CITY OF BAYTOWN
HAZARD MITIGATION ACTION PLAN UPDATE

2025 DRAFT

Mitigating Risk for a Safe, Secure, Sustainable Future



H2O PARTNERS

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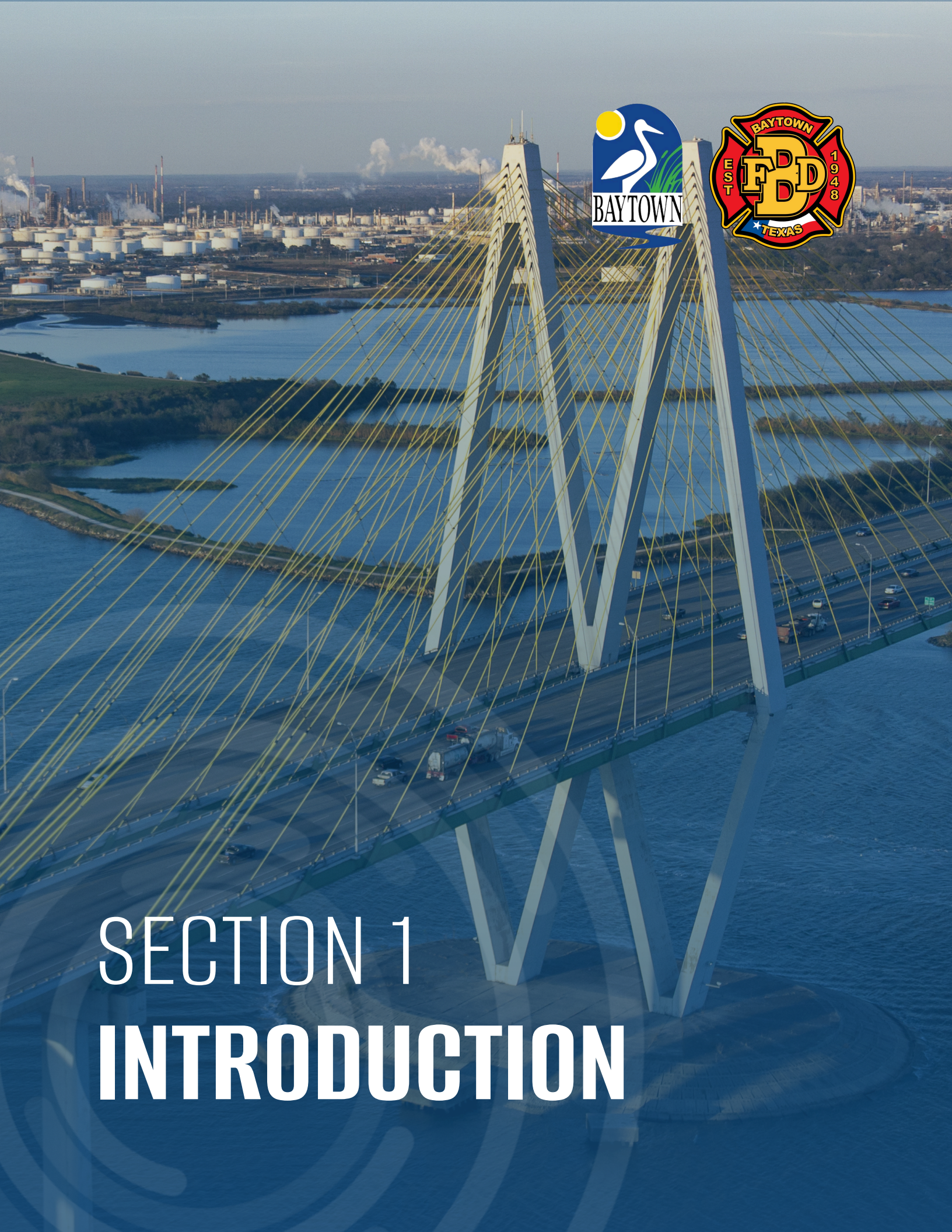

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INTRODUCTION

SECTION 1: INTRODUCTION

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BACKGROUND

The City of Baytown is located along the Gulf Coast of Texas, 30 miles east of Houston. Located within both Harris and Chamber Counties, the city is a part of the Houston-The Woodlands- Sugar Land metropolitan area and is the third largest city in Harris County. The City of Houston is adjacent to the west, Beaumont is to the northeast, and Galveston is to the south. The Trinity and Galveston Bays as well as the San Jacinto River and Cedar Bayou form the sizeable coast of the City of Baytown.

Texas is prone to extremely heavy rains and flooding with half of the world record rainfall rates (48 hours or less).[1] While flooding is a well-known risk, the City of Baytown is susceptible to a wide range of natural hazards, including but not limited to tornadoes, extreme heat, wildfire, and drought. These life-threatening hazards can destroy property, disrupt the economy, and lower the overall quality of life for individuals.

While it is impossible to prevent an event from occurring, the impacts from many hazards on people and property can be lessened through mitigation. The Federal Emergency Management Agency (FEMA) defines mitigation as *sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.*[2] Communities participate in hazard mitigation by developing hazard mitigation plans. The Texas Division of Emergency Management (TDEM) is required to review the plan, and FEMA has the authority to review and approve hazard mitigation plans through the Disaster Mitigation Act of 2000.

