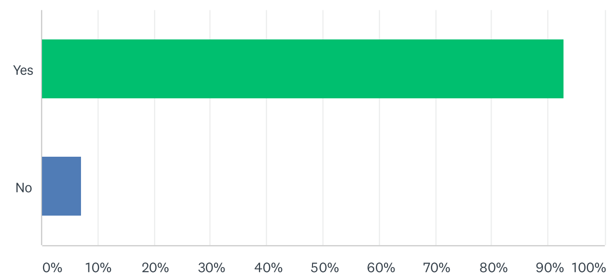
This appendix provides documentation of public and stakeholder outreach. Stakeholder involvement in this planning process was broad and productive as discussed and further documented in Section 3 (Planning Process). Public and stakeholder input has been incorporated throughout this HMP as appropriate, as identified in Section 3 and the References section.

D.1 City of Sugar Land Citizen Survey Results

This section contains information and results gathered from the City of Sugar Land Citizen Survey. The main objective of this survey was to gather information from citizens regarding their level of knowledge regarding hazard vulnerability and knowledge of hazard mitigation information for their local communities. The survey was available on the City of Sugar Land Planning Department website in Summer 2020. 112 respondents completed this survey over a period of five months during the planning process. Respondents primarily consisted of individuals who have lived in City of Sugar Land for 15 years or more with university or college degrees, live in a single-family home, and are older than 50 years old. Survey respondents indicated that severe thunderstorms, flooding, and hurricanes, tropical storms, and depressions were the hazards of greatest concern. Mitigation projects identified by survey respondents to reduce the effects of hazards include: retrofitting infrastructure, installing or improving protective structures, and improving damage resistance of utilities. Survey results are listed below. Personal information was redacted from the survey.

Q1 Do you work or live within the City of Sugar Land?

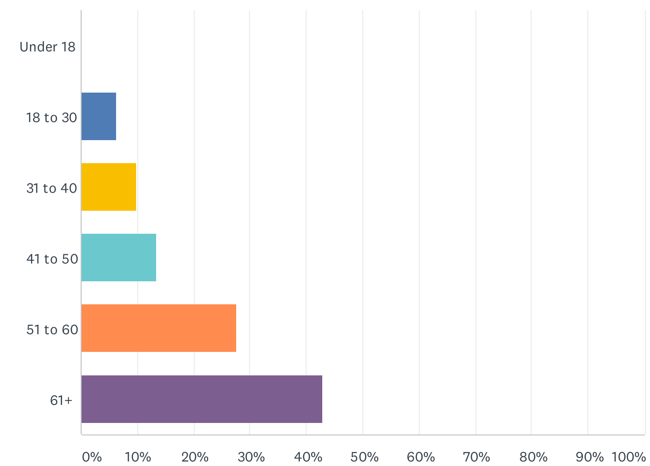
Answered: 112 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	92.86%	104
No	7.14%	8
TOTAL		112

Q2 Please indicate your age range:

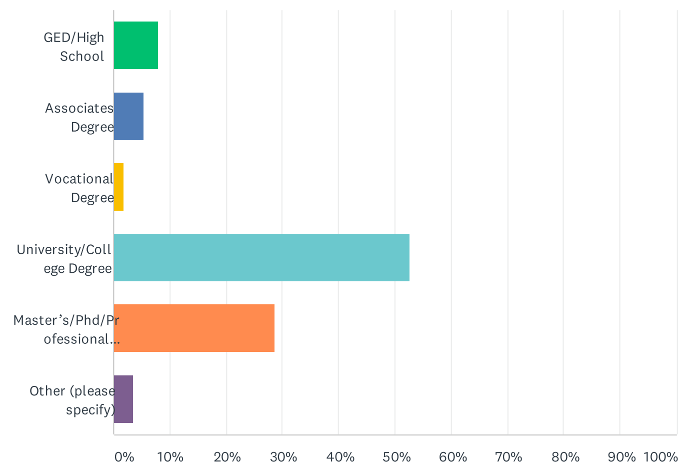
Answered: 112 Skipped: 0



ANSWER CHOICES	RESPONSES	
Under 18	0.00%	0
18 to 30	6.25%	7
31 to 40	9.82%	11
41 to 50	13.39%	15
51 to 60	27.68%	31
61+	42.86%	48
TOTAL		112

Q3 What is your education Level?

Answered: 112 Skipped: 0

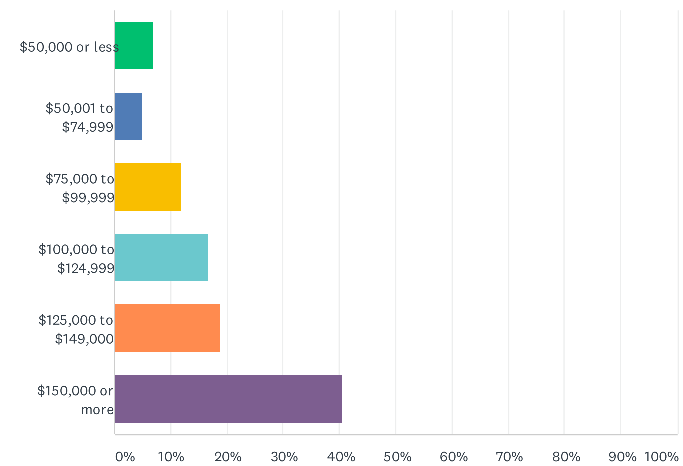


ANSWER CHOICES	RESPONSES	
GED/High School	8.04%	9
Associates Degree	5.36%	6
Vocational Degree	1.79%	2
University/College Degree	52.68%	59
Master's/Phd/Professional Degree	28.57%	32
Other (please specify)	3.57%	4
TOTAL		112

#	OTHER (PLEASE SPECIFY)	DATE
1	presently attending college	3/18/2020 9:29 AM
2	Business College + additional college classes; no degree	3/10/2020 9:07 PM
3	5 hrs short of Associates Degree	3/9/2020 11:17 AM
4	Some College	2/27/2020 4:17 PM

Q4 How much is your gross household income?

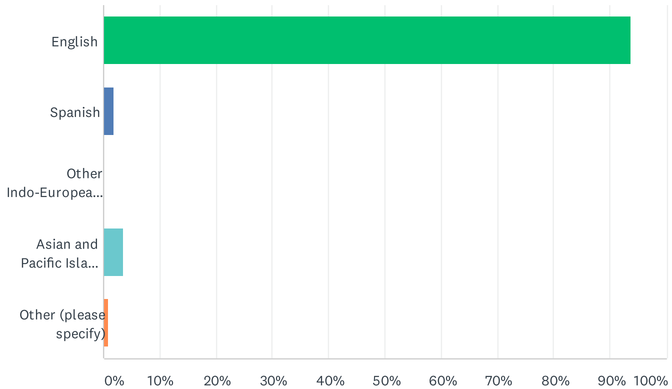
Answered: 101 Skipped: 11



ANSWER CHOICES	RESPONSES	
$50,000 or less	6.93%	7
$50,001 to $74,999	4.95%	5
$75,000 to $99,999	11.88%	12
$100,000 to $124,999	16.83%	17
$125,000 to $149,000	18.81%	19
$150,000 or more	40.59%	41
TOTAL		101

Q5 Please indicate the primary language spoken in your household:

Answered: 112 Skipped: 0

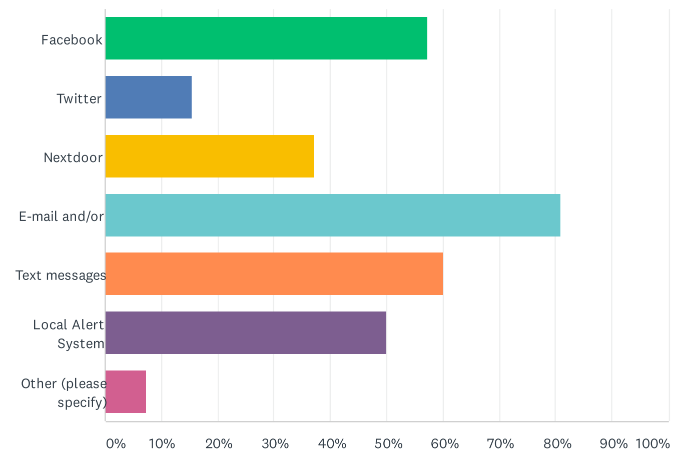


ANSWER CHOICES	RESPONSES	
English	93.75%	105
Spanish	1.79%	2
Other Indo-European Language	0.00%	0
Asian and Pacific Island Languages	3.57%	4
Other (please specify)	0.89%	1
TOTAL		112

#	OTHER (PLEASE SPECIFY)	DATE
1	Hindi	3/6/2020 3:58 PM

Q6 Which of the following digital media outlets do you subscribe to receive news and information about the City of Sugar Land? Select all that apply:

Answered: 110 Skipped: 2



ANSWER CHOICES	RESPONSES	
Facebook	57.27%	63
Twitter	15.45%	17
Nextdoor	37.27%	41
E-mail and/or	80.91%	89
Text messages	60.00%	66
Local Alert System	50.00%	55
Other (please specify)	7.27%	8
Total Respondents: 110		

#	OTHER (PLEASE SPECIFY)	DATE
1	recorded messages over cell phone	3/18/2020 9:29 AM
2	fire department active 911 and city email and call back system	3/14/2020 7:38 AM
3	Instagram	3/10/2020 9:36 AM
4	Wechat	3/9/2020 11:26 AM
5	City website	3/9/2020 10:52 AM
6	MySugarLand app	3/7/2020 4:44 PM
7	Houston Chronicle/TV	3/7/2020 1:04 AM
8	Local news	3/6/2020 4:45 PM

Q7 What neighborhood/part of the City do you live in? (Please specify if you do not live in the City)