The Disaster Mitigation Act requires that hazard mitigation plans be reviewed and revised every five years to maintain eligibility for Hazard Mitigation Assistance (HMA) grant funding. In 2020, the City of Baytown participated in the Harris County Multi-Jurisdictional Hazard Mitigation Action Plan (HMAP). Harris County developed their

[1] Source: http://www.floodsafety.com/texas/regional-info/san-antonio-flooding/

[2] Source: http://www.fema.gov/hazard-mitigation-planning-resources

previous Multi-Jurisdictional HMAP to be specific to 38 jurisdictions, including the City of Baytown.

FEMA approved the previous Harris County Multi-Jurisdictional HMAP in 2020, which then was set to expire in 2025. Therefore, the City began the process of developing a single jurisdictional Hazard Mitigation Plan Update, specific to the City of Baytown, in order to maintain eligibility for grant funding. The HMAP Update planning process provided an opportunity for the City of Baytown to evaluate successful mitigation actions and explore opportunities to avoid future disaster loss.

The City of Baytown selected H2O Partners, Inc. to write and develop the 2025 HMAP Update, hereinafter titled: "City of Baytown Hazard Mitigation Action Plan Update 2025: Maintaining a Safe, Secure, and Sustainable Community" (Plan Update). This is a single-jurisdictional plan; the City of Baytown is the only participant in the Plan Update.

Hazard mitigation activities are an investment in a community's safety and sustainability. It is widely accepted that the most effective hazard mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. A comprehensive review of a hazard mitigation plan addresses vulnerabilities to hazards that exist today and in the foreseeable future. Therefore, it is essential that a plan identify projected patterns of how future development will increase or decrease a community's overall hazard vulnerability.

SCOPE

The focus of the Plan Update is to identify activities to mitigate hazards classified as "high" or "moderate" risk, as determined through a detailed hazard risk assessment conducted for the City of Baytown. The hazard classification enables the City to prioritize mitigation actions based on hazards which can present the greatest risk to lives and property in the geographic scope.

PURPOSE

The Plan Update was prepared by the City of Baytown and H2O Partners, Inc. The purpose of the Plan Update is to protect people and structures and to minimize the costs of disaster response and recovery. The goal of the Plan Update is to minimize or eliminate long-term risks to human life, property, operations, and the environment from known hazards by identifying risks and implementing cost-effective hazard mitigation actions.

SECTION 1: INTRODUCTION

The planning process is an opportunity for the City of Baytown, stakeholders, and the general public to evaluate and develop successful hazard mitigation actions to reduce future risk of loss of life and damage to property resulting from a disaster in the City of Baytown.

The Mission Statement of the Plan Update is, "*Maintaining a secure and sustainable future through the revision and development of targeted hazard mitigation actions to protect life and property.*"

The City of Baytown Planning Team identified 13 natural hazards to be addressed by the Plan Update. The specific goals of the Plan Update are to:

- Provide a comprehensive update to the 2020 HMAP;
- Minimize disruption to the City of Baytown following a disaster;
- Streamline disaster recovery by articulating actions to be taken before a disaster strikes to reduce or eliminate future damage;
- Demonstrate a firm local commitment to hazard mitigation principles;
- Serve as a basis for future funding that may become available through grants and technical assistance programs offered by the State or Federal government. The Plan will enable the City of Baytown to take advantage of rapidly developing mitigation grant opportunities as they arise; and
- Ensure that the City of Baytown maintains eligibility for the full range of future Federal disaster relief.

AUTHORITY

The Plan is tailored specifically for the City of Baytown and plan participants including Planning Team members, stakeholders, and the general public who participated in the Plan Update development process. The Plan complies with all requirements promulgated by the Texas Division of Emergency Management (TDEM) and all applicable provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Section 104 of the Disaster Mitigation Act of 2000 (DMA 2000) (P.L. 106-390), and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). Additionally, the Plan complies with the Interim Final Rules for the Hazard Mitigation Planning and Hazard Mitigation Grant Program (44 CFR, Part 201), which specify the criteria for approval of mitigation plans required in Section 322 of the DMA 2000 and standards found in FEMA's "Local Mitigation Planning Policy Guide" (April 2023), and the

"Local Mitigation Planning Handbook" (May 2023). Additionally, the Plan is developed in accordance with FEMA's Community Rating System (CRS) Floodplain Management Plan standards and policies.

SUMMARY OF SECTIONS

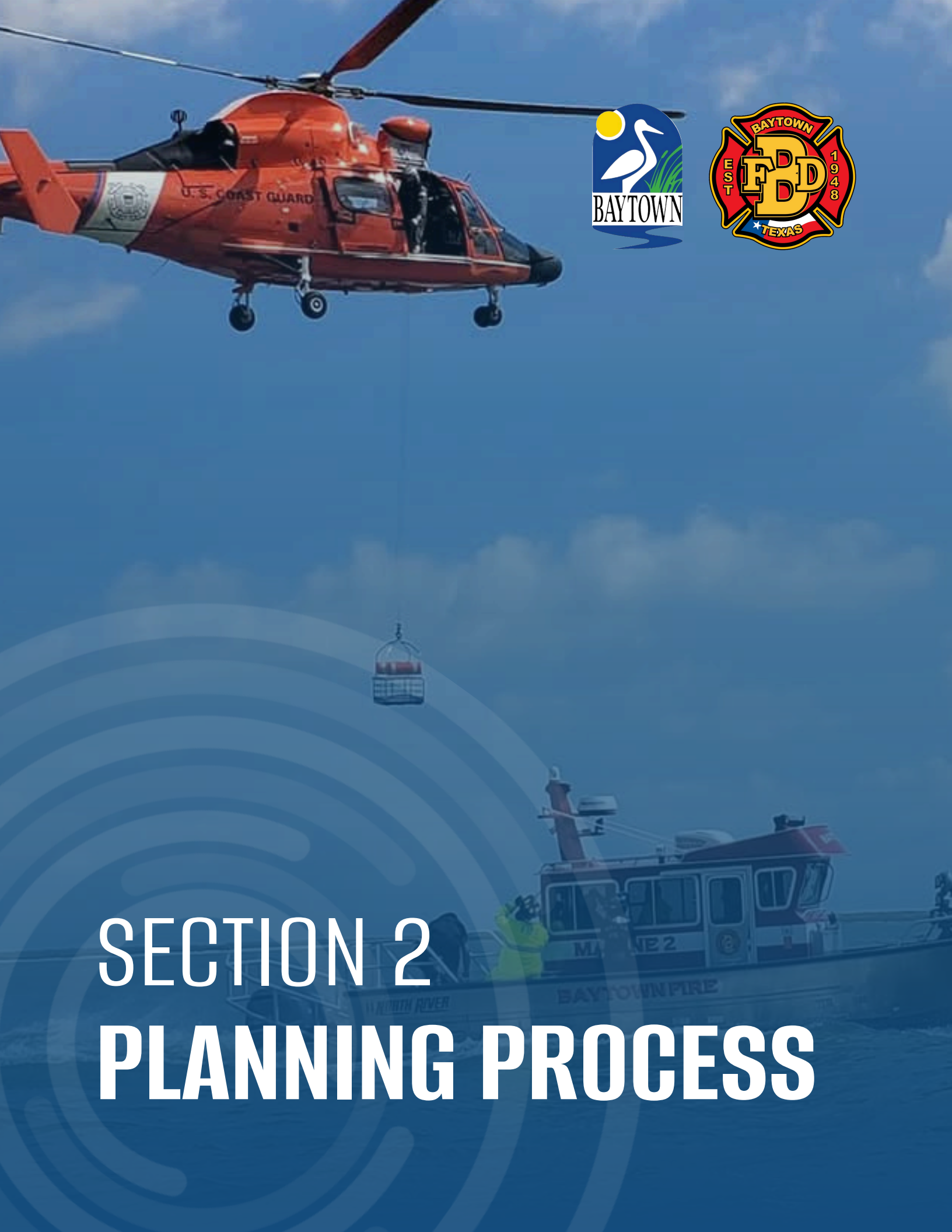
Sections 1 and 2 of the Plan Update outline the Plan's purpose and development, including how Planning Team members, stakeholders, and members of the general public were involved in the planning process. Section 3 profiles the City of Baytown's population and economy.

Sections 4 through 17 present a hazard overview and information on individual natural hazards in the planning area. For each hazard, the Plan Update presents a description of the hazard, a list of historical hazard events, and the results of the vulnerability and risk assessment process.

Section 18 presents hazard mitigation goals and objectives. Section 19 gives an analysis for the previous actions and Section 20 presents hazard mitigation actions for the City of Baytown. Section 21 identifies Plan maintenance mechanisms.

Human-caused hazards are included in Appendix A. A consequence analysis for each of the profiled hazards can be found in Appendix B. Community Rating System (CRS) requirements are located within Appendix C. The list of planning team members and stakeholders is located in Appendix D. Public survey results are analyzed and presented in Appendix E. Appendix F contains a detailed list of critical facilities for the area. Appendix G contains information regarding workshops and meeting documentation. The Capability Assessment results for the City of Baytown are in Appendix H. Appendix I includes State and Federal Funding Opportunities. Appendix J includes additional Hazus summary data.[3]

[3] Information contained in some of these appendices are exempt from public release under the Freedom of Information Act (FOIA).



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PLANNING PROCESS

SECTION 2: PLANNING PROCESS

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PLAN PREPARATION AND DEVELOPMENT

Hazard mitigation planning involves coordination with various constituents and stakeholders to develop a more disaster-resistant community. Section 2 provides an overview of the planning process including the identification of key steps and a detailed description of how stakeholders and the public were involved.

OVERVIEW OF THE PLAN

The City of Baytown hired H2O Partners, Inc. (Consultant Team), to provide technical support and oversee the development of the City of Baytown Hazard Mitigation Action Plan Update 2025. The Consultant Team used the FEMA "Local Mitigation Planning

Policy Guide" (April 2023), and the "Local Mitigation Planning Handbook" (May 2023) to develop the Plan Update. The overall planning process is shown in Figure 2-1 below.

Figure 2-1. Mitigation Planning Process



The City of Baytown and the Consultant Team met in October 2024, to begin organizing resources, identify Planning Team members, and conduct a Capability Assessment.