Answered: 105 Skipped: 7

#	RESPONSES	DATE
1	Settlers Park	5/29/2020 12:08 AM
2	New Territory	5/26/2020 11:07 AM
3	Royal Lakes Estate	5/14/2020 3:58 PM
4	Do not live within the city	5/14/2020 3:32 PM
5	Pheasant Creek	5/14/2020 2:37 PM
6	I live in Missouri City, Enclave at Lake ShoreHarbour	4/26/2020 5:52 PM
7	Greatwood	4/20/2020 3:37 PM
8	Greatwood Subdivision	4/11/2020 8:27 AM
9	Greatwood	4/10/2020 9:09 PM
10	Greatwood	4/2/2020 4:51 PM
11	Greatwood	4/2/2020 10:23 AM
12	Greatwood	3/24/2020 10:25 AM
13	Glen Laurel	3/19/2020 9:59 PM
14	Lakeview Dr	3/19/2020 5:54 PM
15	Hall Lake	3/18/2020 9:37 AM
16	GreatWood	3/16/2020 3:55 PM
17	Colony Bend II- Williams Trace and Country Side	3/14/2020 7:39 AM
18	Greatwood	3/13/2020 4:07 PM
19	Glen Laurel	3/11/2020 10:24 AM
20	Do not live in Sugar Land.	3/11/2020 10:08 AM
21	Greatwood	3/10/2020 9:11 PM
22	I do not live in the City	3/10/2020 4:25 PM
23	ragus lakes	3/10/2020 3:33 PM
24	Greatwood	3/10/2020 12:06 PM
25	Do not live in Sugar Land. Live in Brazoria County, about 50 minutes from work.	3/10/2020 9:41 AM
26	Live in Stafford Tx	3/9/2020 5:49 PM
27	Rivercrest Apartments	3/9/2020 4:45 PM
28	(work)	3/9/2020 3:53 PM
29	Greatwood	3/9/2020 2:53 PM
30	Do not live in the city. County of Fort Bend	3/9/2020 2:44 PM
31	Great wood Subdivision Terrace Section	3/9/2020 12:08 PM
32	Commonwealth	3/9/2020 11:32 AM
33	Barrington Place	3/9/2020 11:24 AM
34	New Territory, Walker Station Subdivision	3/9/2020 11:08 AM
35	Rivercrest	3/9/2020 11:03 AM
36	Greatwood Trails Section II	3/9/2020 10:54 AM
37	Greatwood	3/9/2020 6:58 AM

38	Greatwood Village	3/8/2020 6:50 PM
39	Greatwood Forest	3/8/2020 2:56 PM
40	Greatwood	3/8/2020 11:57 AM
41	Greatwood	3/8/2020 10:17 AM
42	Greatwood	3/7/2020 8:52 PM
43	Greatwood	3/7/2020 4:45 PM
44	Greatwood Mannor	3/7/2020 4:24 PM
45	Greatwood	3/7/2020 4:22 PM
46	Great wood	3/7/2020 10:45 AM
47	Great Wood	3/7/2020 9:19 AM
48	Greatwood	3/7/2020 9:13 AM
49	Greatwood	3/7/2020 8:40 AM
50	Greatwood	3/7/2020 8:02 AM
51	Greatwood-Terrace	3/7/2020 5:51 AM
52	Vistas of Greatwood	3/7/2020 1:05 AM
53	Greatwood	3/7/2020 12:51 AM
54	The Terrace in Greatwood	3/6/2020 10:59 PM
55	Greatwood	3/6/2020 10:38 PM
56	Greatwood	3/6/2020 9:25 PM
57	Greatwood	3/6/2020 8:53 PM
58	Greatwood	3/6/2020 7:50 PM
59	Greatwood	3/6/2020 7:26 PM
60	Great wood Highland Prk II	3/6/2020 6:59 PM
61	Greatwood	3/6/2020 6:56 PM
62	Greatwood	3/6/2020 5:56 PM
63	Greatwood	3/6/2020 5:31 PM
64	Greatwood	3/6/2020 5:13 PM
65	Greatwood subdivision	3/6/2020 5:12 PM
66	Greatwood	3/6/2020 5:09 PM
67	Greatwood, Forest section	3/6/2020 5:08 PM
68	Greatwood	3/6/2020 4:57 PM
69	Greatwood	3/6/2020 4:48 PM
70	greatwood village	3/6/2020 4:45 PM
71	Greatwood Village	3/6/2020 4:39 PM
72	Greatwood - Work only	3/6/2020 4:38 PM
73	Greatwood	3/6/2020 4:37 PM
74	Greatwood	3/6/2020 4:29 PM
75	Vistas-Greatwood	3/6/2020 4:23 PM

76	Greatwood Trails	3/6/2020 4:06 PM
77	Greatwood	3/6/2020 4:00 PM
78	Greatwood	3/6/2020 3:59 PM
79	Greatwood	3/3/2020 1:35 PM
80	Telfair	3/2/2020 5:08 AM
81	Greatwood	3/1/2020 8:10 PM
82	settlers park	3/1/2020 2:49 PM
83	Hwy 6 & Old Richmond	2/29/2020 5:56 PM
84	New Territory	2/28/2020 11:18 AM
85	Covington West Subdivision	2/28/2020 10:40 AM
86	Sweetwater Area-Crescents On The Green	2/28/2020 9:30 AM
87	New Territory	2/28/2020 8:24 AM
88	New Territory	2/27/2020 11:24 PM
89	Greatwood	2/27/2020 10:42 PM
90	Covington Woods	2/27/2020 8:44 PM
91	The Cove at Crescent Lakes in First Colony	2/27/2020 5:05 PM
92	Summerfield in unincorporated Sugar Land	2/27/2020 4:19 PM
93	New Territory	2/27/2020 2:42 PM
94	First Colony	2/27/2020 2:32 PM
95	First Colony	2/27/2020 2:10 PM
96	Clayton's Bend in New Territory	2/27/2020 12:54 PM
97	New Territory	2/27/2020 12:52 PM
98	New Territory, Imperial	2/27/2020 7:42 AM
99	Imperial	2/26/2020 7:24 PM
100	Avalon	2/26/2020 1:25 PM
101	Villages of Avalon	2/26/2020 1:14 PM
102	Brazos Landing	2/26/2020 1:11 PM
103	Avalon	2/26/2020 12:36 PM
104	Do not live in city	2/23/2020 4:12 PM
105	Do not live in City (employee)	2/20/2020 4:57 PM

Q8 Please provide you zip code

Answered: 105 Skipped: 7

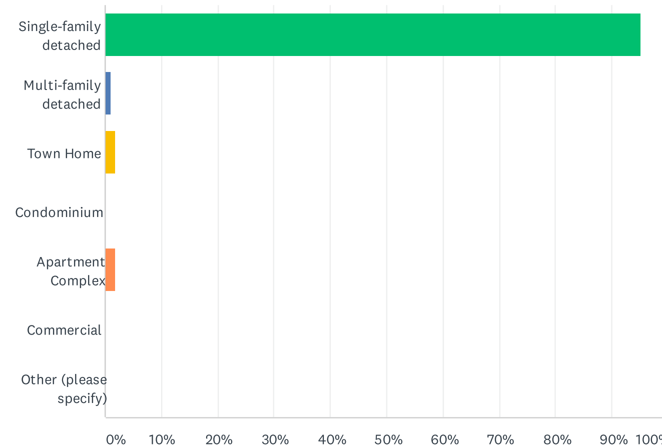
#	RESPONSES	DATE
1	77479	5/29/2020 12:08 AM
2	77479	5/26/2020 11:07 AM
3	77469	5/14/2020 3:58 PM
4	77406	5/14/2020 3:32 PM
5	77498	5/14/2020 2:37 PM
6	77459	4/26/2020 5:52 PM
7	77479	4/20/2020 3:37 PM
8	77479	4/11/2020 8:27 AM
9	77479	4/10/2020 9:09 PM
10	77479	4/2/2020 4:51 PM
11	77479	4/2/2020 10:23 AM
12	77479	3/24/2020 10:25 AM
13	77498	3/19/2020 9:59 PM
14	77498	3/19/2020 5:54 PM
15	77478	3/18/2020 9:37 AM
16	77479	3/16/2020 3:55 PM
17	77479	3/14/2020 7:39 AM
18	77479	3/13/2020 4:07 PM
19	77498	3/11/2020 10:24 AM
20	77433	3/11/2020 10:08 AM
21	77479	3/10/2020 9:11 PM
22	77498	3/10/2020 4:25 PM
23	77498	3/10/2020 3:33 PM
24	77479	3/10/2020 12:06 PM
25	77486	3/10/2020 9:41 AM
26	77477	3/9/2020 5:49 PM
27	77478	3/9/2020 4:45 PM
28	77584	3/9/2020 3:53 PM
29	77479	3/9/2020 2:53 PM
30	77469	3/9/2020 2:44 PM
31	77479	3/9/2020 12:08 PM
32	77479	3/9/2020 11:32 AM
33	77478	3/9/2020 11:24 AM
34	77479	3/9/2020 11:08 AM
35	77478	3/9/2020 11:03 AM
36	77479	3/9/2020 10:54 AM
37	77479	3/9/2020 6:58 AM

38	77479	3/8/2020 6:50 PM
39	77479	3/8/2020 2:56 PM
40	77479	3/8/2020 11:57 AM
41	77479	3/8/2020 10:17 AM
42	77479	3/7/2020 8:52 PM
43	77479	3/7/2020 4:45 PM
44	77479	3/7/2020 4:24 PM
45	77479	3/7/2020 4:22 PM
46	77479	3/7/2020 10:45 AM
47	77379	3/7/2020 9:19 AM
48	77479	3/7/2020 9:13 AM
49	77479	3/7/2020 8:40 AM
50	77479	3/7/2020 8:02 AM
51	77479	3/7/2020 5:51 AM
52	77479	3/7/2020 1:05 AM
53	77479	3/7/2020 12:51 AM
54	77479	3/6/2020 10:59 PM
55	77479	3/6/2020 10:38 PM
56	77479	3/6/2020 9:25 PM
57	77479	3/6/2020 8:53 PM
58	77479	3/6/2020 7:50 PM
59	77479	3/6/2020 7:26 PM
60	77479	3/6/2020 6:59 PM
61	77479	3/6/2020 6:56 PM
62	77479	3/6/2020 5:56 PM
63	77479	3/6/2020 5:31 PM
64	77479	3/6/2020 5:13 PM
65	77479	3/6/2020 5:12 PM
66	77479	3/6/2020 5:09 PM
67	77479	3/6/2020 5:08 PM
68	77479	3/6/2020 4:57 PM
69	77479	3/6/2020 4:48 PM
70	77479	3/6/2020 4:45 PM
71	77479	3/6/2020 4:39 PM
72	77479	3/6/2020 4:38 PM
73	77479	3/6/2020 4:37 PM
74	77479	3/6/2020 4:29 PM
75	77479	3/6/2020 4:23 PM

76	77479	3/6/2020 4:06 PM
77	77479	3/6/2020 4:00 PM
78	77479	3/6/2020 3:59 PM
79	77479	3/3/2020 1:35 PM
80	77479	3/2/2020 5:08 AM
81	77479	3/1/2020 8:10 PM
82	77479	3/1/2020 2:49 PM
83	77498	2/29/2020 5:56 PM
84	77479	2/28/2020 11:18 AM
85	498	2/28/2020 10:40 AM
86	479	2/28/2020 9:30 AM
87	479	2/28/2020 8:24 AM
88	49	2/27/2020 11:24 PM
89	479	2/27/2020 10:42 PM
90	498	2/27/2020 8:44 PM
91	479	2/27/2020 5:05 PM
92	498	2/27/2020 4:19 PM
93	479	2/27/2020 2:42 PM
94	478	2/27/2020 2:32 PM
95	479	2/27/2020 2:10 PM
96	479	2/27/2020 12:54 PM
97	479	2/27/2020 12:52 PM
98	433	2/27/2020 7:42 AM
99	498	2/26/2020 7:24 PM
100	479	2/26/2020 1:25 PM
101	479	2/26/2020 1:14 PM
102	479	2/26/2020 1:11 PM
103	479	2/26/2020 12:36 PM
104	493	2/23/2020 4:12 PM
105	433	2/20/2020 4:57 PM

Q9 What type of residence do you live in?