PLANNING TEAM

Key members of H2O Partners, Inc. developed the Plan Update in conjunction with the Planning Team. The Planning Team was established using a direct representation model. Some of the responsibilities of the Planning Team included: completing Capability Assessment surveys, providing input regarding the identification of hazards, identifying mitigation goals, and developing mitigation strategies. An Executive Planning Team consisting of key personnel from the Office of Emergency Management involved in hazard mitigation activities within the City of Baytown, shown in Table 2-1, was formed to coordinate planning efforts and request input and participation in the planning process.

Table 2-2 reflects the Advisory Planning Team, consisting of additional representatives from City departments that participated throughout the planning process. All Executive and Advisory Planning Team members are involved in hazard mitigation activities; those with the authority to regulate development are identified with an asterisk next to their title.

Table 2-1. Executive Planning Team

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Emergency Management	Emergency Management Coordinator
City of Baytown – Emergency Management	Deputy Emergency Management Coordinator

Table 2-2. Advisory Planning Team

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Fire	Public Information & Education Coordinator
City of Baytown – Government	Council Member District 1 *
City of Baytown – Government	Council Member District 2 *
City of Baytown – Government	Council Member District 3 *
City of Baytown – Government	Council Member District 4 *
City of Baytown – Government	Council Member District 5 *
City of Baytown – Government	Council Member District 6 *
City of Baytown – Government	Mayor *
City of Baytown – Government	Precinct 2 – Community Engagement
City of Baytown – Government	Precinct 3 – Community Engagement
City of Baytown – Human Resources	Risk Manager
City of Baytown – Parks & Recreation	Director
City of Baytown – Parks & Recreation	Planning & Construction Superintendent
City of Baytown – Planning & Development Services	Assistant Director - Building Services
City of Baytown – Planning & Development Services	Assistant Director - Planning and Community Development
City of Baytown – Planning & Development Services	Chief Building Official *
City of Baytown – Planning & Development Services	Economic Development Manager
City of Baytown – Public Works & Engineering	Assistant Director - Capital Projects
City of Baytown – Public Works & Engineering	Assistant Director / City Engineer / Floodplain Manager *
City of Baytown – Public Works & Engineering	CRS Coordinator
City of Baytown – Public Works & Engineering	Operations Superintendent
City of Baytown – Public Works & Engineering	Project Coordinator

SECTION 2: PLANNING PROCESS

The City of Baytown is an active participant in the Community Rating System (CRS). CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. As part of the Plan Update, the City is pursuing to improve its Community Rating System (CRS) classification under the National Flood Insurance Program (NFIP) beyond the current Class 5 rating. To meet this requirement, the City of Baytown developed an Emergency Management Planning Committee, consisting of various city and community representatives, which was developed and integrated into the planning process. The Emergency Management Planning Committee held a meeting on November 13, 2024, to share valuable input and expertise on potential risks and impacts to the planning area, preliminary risk assessment, and identify mitigation strategies, along with attending all Planning Team Workshops. Another meeting was held on April 8, 2025, to review the draft Plan Update. Table 2-3 reflects those partners who represented this committee. Appendix C provides additional CRS requirements that the City has met to exceed minimum national standards to increase the community's flood resiliency.

Table 2-3. Emergency Management Planning Committee

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Administration	City Manager
City of Baytown – Fire	Division Chief - Training
City of Baytown – Fire	Fire Chief
City of Baytown – Health	Director
City of Baytown – Police	Assistant Chief of Police
City of Baytown – Police	Chief of Police
City of Baytown – Public Works & Engineering	Director
CenterPoint Energy	Service Area Manager
ExxonMobil	Emergency Coordinator / Industry Representative
General Public	Former Council Member / Public Representative
Goose Creek Consolidated ISD	Director of Safe & Secure Schools
Goose Creek Consolidated ISD	Director of Safe & Secure Schools / Education Representative

ORGANIZATION / DEPARTMENT	TITLE
Houston Methodist – Baytown Hospital	Director of Pharmacy / Hospital Safety Officer
United Way of Greater Baytown Area & Chambers County (UWGBACC)	CEO / Non-Profit Representative

Additionally, a Stakeholder Group was invited via email to participate in the planning process by attending meetings, commenting on draft versions of the plan, and/or by providing data to inform the planning process. The Consultant Team, Planning Teams, and Stakeholder Group coordinated to identify mitigation goals, and develop mitigation strategies and actions for the Plan Update. Appendix D provides a complete listing of all participating Planning Team members and stakeholders by organization and title. Stakeholder involvement is discussed further below.

Based on the results of the completed Capability Assessment survey, the City of Baytown described methods for achieving future hazard mitigation measures by expanding existing capabilities. For example, the City of Baytown has the opportunity to identify opportunities for cross-training or increasing the technical expertise of staff by attending free training available through FEMA and the Texas Division of Emergency Management (TDEM) by monitoring classes and availability through TDEM Training Division Learning Management Site (LMS) (https://tdem.texas.gov/preparedness/training). In addition, the City of Baytown can identify Planning Team members with the authority to monitor the Plan and identify grant funding opportunities for expanding staff. Other options for improving capabilities include the following:

Table 2-4 Opportunities for Improving and Expanding Existing Capabilities

JURISDICTION	OPPORTUNITIES
City of Baytown	• Integrate risk information from HMAP into future updates to **Capital Improvement Plan**. • Integrate risk information from HMAP into future updates to **Comprehensive Plan**. • Integrate risk information from HMAP into future updates to **Community Wildfire Protection Plan**. • Review current **floodplain ordinances** for opportunities to increase resiliency such as modifying permitting or building codes.