Answered: 104 Skipped: 8



ANSWER CHOICES	RESPONSES	
Single-family detached	95.19%	99
Multi-family detached	0.96%	1
Town Home	1.92%	2
Condominium	0.00%	0
Apartment Complex	1.92%	2
Commercial	0.00%	0
Other (please specify)	0.00%	0
TOTAL		104

#	OTHER (PLEASE SPECIFY)	DATE
	There are no responses.	

Q10 Do you own or rent your place of residence?

Answered: 103 Skipped: 9

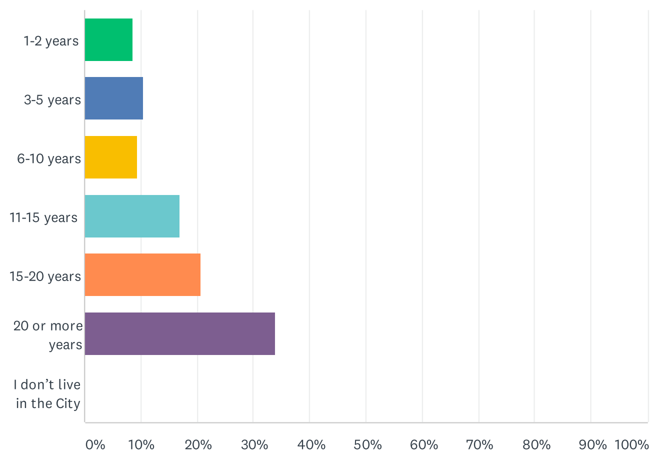
#	RESPONSES	DATE
1	Rent	5/29/2020 12:08 AM
2	Rent	5/26/2020 11:07 AM
3	own	5/14/2020 3:58 PM
4	own	5/14/2020 3:32 PM
5	Own	5/14/2020 2:37 PM
6	Own	4/26/2020 5:52 PM
7	own	4/20/2020 3:37 PM
8	Own	4/11/2020 8:27 AM
9	Own	4/10/2020 9:09 PM
10	Own	4/2/2020 4:51 PM
11	Own	4/2/2020 10:23 AM
12	Own	3/24/2020 10:25 AM
13	Own	3/19/2020 9:59 PM
14	Rent	3/19/2020 5:54 PM
15	own	3/18/2020 9:37 AM
16	own	3/16/2020 3:55 PM
17	own	3/14/2020 7:39 AM
18	Own	3/13/2020 4:07 PM
19	Own	3/11/2020 10:24 AM
20	Own	3/11/2020 10:08 AM
21	own	3/10/2020 9:11 PM
22	own	3/10/2020 4:25 PM
23	own	3/10/2020 3:33 PM
24	Own	3/10/2020 12:06 PM
25	Rent	3/10/2020 9:41 AM
26	Own	3/9/2020 5:49 PM
27	rent	3/9/2020 4:45 PM
28	own	3/9/2020 3:53 PM
29	Own	3/9/2020 2:53 PM
30	Own	3/9/2020 2:44 PM
31	own	3/9/2020 12:08 PM
32	Own	3/9/2020 11:32 AM
33	Own	3/9/2020 11:24 AM
34	own	3/9/2020 11:08 AM
35	rent	3/9/2020 11:03 AM
36	Own	3/9/2020 10:54 AM
37	Own	3/9/2020 6:58 AM

38	Own	3/8/2020 6:50 PM
39	Own	3/8/2020 2:56 PM
40	own	3/8/2020 11:57 AM
41	Own	3/8/2020 10:17 AM
42	Own	3/7/2020 8:52 PM
43	own	3/7/2020 4:45 PM
44	Own	3/7/2020 4:24 PM
45	Own	3/7/2020 4:22 PM
46	Own	3/7/2020 10:45 AM
47	Own	3/7/2020 9:19 AM
48	Own	3/7/2020 9:13 AM
49	Own	3/7/2020 8:40 AM
50	Own	3/7/2020 8:02 AM
51	Own	3/7/2020 5:51 AM
52	Own	3/7/2020 1:05 AM
53	own	3/7/2020 12:51 AM
54	Own	3/6/2020 10:59 PM
55	own	3/6/2020 10:38 PM
56	Own	3/6/2020 9:25 PM
57	Own	3/6/2020 8:53 PM
58	own	3/6/2020 7:50 PM
59	Own	3/6/2020 7:26 PM
60	Pwn	3/6/2020 6:59 PM
61	Own	3/6/2020 6:56 PM
62	Own	3/6/2020 5:56 PM
63	Own	3/6/2020 5:31 PM
64	Own	3/6/2020 5:13 PM
65	Own	3/6/2020 5:12 PM
66	own	3/6/2020 5:09 PM
67	Own	3/6/2020 5:08 PM
68	own	3/6/2020 4:57 PM
69	Own	3/6/2020 4:48 PM
70	own	3/6/2020 4:45 PM
71	Own	3/6/2020 4:39 PM
72	n/a	3/6/2020 4:38 PM
73	Own	3/6/2020 4:37 PM
74	Own	3/6/2020 4:29 PM
75	Own	3/6/2020 4:23 PM

76	Own	3/6/2020 4:06 PM
77	Own	3/6/2020 3:59 PM
78	Own	3/3/2020 1:35 PM
79	Own	3/2/2020 5:08 AM
80	Own	3/1/2020 8:10 PM
81	own	3/1/2020 2:49 PM
82	Own	2/29/2020 5:56 PM
83	Own	2/28/2020 11:18 AM
84	own	2/28/2020 10:40 AM
85	Own	2/28/2020 9:30 AM
86	Own	2/28/2020 8:24 AM
87	Own	2/27/2020 11:24 PM
88	Own	2/27/2020 10:42 PM
89	Own	2/27/2020 8:44 PM
90	Rent	2/27/2020 4:19 PM
91	own	2/27/2020 2:42 PM
92	Own	2/27/2020 2:32 PM
93	own	2/27/2020 2:10 PM
94	own	2/27/2020 12:54 PM
95	own	2/27/2020 12:52 PM
96	Own	2/27/2020 7:42 AM
97	Own	2/26/2020 7:24 PM
98	own	2/26/2020 1:25 PM
99	Own	2/26/2020 1:14 PM
100	Own	2/26/2020 1:11 PM
101	Own	2/26/2020 12:36 PM
102	Rent	2/23/2020 4:12 PM
103	own	2/20/2020 4:57 PM

Q11 How long have you lived at your current residence?

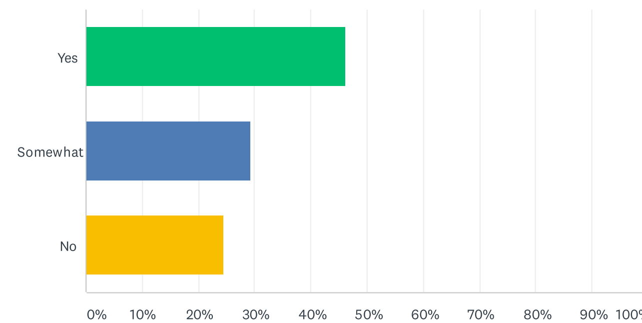
Answered: 106 Skipped: 6



ANSWER CHOICES	RESPONSES	
1-2 years	8.49%	9
3-5 years	10.38%	11
6-10 years	9.43%	10
11-15 years	16.98%	18
15-20 years	20.75%	22
20 or more years	33.96%	36
I don't live in the City	0.00%	0
TOTAL		106

Q12 When you moved into your home, did you consider the impact a natural or non-natural disaster could have on your home?

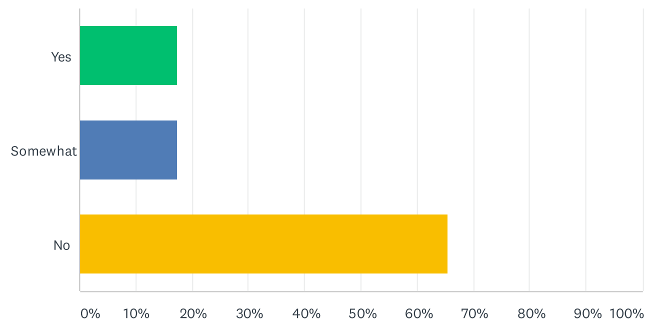
Answered: 106 Skipped: 6



ANSWER CHOICES	RESPONSES	
Yes	46.23%	49
Somewhat	29.25%	31
No	24.53%	26
TOTAL		106

Q13 Was the presence of a natural hazard risk zone (e.g., dam failure zone, flood zone, landslide hazard area, high fire risk area) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?

Answered: 104 Skipped: 8



ANSWER CHOICES	RESPONSES	
Yes	17.31%	18
Somewhat	17.31%	18
No	65.38%	68
TOTAL		104

Q14 If your home has experience damage from a hazard event, please describe type of damage.

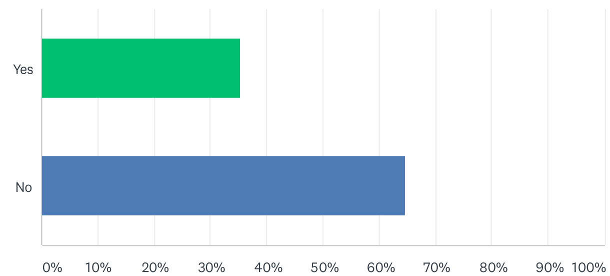
Answered: 54 Skipped: 58

#	RESPONSES	DATE
1	Damaged siding, outside A/C unit pushed off concrete pad by winds	5/29/2020 12:08 AM
2	none	5/14/2020 3:58 PM
3	N/A	5/14/2020 3:32 PM
4	Wind damage to fence.	5/14/2020 2:37 PM
5	New Home	4/26/2020 5:52 PM
6	Wind only	4/2/2020 4:51 PM
7	N/A	4/2/2020 10:23 AM
8	No	3/19/2020 5:54 PM
9	roof damage	3/18/2020 9:37 AM
10	Almost. Water was within 2 inches of getting in my house during Harvey	3/14/2020 7:39 AM
11	No damage	3/11/2020 10:24 AM
12	N/A	3/11/2020 10:08 AM
13	n/a	3/10/2020 4:25 PM
14	Flooding	3/10/2020 9:41 AM
15	no	3/9/2020 5:49 PM
16	N/A	3/9/2020 4:45 PM
17	None	3/9/2020 2:44 PM
18	A tornado or a twister damage my roof. The shingles where picked up do to the high winds and the rain came into my home in two locations.	3/9/2020 12:08 PM
19	Not yet. Maybe some wind caused damage to my roof, window and fence.	3/9/2020 11:32 AM
20	none	3/9/2020 11:08 AM
21	n/a	3/9/2020 11:03 AM
22	NA	3/9/2020 10:54 AM
23	N/A	3/9/2020 6:58 AM
24	Had to replace entire fence due to Hurricane damage	3/8/2020 6:50 PM
25	Shingles flew off the shed. Several sections of our fence were blown down.	3/7/2020 8:52 PM
26	None	3/7/2020 4:45 PM
27	Minor roof damage from storms	3/7/2020 10:45 AM
28	None	3/7/2020 8:02 AM
29	no damage	3/7/2020 12:51 AM
30	Roof damage from wind and hail.	3/6/2020 10:59 PM
31	Few shingles blown off from hurricane	3/6/2020 9:25 PM
32	hurricane - roof damage, brick facade damage	3/6/2020 7:50 PM
33	None	3/6/2020 7:26 PM
34	Roof damage, wind, Ike	3/6/2020 5:56 PM
35	N/A	3/6/2020 5:31 PM
36	hail damage to the roof	3/6/2020 5:13 PM
37	None	3/6/2020 5:12 PM

38	None known.	3/6/2020 5:08 PM
39	Nothing significant, other than roof damage due to hurricane.	3/6/2020 4:37 PM
40	N/A	3/6/2020 4:23 PM
41	No	3/6/2020 3:59 PM
42	No	3/2/2020 5:08 AM
43	Hurricane: fence & roof damage	2/29/2020 5:56 PM
44	Very minor roof damage from Hurricane Ike.	2/28/2020 11:18 AM
45	Minimal during Hurricane Ike	2/28/2020 10:40 AM
46	N/A	2/27/2020 11:24 PM
47	Foundation issues from Harvey. The house is about 6-9 inches above ground and water was at our threshold.	2/27/2020 4:19 PM
48	n/a	2/27/2020 2:42 PM
49	Flood / wind damage	2/27/2020 2:32 PM
50	na	2/27/2020 2:10 PM
51	none	2/27/2020 12:54 PM
52	N/A	2/27/2020 7:42 AM
53	N/a	2/26/2020 7:24 PM
54	Water leaking in the attic during Harvey	2/26/2020 12:36 PM

Q15 Is your residence located in or near a FEMA designated floodplain? If you do not know, please go to the following link at: HTTP://msc.fema.gov/portal/home

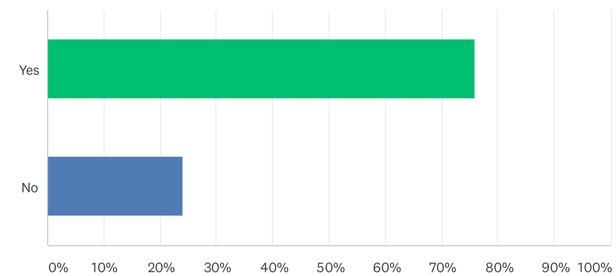
Answered: 102 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	35.29%	36
No	64.71%	66
TOTAL		102

Q16 Do you have flood insurance?

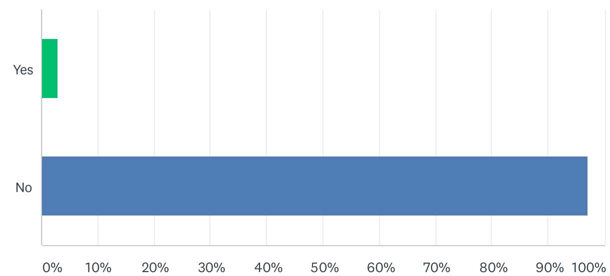
Answered: 104 Skipped: 8



ANSWER CHOICES	RESPONSES	
Yes	75.96%	79
No	24.04%	25
TOTAL		104

Q17 Have you ever had problems securing homeowners or renters insurance due to risks from hazards?

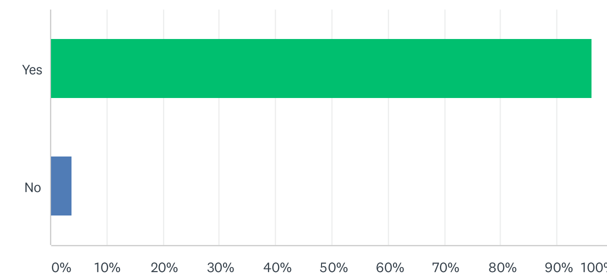
Answered: 106 Skipped: 6



ANSWER CHOICES	RESPONSES	
Yes	2.83%	3
No	97.17%	103
TOTAL		106

Q18 Do you support policies to restrict or prohibit development in designated hazard zones?

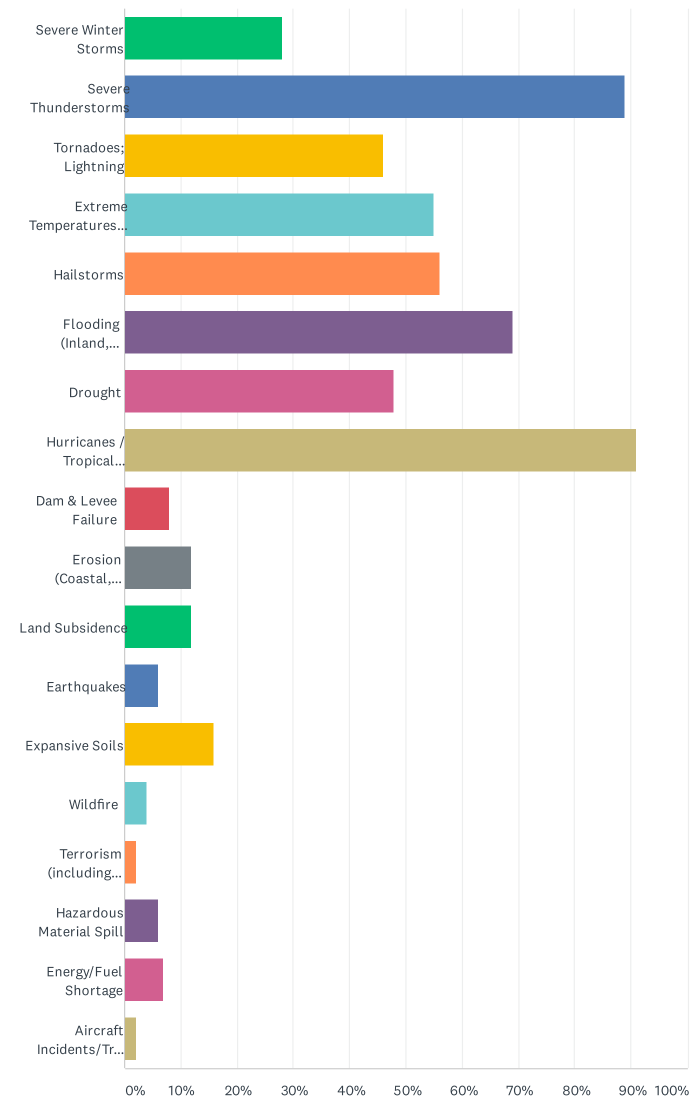
Answered: 106 Skipped: 6



ANSWER CHOICES	RESPONSES	
Yes	96.23%	102
No	3.77%	4
TOTAL		106

Q19 Which of the following natural hazard events have you or has anyone in your household experienced within the past 20 years? Select all that apply:

Answered: 100 Skipped: 12



ANSWER CHOICES	RESPONSES	
Severe Winter Storms	28.00%	28
Severe Thunderstorms	89.00%	89
Tornadoes; Lightning	46.00%	46
Extreme Temperatures (Cold/Heat)	55.00%	55
Hailstorms	56.00%	56
Flooding (Inland, Riverine, and Severe Coastal Flooding)	69.00%	69
Drought	48.00%	48
Hurricanes / Tropical Storms, Depressions	91.00%	91
Dam & Levee Failure	8.00%	8
Erosion (Coastal, Inland)	12.00%	12
Land Subsidence	12.00%	12
Earthquakes	6.00%	6
Expansive Soils	16.00%	16
Wildfire	4.00%	4
Terrorism (including Cyber-Attack)	2.00%	2
Hazardous Material Spill	6.00%	6
Energy/Fuel Shortage	7.00%	7
Aircraft Incidents/Transportation Accidents	2.00%	2
Total Respondents: 100		

Q20 In the last 10 years, were you evacuated from your home as a result of a disaster (e.g. flooding)? If so, how long were you displaced? Did you go to a shelter?