JURISDICTION	OPPORTUNITIES
	• Review current **land use and building ordinances** that will require all new developments to conform to the highest mitigation standards.

Sample hazard mitigation actions developed with similar hazard risks were shared at the meetings. These important discussions resulted in the development of multiple mitigation actions that are included in the Plan Update to further mitigate risk from natural hazards in the future.

The Planning Team developed hazard mitigation actions for mitigating risk from all of the identified hazards including potential flood, tornado, and wildfire events. These actions include but are not limited to implementing education and awareness programs on hazards, enhancing and improving and hardening the Baytown Emergency Operations Center to sustain emergency service and core city services, as well as actively participating in and supporting the implementation of the area-wide actions identified in the Plan Update.

PLANNING PROCESS

The process used to prepare the Plan Update followed the four major steps included in Figure 2-1. After the Planning Team was organized, a capability assessment was developed and distributed at the Kickoff Workshop. Hazards were identified and assessed, and results associated with each of the hazards were provided at the Risk Assessment Workshop. Based on the City of Baytown's identified vulnerabilities, specific mitigation strategies were discussed and developed at the Mitigation Strategy Workshop. Finally, Plan maintenance and implementation procedures were developed and are included in Section 21. Participation of Planning Team members, stakeholders, and the public at each of the workshops is documented in Appendix G.

At the Plan development workshops held throughout the planning process described herein, the following factors were taken into consideration:

- The nature and magnitude of risks currently affecting the city;
- Hazard mitigation goals to address current and expected conditions;
- Whether current resources will be sufficient for implementing the Plan Update;
- Implementation problems, such as technical, political, legal, and coordination issues that may hinder development;
- Anticipated outcomes; and

- How the City of Baytown, agencies, and partners will participate in implementing the Plan Update.

KICKOFF WORKSHOP

The Kickoff Workshop was held on October 23, 2024, at the Baytown Emergency Operations Center with the option to attend virtually via Zoom. The initial workshop informed participating officials and key department personnel about how the planning process pertained to their distinct roles and responsibilities and engaged stakeholder groups that focus on vulnerable populations and underserved communities including, but not limited to the utility providers, local medical partners, local ISDs, and surrounding counties. In addition to the kickoff presentation, participants received the following information:

- Project overview regarding the planning process;
- Public survey access information;
- Hazard Ranking form; and
- Capability Assessment survey for completion.

A risk ranking exercise was conducted at the Kickoff Workshop to get input from the Planning Team and stakeholders pertaining to various risks from a list of natural hazards affecting the planning area. Each participant at the Kickoff Workshop was provided a risk ranking sheet that asked participants to rank hazards in terms of the probability or frequency of occurrence, extent of spatial impact, and the magnitude of impact. The results of the ranking sheets identified unique perspectives on varied risks throughout the planning area. The assessments were also used to set priorities for hazard mitigation actions based on potential loss of lives and dollar losses.

HAZARD IDENTIFICATION

At the Kickoff Workshop, and through e-mail and phone correspondence, the Planning Team conducted preliminary hazard identification. The Planning Team, in coordination with the Consultant Team reviewed and considered a full range of natural hazards. Once identified, the teams narrowed the list to significant hazards by reviewing hazards affecting the area, the 2023 State of Texas Hazard Mitigation Plan, and initial study results from reputable sources such as federal and state agencies. Based on this initial analysis, the teams identified a total of 13 natural hazards which pose a significant threat to the planning area.

SECTION 2: PLANNING PROCESS

RISK ASSESSMENT

An initial risk assessment for the City of Baytown was completed in December 2024 and results were presented to Planning Team members at the Risk Assessment Workshop held on January 08, 2025, in conjunction with the Mitigation Strategy Workshop, at the Baytown Public Safety Building with the option to attend virtually via Zoom. At the workshop, the characteristics and consequences of each hazard were evaluated to determine the extent to which the planning area would be affected in terms of potential danger to property and citizens.

Property and crop damages were estimated by gathering data from the National Centers for Environmental Information (NCEI) and the National Oceanic and Atmospheric Administration (NOAA). The assessment also examined the impact of various hazards on the built environment, including general building stock, critical facilities, lifelines, and infrastructure. The resulting risk assessment profiled hazard events provided information on previous occurrences, estimated probability of future events, and detailed the spatial extent and magnitude of impact on people and property. Following the risk assessment workshop, past event data from NCEI was provided to the planning team for their review and assistance in identifying significant events. A hazard profile and vulnerability analysis for each of the hazards can be found in Sections 4 through 17.

MITIGATION REVIEW AND DEVELOPMENT

Developing the Mitigation Strategy for the Plan involved identifying mitigation goals and new mitigation actions. A Mitigation Workshop was held on January 08, 2025, in conjunction with the Risk Assessment Workshop, at the Baytown Public Safety Building with the option to attend virtually via Zoom. In addition to the Planning Team, stakeholder groups were invited to attend the workshop. Regarding hazard mitigation actions, workshop participants emphasized the desire for drought and extreme heat projects. The Planning Team was proactive in identifying mitigation actions to lessen the risk of all the identified hazards included in the Plan Update.

An inclusive and structured process was used to develop and prioritize new hazard mitigation actions for the Plan Update. The prioritization method was based on FEMA's STAPLEE criteria and included social, technical, administrative, political, legal, economic, and environmental considerations. As a result, each Planning Team member assigned an overall priority to each hazard mitigation action. The overall priority of each action is reflected in the hazard mitigation actions found in Section 20.

Planning Team members then developed action plans identifying proposed actions, costs and benefits, the responsible organization(s), effects on new and existing buildings, implementation schedules, priorities, and potential funding sources.

Specifically, the process involved:

- Listing optional hazard mitigation actions based on information collected from previous plan reviews, studies, and interviews with federal, state, and local officials. Workshop participants reviewed the optional mitigation actions and selected actions that were most applicable to their area of responsibility, cost-effective in reducing risk, easily implemented, and likely to receive institutional and community support.
- Workshop participants inventoried federal and state funding sources that could assist in implementing the proposed hazard mitigation actions. Information was collected, including the program name, authority, purpose of the program, types of assistance and eligible projects, conditions on funding, types of hazards covered, matching requirements, application deadlines, and a point of contact.
- Planning Team members considered the benefits that would result from implementing the hazard mitigation actions compared to the cost of those projects. Although detailed cost-benefit analyses were beyond the scope of the Plan Update, Planning Team members utilized economic evaluation as a determining factor between hazard mitigation actions.

Planning Team members then selected and prioritized mitigation actions. Hazard mitigation actions identified in the process were made available to the Planning Team for review. The draft Plan Update was maintained on file by the City of Baytown Office of Emergency Management and was made available to the general public for review on the City's website.

REVIEW AND INCORPORATION OF EXISTING PLANS

REVIEW

Background information utilized during the planning process included various studies, plans, reports, and technical information from sources such as FEMA, the United States Army Corps of Engineers (USACE), the U.S. Fire Administration, National Oceanic and Atmospheric Administration (NOAA), the Texas Water Development Board (TWDB), the Texas Commission on Environmental Quality (TCEQ), the Texas State Data Center, Texas A&M Forest Service, the Texas Division of Emergency Management (TDEM), and local

hazard assessments and plans. Section 4 and the hazard-specific sections of the Plan (Sections 5-17) summarize the relevant background information.

Specific background documents, including those from FEMA, provided information on hazard risk, hazard mitigation actions currently being implemented, and potential mitigation actions. Previous hazard events, occurrences, and descriptions were identified through NOAA's National Centers for Environmental Information (NCEI). Results of past hazard events were found by searching the NCEI Storm Event Database. The USACE studies were reviewed for their assessment of risk and potential projects in the region. Information from the State Demographer was reviewed for population and other projections and included in Section 3 of the Plan. Data from the Texas A&M Forest Service was used to appropriately rank the wildfire hazard and to help identify potential grant opportunities. Materials from FEMA and TDEM were reviewed for guidance on Plan Update development requirements.

INCORPORATION OF EXISTING PLANS INTO THE HMAP PROCESS

A Capability Assessment was completed by key departments from the City of Baytown which provided information pertaining to existing plans, policies, ordinances, and regulations to be integrated into the goals and objectives of the Plan Update. The relevant information was included in a master Capability Assessment, Appendix H.

Existing projects and studies were utilized as a starting point for discussing hazard mitigation actions among Planning and Consultant Team members. For example, mitigation projects completed by the City of Baytown include:

- Upgrading City Code Chapter 110 to require Increased Freeboard (500-year + 2 feet) for Construction in Floodplain;
- Developing a hardened Portable Water Treatment Plant to provide an alternate water source during drought conditions;
- Creating and establishing a hazard risk profile database and GIS mapping of Pipeline Risk Areas;
- Developing and updating Commodity Flow Study and inventory of chemical facilities within the community to understand risk profile and implement appropriate mitigation measures.

For a comprehensive list of actions from the previous 2020 Harris County Multi-HMAP, please refer to Section 19.

The City of Baytown is located in both Harris and Chambers Counties. The majority of the Baytown planning area (95%) is located in Harris County, with a small portion (5%) in

Chambers County. The current Flood Insurance Study (FIS) for both counties, as well as the current effective Flood Insurance Rate Maps (FIRMs), were used in the flood hazard risk assessment (Section 9). Harris County FIRM's have an effective date of January 6, 2017, while the current Chambers County FIRM's have an effective date of January 19, 2018.

The Harris County FIRM panels (map number 48201C panels 745, 755, 760, 765, 770, 935, 955, 960, and 970) and the Chambers County FIRM panels (map number 48071C panels 160, 170, 180, 190, 335, 345, 355, 365, 745, 755, 760, 765, 770, 935, 955, 960, 970) show the areas throughout the City of Baytown at greater risk of flooding. The FIS reports contains detailed flood elevation data in flood profiles and data tables and are utilized in determining extent.

The Baytown annual groundwater report (2023) provides recent observations on subsidence rates in the planning area as well as groundwater withdrawal trends associated with drought conditions. Analytical data was utilized in the development of the drought and land subsidence hazard profiles.