Answered: 89 Skipped: 23

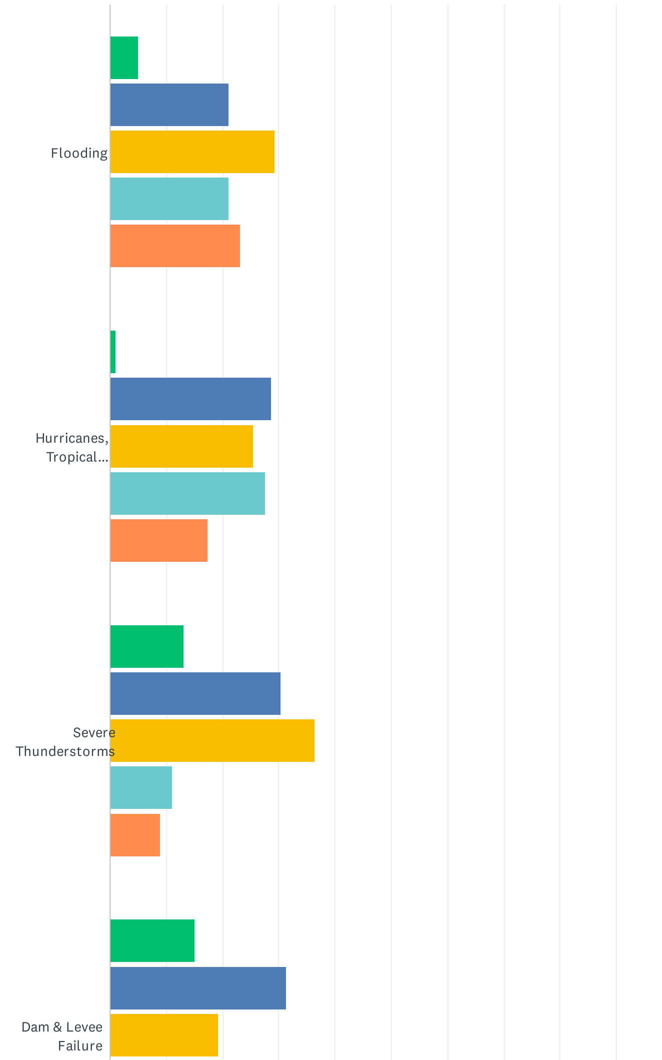
#	RESPONSES	DATE
1	No but came close during Harvey.	5/29/2020 12:16 AM
2	No	5/26/2020 11:10 AM
3	no	5/14/2020 4:05 PM
4	no	5/14/2020 3:37 PM
5	n/a	5/14/2020 2:42 PM
6	No	4/26/2020 5:56 PM
7	4 days	4/10/2020 9:15 PM
8	Evacuated during hurricane....went to Austin	4/2/2020 4:55 PM
9	No	4/2/2020 10:25 AM
10	no	3/24/2020 10:33 AM
11	No	3/19/2020 10:07 PM
12	No	3/19/2020 5:57 PM
13	NO	3/18/2020 9:53 AM
14	Yes, Harvey voluntary evac, went to San Antonio	3/16/2020 3:58 PM
15	yes. Harvey I was at fire station and wife at mothers house	3/14/2020 7:48 AM
16	No	3/13/2020 4:16 PM
17	No mandatory evacuations	3/11/2020 10:27 AM
18	No	3/11/2020 10:14 AM
19	N/A	3/10/2020 4:30 PM
20	Yes, 5 days	3/10/2020 9:46 AM
21	N/A	3/9/2020 5:53 PM
22	No	3/9/2020 4:49 PM
23	no	3/9/2020 3:55 PM
24	Yes; 5 days	3/9/2020 2:56 PM
25	No. Shelter in place during Harvey	3/9/2020 2:49 PM
26	No	3/9/2020 12:18 PM
27	Yes, once; 5 days; no, went to family member's home	3/9/2020 12:07 PM
28	No	3/9/2020 11:42 AM
29	No	3/9/2020 11:30 AM
30	no	3/9/2020 11:15 AM
31	No	3/9/2020 11:00 AM
32	No	3/9/2020 7:04 AM
33	no	3/8/2020 12:01 PM
34	during harvey we left for about 5 days - precaution	3/8/2020 10:23 AM
35	No	3/7/2020 9:00 PM
36	No	3/7/2020 4:49 PM
37	Yes, for about 3-4 days. No, we didn't go to a shelter.	3/7/2020 4:36 PM

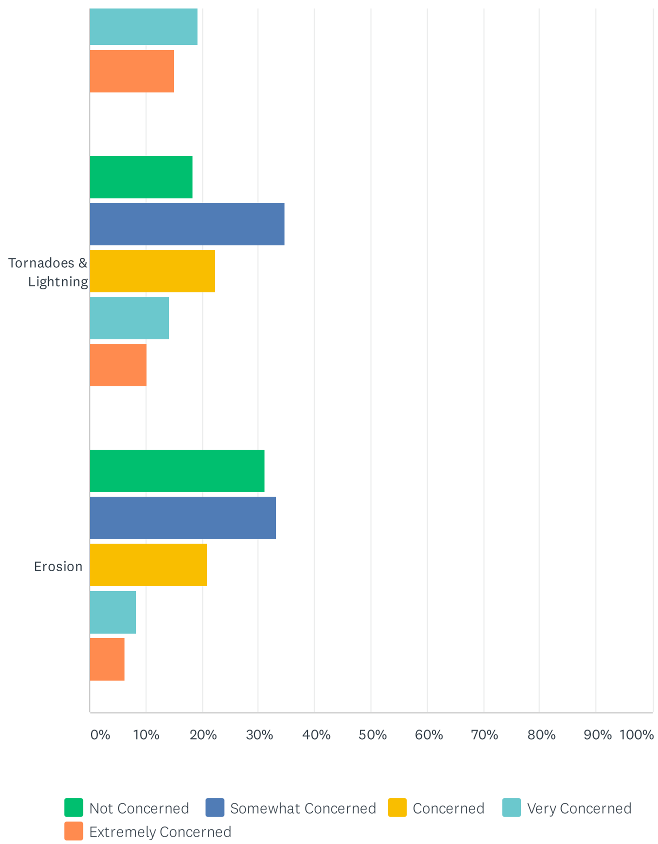
38	No	3/7/2020 4:29 PM
39	No	3/7/2020 10:54 AM
40	No	3/7/2020 9:26 AM
41	No.	3/7/2020 8:44 AM
42	No	3/7/2020 8:05 AM
43	No	3/7/2020 6:04 AM
44	flooding/week/no	3/7/2020 1:11 AM
45	No	3/7/2020 12:54 AM
46	No	3/6/2020 11:05 PM
47	No	3/6/2020 9:34 PM
48	No	3/6/2020 8:58 PM
49	No	3/6/2020 7:55 PM
50	No	3/6/2020 7:32 PM
51	No	3/6/2020 7:04 PM
52	No.	3/6/2020 7:04 PM
53	Yes, voluntary evacuations during Harvey (also for Rita)	3/6/2020 6:07 PM
54	One week / no	3/6/2020 5:40 PM
55	Street flooding 7 days	3/6/2020 5:22 PM
56	voluntary; would have been a few days; no we didn't leave	3/6/2020 5:17 PM
57	no	3/6/2020 5:14 PM
58	no	3/6/2020 5:14 PM
59	No	3/6/2020 5:06 PM
60	Yes; no	3/6/2020 5:02 PM
61	No	3/6/2020 5:00 PM
62	no evac	3/6/2020 4:53 PM
63	Yes. Moved to relative's house for a week.	3/6/2020 4:43 PM
64	n/a	3/6/2020 4:42 PM
65	No	3/6/2020 4:28 PM
66	We have not been evacuated.	3/6/2020 4:15 PM
67	No	3/3/2020 1:38 PM
68	No	3/2/2020 5:15 AM
69	No	3/1/2020 8:13 PM
70	4 days-no	3/1/2020 2:53 PM
71	No	2/29/2020 6:10 PM
72	Yes. 1 week. Sheltered with friends.	2/28/2020 11:23 AM
73	No	2/28/2020 10:52 AM
74	No	2/28/2020 10:46 AM
75	Yes. Evacuated due to flooding threats during hurricane harvey for 5 days	2/28/2020 8:28 AM

76	Yes. One week. No.	2/27/2020 11:28 PM
77	No	2/27/2020 10:48 PM
78	1 night. The Sunday night during Harvey. We got a ride from a stranger to our office and spent the night in our office.	2/27/2020 4:23 PM
79	no	2/27/2020 2:44 PM
80	N/A	2/27/2020 2:37 PM
81	na	2/27/2020 2:13 PM
82	no	2/27/2020 12:58 PM
83	not displaced, but neighborhood under mandatory evacuation during Harvey	2/27/2020 12:56 PM
84	No	2/27/2020 7:47 AM
85	No	2/26/2020 7:31 PM
86	No	2/26/2020 2:47 PM
87	3 days voluntary LID evac, no shelter used	2/26/2020 1:38 PM
88	Yes. 1 week. No	2/26/2020 12:40 PM
89	No	2/20/2020 5:02 PM

Q21 How concerned are you about the following natural hazards? (Please check one for each hazard)

Answered: 100 Skipped: 12



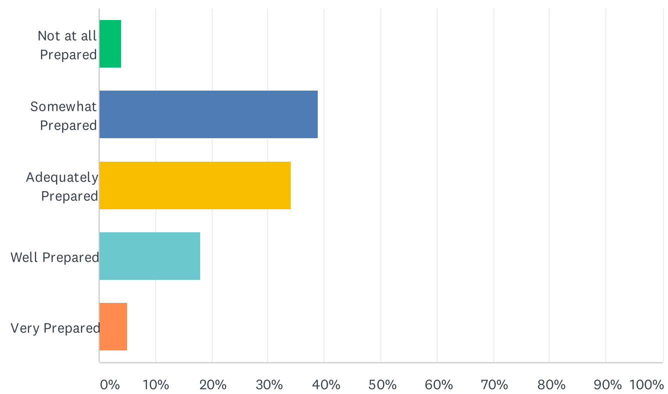


	NOT CONCERNED	SOMEWHAT CONCERNED	CONCERNED	VERY CONCERNED	EXTREMELY CONCERNED	TOTAL
Flooding	5.05% 5	21.21% 21	29.29% 29	21.21% 21	23.23% 23	99
Hurricanes, Tropical Storms, Depressions	1.02% 1	28.57% 28	25.51% 25	27.55% 27	17.35% 17	98
Severe Thunderstorms	13.13% 13	30.30% 30	36.36% 36	11.11% 11	9.09% 9	99
Dam & Levee Failure	15.15% 15	31.31% 31	19.19% 19	19.19% 19	15.15% 15	99
Tornadoes & Lightning	18.37% 18	34.69% 34	22.45% 22	14.29% 14	10.20% 10	98
Erosion	31.25% 30	33.33% 32	20.83% 20	8.33% 8	6.25% 6	96

#	OTHER (PLEASE SPECIFY)	DATE
1	virus outbreak	3/9/2020 11:42 AM
2	extreme temperatures, solar radiation	3/6/2020 7:55 PM
3	Soil settling	3/6/2020 5:22 PM
4	worried about the Brazos River changing course	3/6/2020 5:17 PM
5	To much land development in area and up stream along Brazos River increasing more than normal River bank erosion. Can counties work together to leave more open land?	2/28/2020 10:52 AM
6	Chemical disaster from nearby Nalco plant	2/26/2020 7:31 PM

Q22 The FEMA website - Ready.gov - provides important information on how to prepare you and your family in the event of a disaster. How prepared is your household for a natural or human-caused hazard event? (Check one)

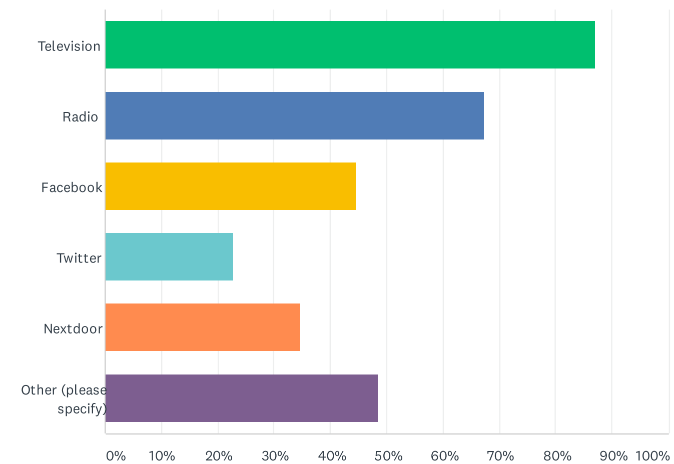
Answered: 100 Skipped: 12



ANSWER CHOICES	RESPONSES	
Not at all Prepared	4.00%	4
Somewhat Prepared	39.00%	39
Adequately Prepared	34.00%	34
Well Prepared	18.00%	18
Very Prepared	5.00%	5
TOTAL		100

Q23 How would you expect to be notified in case of an immediate threat caused by a natural or non-natural hazard? Select all that apply:

Answered: 101 Skipped: 11



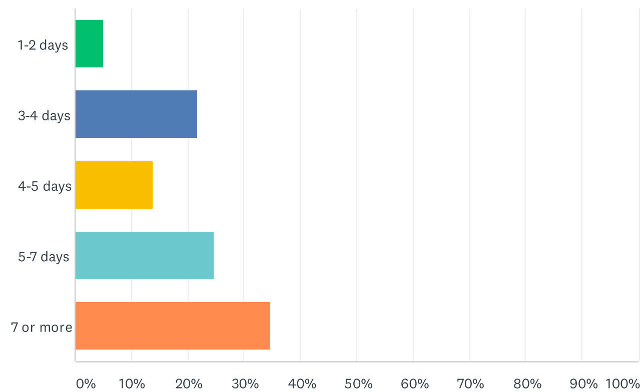
ANSWER CHOICES	RESPONSES	
Television	87.13%	88
Radio	67.33%	68
Facebook	44.55%	45
Twitter	22.77%	23
Nextdoor	34.65%	35
Other (please specify)	48.51%	49
Total Respondents: 101		

#	OTHER (PLEASE SPECIFY)	DATE
1	city alert system via phone/text	5/29/2020 12:16 AM
2	cell phone	5/14/2020 2:42 PM
3	Text messages to cell phones	4/11/2020 8:36 AM
4	Emergency alerts on my cellphone	4/10/2020 9:15 PM
5	Text or email	3/24/2020 10:33 AM
6	RECORDED MESSAGE TO CELL PHONE	3/18/2020 9:53 AM
7	City call back and city email	3/14/2020 7:48 AM
8	E mail notification or text	3/13/2020 4:16 PM
9	Via text or email	3/11/2020 10:27 AM
10	local alert system/text messaging	3/10/2020 9:20 PM
11	Phone	3/10/2020 4:30 PM
12	Email	3/10/2020 12:16 PM
13	Instagram	3/10/2020 9:46 AM
14	Cell phone via city alert system	3/9/2020 4:49 PM
15	text	3/9/2020 3:55 PM
16	City of Sugar Land e-mails or text messages or phone message	3/9/2020 12:18 PM
17	County and City Notifications	3/9/2020 12:07 PM
18	emails, phones	3/9/2020 11:42 AM
19	Employee Hotline	3/9/2020 11:30 AM
20	notification should go accross all platforms	3/9/2020 11:15 AM
21	Text Alert	3/9/2020 7:04 AM
22	New media	3/8/2020 10:23 AM
23	Text message	3/7/2020 9:00 PM
24	MySugarLand app	3/7/2020 4:49 PM
25	email/text	3/7/2020 4:36 PM
26	internet	3/7/2020 4:29 PM
27	Text message, email	3/7/2020 10:54 AM
28	Phone text	3/7/2020 8:05 AM
29	email/call from city	3/7/2020 1:11 AM
30	Phone message from city of SL	3/6/2020 10:41 PM
31	local alert on text	3/6/2020 7:55 PM
32	Email (from LID, for example)	3/6/2020 7:04 PM
33	Text	3/6/2020 6:07 PM
34	Text	3/6/2020 5:22 PM
35	all of the above plus email/text	3/6/2020 5:17 PM
36	Text and email alert	3/6/2020 5:02 PM
37	Email	3/6/2020 5:00 PM

38	email	3/6/2020 4:42 PM
39	phone text alerts	3/6/2020 4:28 PM
40	Emergency text on cell phone.	3/6/2020 4:15 PM
41	Daughter	3/6/2020 4:12 PM
42	Cell phone	3/2/2020 5:15 AM
43	Text	3/1/2020 8:13 PM
44	Email, text	2/28/2020 11:23 AM
45	Text	2/28/2020 10:46 AM
46	Emergency call and text from the City	2/27/2020 5:06 PM
47	alert system	2/27/2020 12:56 PM
48	Text	2/27/2020 7:47 AM
49	Text or Automated system to phone	2/20/2020 5:02 PM

Q24 FEMA suggests that households have at least 3 days of food, water, and vital supplies (e.g. medications) in hand in the event of a disaster. How many days of food, water, and vital supplies does your family have on hand in the event of a disaster?

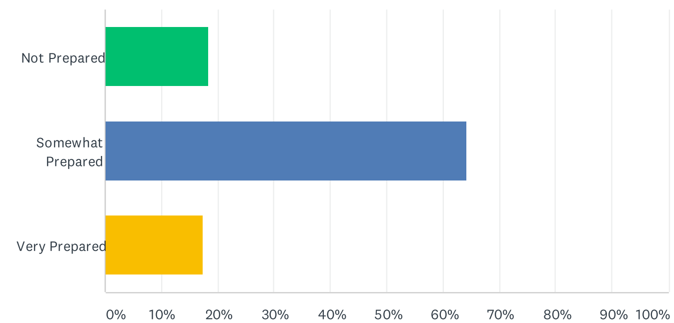
Answered: 101 Skipped: 11



ANSWER CHOICES	RESPONSES	
1-2 days	4.95%	5
3-4 days	21.78%	22
4-5 days	13.86%	14
5-7 days	24.75%	25
7 or more	34.65%	35
TOTAL		101

Q25 How prepared are you to get along without electricity or natural gas for 1-5 days? (Check one)

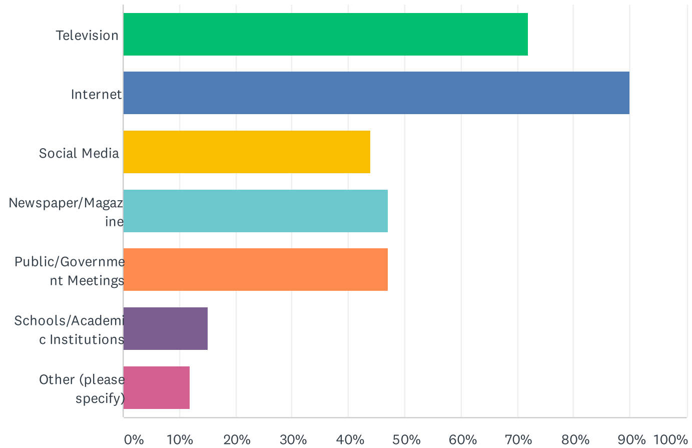
Answered: 98 Skipped: 14



ANSWER CHOICES	RESPONSES	
Not Prepared	18.37%	18
Somewhat Prepared	64.29%	63
Very Prepared	17.35%	17
TOTAL		98

Q26 Where would you expect to find useful information to help you be prepared?Select all that apply:

Answered: 100 Skipped: 12

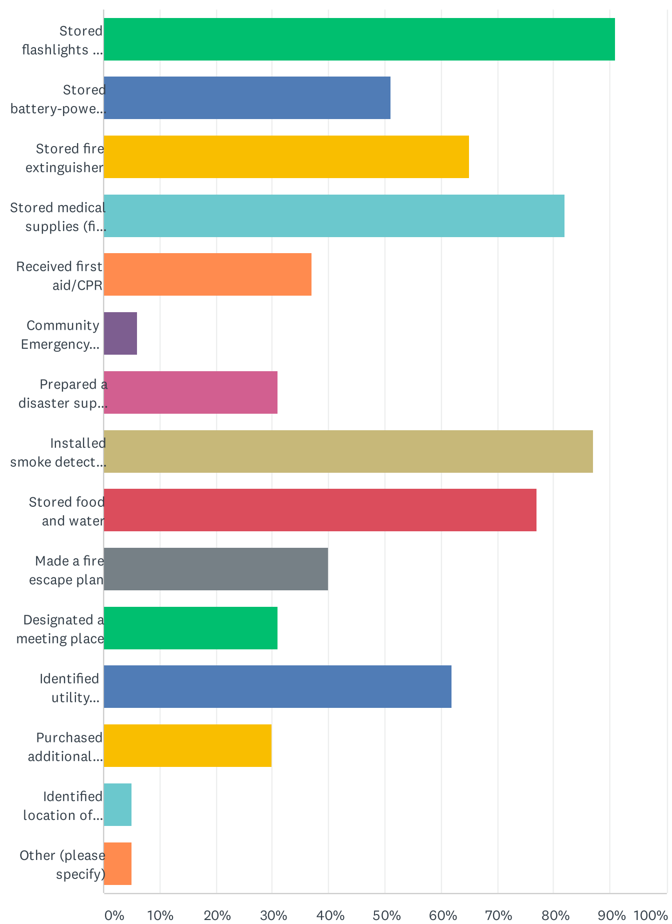


ANSWER CHOICES	RESPONSES	
Television	72.00%	72
Internet	90.00%	90
Social Media	44.00%	44
Newspaper/Magazine	47.00%	47
Public/Government Meetings	47.00%	47
Schools/Academic Institutions	15.00%	15
Other (please specify)	12.00%	12
Total Respondents: 100		

#	OTHER (PLEASE SPECIFY)	DATE
1	Ready.gov	5/29/2020 12:16 AM
2	City of Sugar Land e-mails, text messages or phone message	3/9/2020 12:18 PM
3	Common Sense, & Years of (watching parental) experience while growing up on the Gulf Coast	3/9/2020 12:07 PM
4	government website	3/9/2020 11:42 AM
5	work	3/9/2020 11:15 AM
6	Government websites	3/8/2020 12:01 PM
7	phone calls from city	3/7/2020 1:11 AM
8	Radio	3/6/2020 5:22 PM
9	email alert	3/6/2020 5:02 PM
10	Neighbors	3/6/2020 4:28 PM
11	Cell phone	3/2/2020 5:15 AM
12	Preparedness classes I have taken	2/28/2020 10:46 AM

Q27 Which of the following steps has your household already undertaken to prepare for a natural or non-natural disaster? Select all that apply:

Answered: 100   Skipped: 12

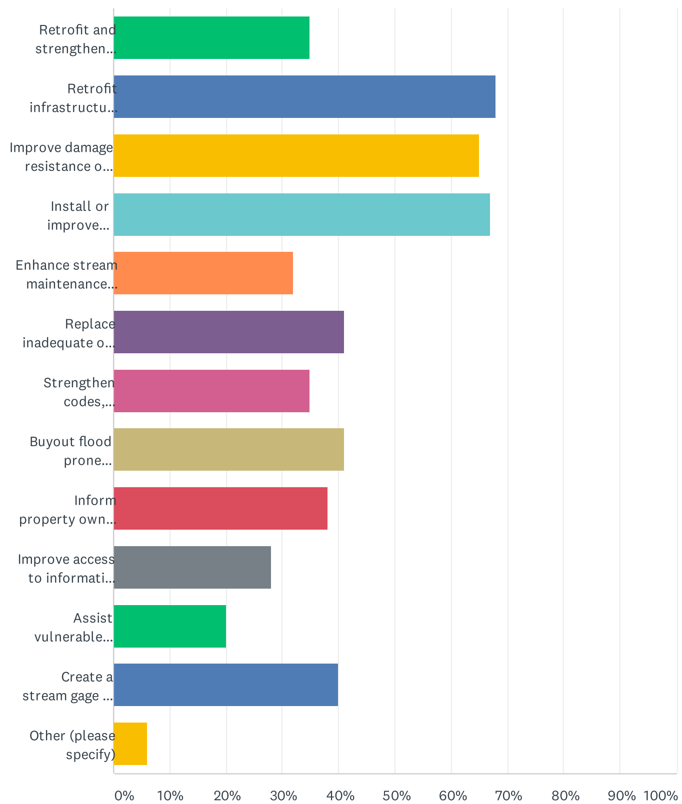


ANSWER CHOICES	RESPONSES	
Stored flashlights and batteries	91.00%	91
Stored battery-powered radio	51.00%	51
Stored fire extinguisher	65.00%	65
Stored medical supplies (first aid kit, medications)	82.00%	82
Received first aid/CPR	37.00%	37
Community Emergency Response Training (CERT)	6.00%	6
Prepared a disaster supply kit	31.00%	31
Installed smoke detectors on each level of the house	87.00%	87
Stored food and water	77.00%	77
Made a fire escape plan	40.00%	40
Designated a meeting place	31.00%	31
Identified utility shutoffs	62.00%	62
Purchased additional hazard insurance	30.00%	30
Identified location of nearest emergency shelter	5.00%	5
Other (please specify)	5.00%	5
Total Respondents: 100		

#	OTHER (PLEASE SPECIFY)	DATE
1	I work for the FD	3/14/2020 7:48 AM
2	Whole-house standby generator	3/7/2020 8:44 AM
3	t	3/7/2020 6:04 AM
4	evacuation plan created, notified family of evacuation plan	3/6/2020 7:55 PM
5	both adults firefighter/emergency medical services	2/20/2020 5:02 PM

Q28 What types of projects do you believe local, county, state, or federal government agencies could be doing to reduce the damage and disruption of disasters in the City of Sugar Land? Select your top three choices.

Answered: 100 Skipped: 12



ANSWER CHOICES	RESPONSES	
Retrofit and strengthen essential facilities such as police, schools, and hospitals	35.00%	35
Retrofit infrastructure, such as elevating roadways and improving drainage systems	68.00%	68
Improve damage resistance of utilities (electricity, communications, water/wastewater facilities etc.)	65.00%	65
Install or improve protective structures, such as floodwalls, levees, bulkheads, and firebreaks	67.00%	67
Enhance stream maintenance programs/projects	32.00%	32
Replace inadequate or vulnerable bridges and causeways	41.00%	41
Strengthen codes, ordinances and plans to require higher hazard risk management standards	35.00%	35
Buyout flood prone properties and maintain as open space	41.00%	41
Inform property owners of ways they can mitigate damage to their properties	38.00%	38
Improve access to information about hazard risks and high-hazard areas	28.00%	28
Assist vulnerable property owners with securing funding to mitigate their properties	20.00%	20
Create a stream gage and weather monitoring program to provide more accurate data and warnings	40.00%	40
Other (please specify)	6.00%	6
Total Respondents: 100		

#	OTHER (PLEASE SPECIFY)	DATE
1	ADD VOLUNTEER PROGRAMS TO HELP PD AND FIRE	3/18/2020 9:53 AM
2	Better flood water removal pumping stations.	3/14/2020 7:48 AM
3	I have faith in our govt to do what they feel is best	3/9/2020 11:15 AM
4	Slow down development	3/7/2020 9:26 AM
5	Stop new constructions on open Land.	3/2/2020 5:15 AM
6	Floodplain info MUST be provided to all property buyers	2/28/2020 10:46 AM

Q29 Please provide any additional comments you would like to share with the Steering Committee:

Answered: 20 Skipped: 92

#	RESPONSES	DATE
1	Flooding is still an issue in Settlers Park three years after Harvey. Just a week or so ago, streets became impassable during a heavy rain event. They are working on a drainage project on Mesquite Drive however why does the city wait until almost hurricane season to do this type of work? Our winters here are mild enough to start the work early enough to have it finished before June 1. The Mesquite project contributed to drainage issues during the most recent rain event.	5/29/2020 12:16 AM
2	Hazard Mitigation is of up most priority in our community.	5/26/2020 11:10 AM
3	I note that the levee protecting Greatwood from Brazos River flooding has been raised. But, at Highway 59, the levee is higher than the roadway, and flood waters from a high river level will bypass the raised levee, likely quickly eroding the levee and flooding Greatwood. Also, when Highway was upgraded several years ago, the highway department installed drainage lines underground along the access road, draining to the river. The have backflow preventers in the drains, so when the river rises, the water will backup onto the highway and eventually overflowing into the Greatwood subdivision.	4/11/2020 8:36 AM
4	Apply common sense and reasoning. Prioritize spending on "value add" initiatives. You can't do everything.	3/24/2020 10:33 AM
5	CREATE PROGRAM TO CLEAN FOLIAGE FROM STREET TO PREVENT CLOGGING DURING SPRING	3/18/2020 9:53 AM
6	Improve electrical reliability in high wind situations	3/16/2020 3:58 PM
7	Flood water removal is my number one concern. IN the 40 years I have lived here it has never been this bad.	3/14/2020 7:48 AM
8	Implement some type of drainage system flushing in the spring , trees grow and produce more leave possibly blocking drainage	3/13/2020 4:16 PM
9	N/A	3/11/2020 10:14 AM
10	N/A	3/10/2020 4:30 PM
11	Most concerning thing for us is that there are only 2 ways in and out of Greatwood. I am terrified it would be jammed in an evacuation emergency.	3/9/2020 2:56 PM
12	Improve the abilities to allow employees to work from home during a hazard.	3/9/2020 11:42 AM
13	none	3/9/2020 11:15 AM
14	the FEMA floodplain map was confusing	3/8/2020 10:23 AM
15	Happy with levy around Greatwood and it is being improved.	3/7/2020 6:04 AM
16	Please share Sugar Land emergency plan	3/6/2020 5:22 PM
17	Stop transforming green areas to concrete.	3/2/2020 5:15 AM
18	Thank you for looking out for the citizens!	2/28/2020 10:46 AM
19	Although my family does not have a disaster kit today, we update our "disaster box" as we get closer to Hurricane season our	2/27/2020 5:06 PM
20	NA	2/27/2020 2:37 PM

Q30 If you would like to receive information regarding upcoming public events and other participatory opportunities regarding hazard mitigation, please provide your email address below:

Answered: 42 Skipped: 70

#	RESPONSES	DATE
1	gmail.com	5/29/2020 12:16 AM
2	m	5/14/2020 4:05 PM
3	f@gmail.com	4/26/2020 5:56 PM
4		4/20/2020 3:43 PM
5		4/11/2020 8:36 AM
6		3/24/2020 10:33 AM
7		3/19/2020 10:07 PM
8		3/18/2020 9:53 AM
9		3/16/2020 3:58 PM
10		3/13/2020 4:16 PM
11		3/11/2020 10:14 AM
12		3/10/2020 12:16 PM
13		3/9/2020 11:42 AM
14		3/8/2020 12:01 PM
15		3/8/2020 10:23 AM
16		3/7/2020 9:00 PM
17		3/7/2020 4:36 PM
18		3/7/2020 9:26 AM
19		3/7/2020 8:05 AM
20		3/7/2020 6:04 AM
21		3/7/2020 1:11 AM
22		3/6/2020 11:05 PM
23		3/6/2020 7:55 PM
24		3/6/2020 7:04 PM
25		3/6/2020 6:07 PM
26		3/6/2020 5:22 PM
27		3/6/2020 5:17 PM
28		3/6/2020 5:00 PM
29		3/6/2020 4:57 PM
30		3/6/2020 4:28 PM
31		3/6/2020 4:15 PM
32		3/1/2020 8:13 PM
33		2/28/2020 11:23 AM
34		2/28/2020 10:46 AM
35		2/27/2020 11:28 PM
36		2/27/2020 8:49 PM
37		2/27/2020 2:37 PM
38		2/27/2020 12:58 PM
39		2/27/2020 7:47 AM
40		2/26/2020 7:31 PM
41		2/26/2020 2:47 PM
42		2/26/2020 12:40 PM

D.2 Website and Social Media Posts

The following provides screenshots of websites, news articles, and social media posts.

Figure D-1. City of Sugar Land Planning Department, February 10, 2020 Facebook Post


The City of Sugar Land, Texas – City Government
February 10 ·

Hey Sugar Land! 🎉 Help keep our City as safe as ever by participating in a risk management workshop on Wednesday, Feb. 26 from 6-8 p.m. at City Hall. This workshop is a key step in the update of the City's Hazard Mitigation Plan. Click on the event for more details 👇

WED, FEB 26
Public Mtg - Hazard Mitigation Plan
Sugar Land City Hall, 2700 Town Center Blvd. N - Cane Room
Other
Interested

5

Figure D-2. Fort Bend Star Website Article

fortbendstar.com/sugar-land-hosting-public-meeting-for-hazard-mitigation-plan/?fbclid=IwAR1PxCPr6N7p5JTdWBoWwnSBznqBfvoh64gqGnIPu-bkwZ

Storm Prediction C... Tetra Linx Facebook Gmail Imported From IE Staples FEMA Disaster Decl... My Tetra Tech US

HOME OPINIONS NEWS SPORTS DIGITAL ISSUE ADVERTISE CONTACT US

Sugar Land hosting public meeting for hazard mitigation plan

February 18, 2020 by Staff Reports

The public is invited to attend a risk assessment workshop for an update to the city of Sugar Land's hazard mitigation plan from 6-8 p.m. Wednesday, Feb. 26 in the Cane Room at Sugar Land City Hall, located at 2700 Town Center Blvd. North.