Additionally, policies and ordinances were reviewed by the City of Baytown. Other plans were reviewed, such as the Comprehensive Plan 2040, Baytown Flood Mitigation Plan, Cedar Bayou Initiative and Cedar Bayou Initiative Project List Strategy, and Stormwater Management Plan, to identify any additional mitigation actions. Finally, the 2023 State of Texas Hazard Mitigation Plan, developed by TDEM, was discussed in the initial planning meeting in order to develop a specific group of hazards to address in the planning effort. The 2023 State Plan was also used as a guidance document, along with FEMA materials, in the development of the City of Baytown Hazard Mitigation Action Plan Update 2025.

MITIGATION SUCCESS

The City of Baytown understands the importance of building resiliency throughout the community and recognizes the cost savings realized from the successful implementation of sound mitigation projects. The City has been successfully implementing mitigation projects for decades, many of which are referenced throughout this plan. A few examples of recent mitigation projects are detailed here.

Baytown Nature Center Crystal Bay Shoreline Stabilization project

The rate of coastal erosion is typically offset by continuous, aggressive community planning to protect the island's assets including critical structures and infrastructure. An example of this is seen with the Baytown Nature Center Crystal Bay Shoreline Stabilization project. The City of Baytown is committed to protecting and preserving

coastal natural resources and has shown this by sprigging a Spartina alterniflora salt marsh for erosion control (Figures 2-2 and 2-3).

Additional mitigation projects were incorporated into the planning process to further address coastal erosion. These include the Coral Reef Bay Project with the Baytown Nature Center and Galveston Bay Organization to maintain the shoreline and restore some of the lost habitat, as well as the expansion of the Greenhouse Project currently under development with the Houston Port Authority that will allow the City to grow wetland and native species to promote the restoration of shorelines. All mitigation actions are included in Section 19.

Figure 2-2. Shoreline Stabilization Plantings in the City of Baytown



Figure 2-3. Construction of the 100' Pier with Educational Signage



Regional Groundwater Update Project (RGUP)

The Regional Groundwater Update Project (RGUP) originally started in 2010 as the Harris-Galveston Subsidence District (HGSD) 1999 Regulatory Plan Update, but due to its benefits to two other regional entities that also regulate the production of groundwater, the Fort Bend Subsidence District (FBSD) and the Lone Star Groundwater Conservation District (LSGCD), the three districts partnered to create the RGUP. The primary benefit of collaboration between these three entities is that each of them could use the RGUP to vet their existing regulatory plans using updated population / water demand data and groundwater modeling capability, and in the case of HGSD and FBSD, investigate the physical effects of changing their existing regulatory plans to accommodate the practical realities facing their stakeholders. An additional benefit to LSGCD is that they can use the data and modeling tools as they monitor aquifer conditions and consider their future regulations.

The RGUP has been used to verify the efficacy of existing regulatory planning on mitigating groundwater loss and land subsidence as well as water level and land-surface subsidence predictions, through 2070, for groundwater withdrawals that take into

account population and water demand projections and the regulatory plans that were in effect January 2013.

INCORPORATION OF THE HMAP INTO OTHER PLANNING MECHANISMS

Planning Team members will integrate implementation of the Plan Update with other planning mechanisms for the City of Baytown, such as the Baytown Flood Mitigation Plan and the Comprehensive Plan. This section discusses how the Plan will be implemented by the City of Baytown. It also addresses how the Plan will be evaluated and improved over time, and how the public will continue to be involved in the hazard mitigation planning process.

The City of Baytown will be responsible for implementing hazard mitigation actions contained in Section 20. Each hazard mitigation action has been assigned to a specific City department that is responsible for tracking and implementing the action.

A funding source has been listed for each identified hazard mitigation action and may be utilized to implement the action. An implementation time period has also been assigned to each hazard mitigation action as an incentive and to determine whether actions are implemented on a timely basis.

The City of Baytown will integrate hazard mitigation actions contained in the Plan Update with existing planning mechanisms such as floodplain ordinances, the Stormwater Management Plan, the Evacuation Plan, and other local and area planning efforts. The City of Baytown will work closely with area organizations to coordinate the implementation of hazard mitigation actions that benefit the planning area in terms of financial and economic impact.

Upon formal adoption of the Plan Update, Planning Team members will review existing plans along with building codes to guide development and ensure that hazard mitigation actions are implemented. Each of the City departments will be responsible for coordinating periodic reviews of the Plan Update with members of the Advisory Planning Team to ensure integration of hazard mitigation strategies into these planning mechanisms and codes. The Planning Team will also conduct periodic reviews of various existing planning mechanisms and analyze the need for any revisions or updates in light of the approved Plan Update. The City of Baytown will ensure that future long-term planning objectives will contribute to the goals of the Plan to reduce the long-term risk to life and property from moderate and high-risk hazards. Within one year of formal adoption of the Plan, existing planning mechanisms will be reviewed and analyzed as they pertain to the Plan Update.

Planning Team members will review and revise, as necessary, the long-range goals and objectives in its strategic plan and budgets to ensure that they are consistent with the Plan Update.

Furthermore, the City of Baytown will work with neighboring jurisdictions to advance the goals of the Plan Update as it applies to ongoing, long-range planning goals and actions for mitigating risk to natural hazards throughout the planning area.