According to the city, the goal of the plan is to minimize or eliminate long-term risks to human life and property from known hazards by identifying and implementing cost-effective mitigation actions. The assessment will guide activities proposed in the hazard mitigation plan.

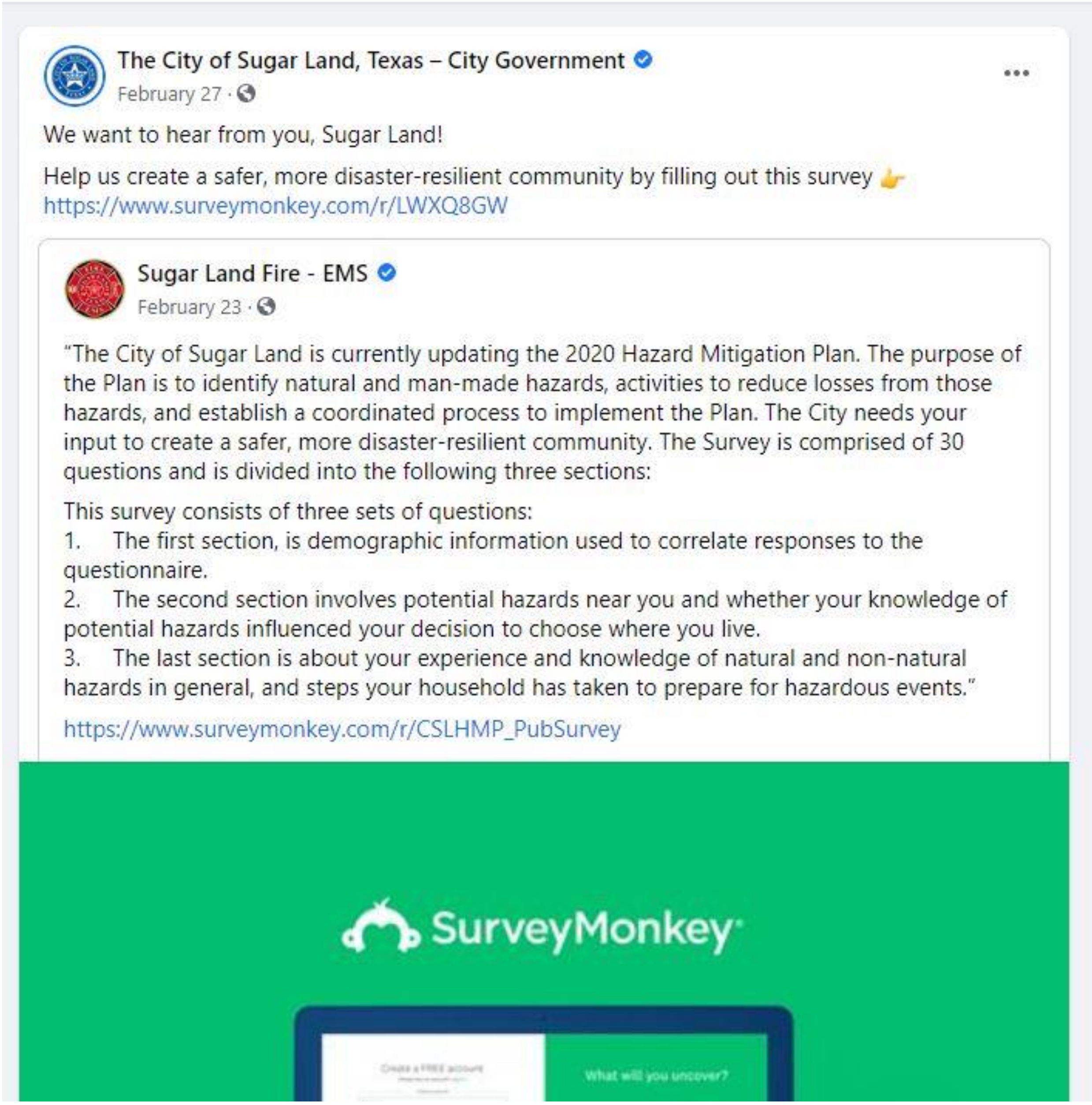
"This project identifies hazards and their occurrence within our area; compares risks of exposure to an established inventory of assets; and provides an estimate of potential human and economic losses based on the vulnerability of people, buildings and infrastructure," Sugar Land Assistant Fire Chief Pat Hughes said in a statement. "It's our goal to ensure Sugar Land remains safer than ever before."

Those unable to attend the workshop may watch the meeting on Channel 16 if they live in Sugar Land and subscribe to Comcast. The meeting will also be livestreamed to the city's website at sugarlandtx.gov and reposted at sugarlandtx.gov/HMP after the meeting.

For more information, visit sugarlandtx.gov/HMP. Residents can also email comments and questions about the plan to Chrissie.Angeletti@tetratech.com.

Figure D-3. Fort Bend Star Facebook Post

Figure D-4. City of Sugar Land, February 27, 2020 Facebook Post



The City of Sugar Land, Texas – City Government
February 27 ·

We want to hear from you, Sugar Land!

Help us create a safer, more disaster-resilient community by filling out this survey
https://www.surveymonkey.com/r/LWXQ8GW

Sugar Land Fire - EMS
February 23 ·

"The City of Sugar Land is currently updating the 2020 Hazard Mitigation Plan. The purpose of the Plan is to identify natural and man-made hazards, activities to reduce losses from those hazards, and establish a coordinated process to implement the Plan. The City needs your input to create a safer, more disaster-resilient community. The Survey is comprised of 30 questions and is divided into the following three sections:

This survey consists of three sets of questions:
1. The first section, is demographic information used to correlate responses to the questionnaire.
2. The second section involves potential hazards near you and whether your knowledge of potential hazards influenced your decision to choose where you live.
3. The last section is about your experience and knowledge of natural and non-natural hazards in general, and steps your household has taken to prepare for hazardous events."

https://www.surveymonkey.com/r/CSLHMP_PubSurvey

Figure D-5. Sugar Land Fire, May 28, 2019 Facebook Post

Sugar Land Fire - EMS

May 28 ·

"The City of Sugar Land is currently updating the 2020 Hazard Mitigation Plan. The purpose of the Plan is to identify natural and man-made hazards, activities to reduce losses from those hazards, and establish a coordinated process to implement the Plan. The City needs your input to create a safer, more disaster-resilient community. The Survey is comprised of 30 questions and is divided into the following three sections:

This survey consists of three sets of questions:

1. The first section, is demographic information used to correlate responses to the questionnaire.
2. The second section involves potential hazards near you and whether your knowledge of potential hazards influenced your decision to choose where you live.
3. The last section is about your experience and knowledge of natural and non-natural hazards in general, and steps your household has taken to prepare for hazardous events."

https://bit.ly/2TgNAp7

Figure D-6. City of Sugar Land, August 7, 2019 Facebook Post

Figure D-7. Nextdoor Post, August 7, 2020

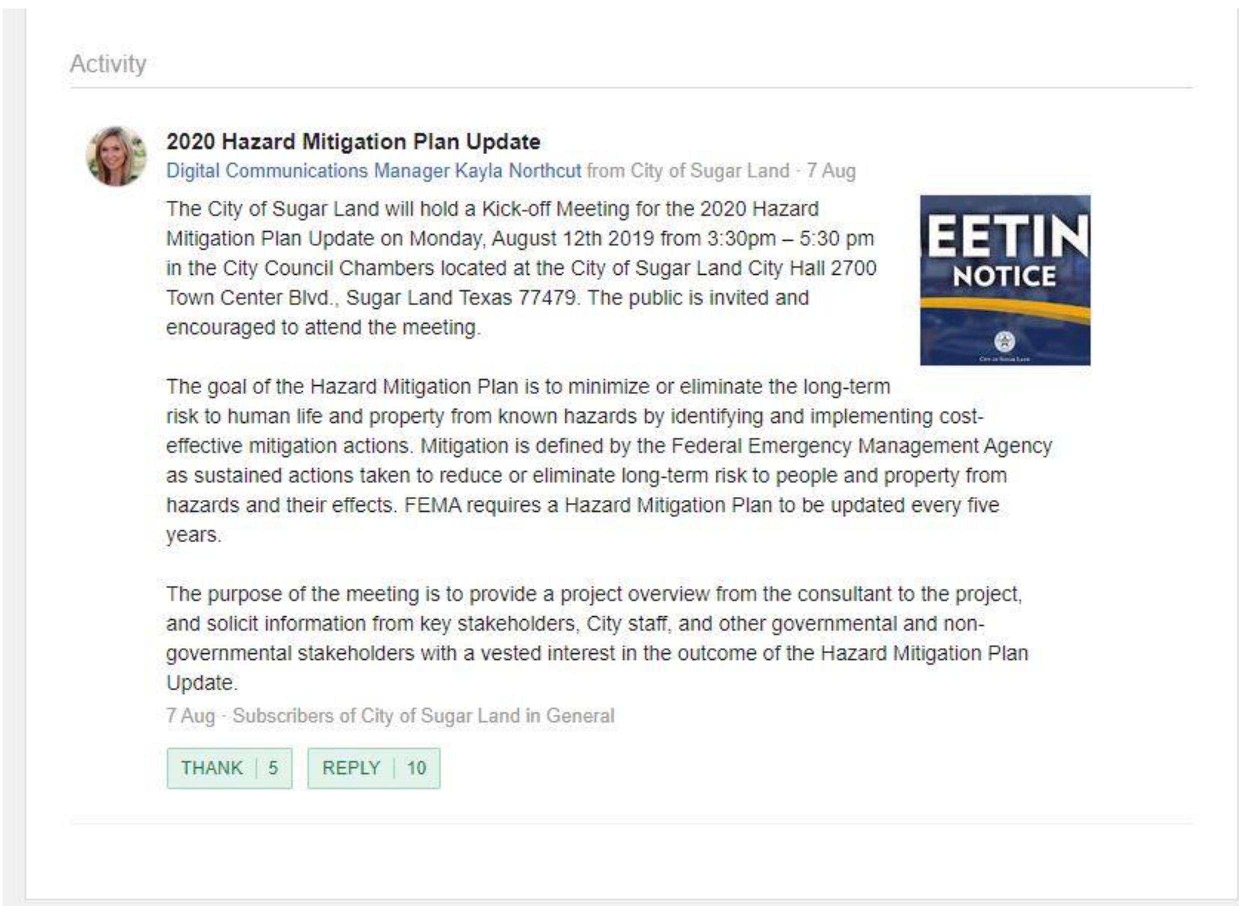


Figure D-8. City of Sugar Land, October 19, 2019 Facebook Post