Table 2-5 identifies types of planning mechanisms and examples of methods for incorporating the Plan into other planning efforts.

Table 2-5. Examples of Methods of Incorporation

PLANNING MECHANISM	INCORPORATION OF PLAN
Annual Budget Review	Various departments and key personnel that participated in the planning process will review this Plan Update and mitigation actions therein when conducting their annual budget review. Allowances will be made in accordance with grant applications sought, and mitigation actions that will be undertaken, according to the implementation schedule of the specific action.
Capital Improvement Plan	Prior to any revisions to the Capital Improvement Plan (CIP), City departments will review the risk assessment and mitigation strategy sections of this Plan Update, as limiting public spending in hazardous zones is one of the most effective long-term mitigation actions available to local governments.
Community Wildfire Protection Plan	Community Wildfire Protection Plans (CWPPs) include preventative and corrective actions to address a community's risk of damage from wildfire. Information found in Section 17 of this Plan Update discussing the people and property at risk to wildfire will be reviewed and revised when the City of Baytown updates their CWPP.

PLANNING MECHANISM	INCORPORATION OF PLAN
Comprehensive Plan	The City of Baytown has a Comprehensive Plan in place. Since comprehensive plans involve developing a unified vision for a community, the mitigation vision and goals of the Plan Update will be reviewed in the revision of the Comprehensive Plan.
Flood Mitigation Plan	Flood Mitigation Plans (also referred to as Floodplain Management Plans) include preventative and corrective actions to address the flood hazard. Therefore, the actions for flooding and information found in Section 9 of this Plan Update discussing the people and property at risk to flood, will be reviewed and revised when updating the flood management plan.
Grant Applications	This Plan Update will be evaluated when grant funding is sought for mitigation projects. If a project is not in the Plan Update, a Plan Revision may be necessary to include the action in the Plan.
Regulatory Plans	Currently, the City of Baytown has regulatory plans in place, such as a Drought Contingency Plan, Land Use Plan, and Evacuation Plan. The Plan Update will be consulted when departments review or revise their current regulatory planning mechanisms, or in the development of regulatory plans that are not currently in place.

Appendix H Capability Assessment provides an overview of the City's existing planning and regulatory capabilities. These existing capabilities provide the mechanisms to implement the City's mitigation strategy objectives. For example, the adoption of building codes and implementation of land use regulations have been demonstrated to help communities avoid losses from natural hazard events. Currently, the City of Baytown has both building codes and land use regulations in place. Please refer to Appendix H for a complete inventory of the City's capabilities.

It should be noted for the purposes of the Plan Update that the HMAP has been used as a reference when reviewing and updating all plans and ordinances for the entire planning area. The Emergency Management Action Plan developed for the City of Baytown is

updated every 5 years and incorporates goals, objectives, and actions identified in the mitigation plan.

PLAN REVIEW AND PLAN UPDATE

As with the development of Plan Update, the City of Baytown will oversee the review and update process for relevance and if necessary, make adjustments. At the beginning of each fiscal year, Planning Team Members will meet to evaluate the Plan and review other planning mechanisms to ensure consistency with long-range planning efforts. In addition, planning participants will also meet once a year, by conference call or presentation, to re-evaluate prioritization of the hazard mitigation actions. The plan may be amended to include additional hazard mitigation actions as they are developed.

TIMELINE FOR IMPLEMENTING MITIGATION ACTIONS

Both the Executive Planning Team (Table 2-1) and the Advisory Planning Team (Table 2-2) will engage in discussions regarding a timeframe for how and when to implement each hazard mitigation action. Considerations include when the action will be started, how existing planning mechanisms' timelines affect implementation, and when the action should be fully implemented. Timeframes may be general, and there will be short-, medium-, and long-term goals for implementation based on prioritization of each action, as identified on the Hazard Mitigation Action table included in the Plan Update for the City of Baytown.

Both the Executive and Advisory Planning Team will evaluate and prioritize the most suitable hazard mitigation actions for the community to implement. The timeline for implementation of actions will partially be directed by the City's comprehensive planning process, budgetary constraints, and community needs. The City of Baytown is committed to addressing and implementing hazard mitigation actions that may be aligned with and integrated into the Plan Update.

Overall, the Planning Team is in agreement that goals and actions of the Plan Update shall be aligned with the timeframe for implementation of hazard mitigation actions with respect to annual review and updates of existing plans and policies.

PUBLIC AND STAKEHOLDER INVOLVEMENT

An important component of hazard mitigation planning is public participation and stakeholder involvement. Input from individual citizens and the community as a whole

provides the Planning Team with a greater understanding of local concerns and increases the likelihood of successfully implemented hazard mitigation actions. If citizens and stakeholders, such as local businesses, non-profits, hospitals, and schools are involved, they are more likely to gain a greater appreciation of the risks that hazards may present in their community and take steps to reduce or mitigate their impact.

The public was involved in the development of the City of Baytown Hazard Mitigation Action Plan Update 2025 at different stages prior to official Plan approval and adoption. Public input was sought using three methods: (1) open public meetings; (2) survey instruments; and (3) making the draft Plan Update available for public review on the City of Baytown's website.

The draft Plan Update was made available to the general public for review and comment on the City of Baytown's website. The public was notified at the public meetings that the draft Plan Update would be available for review. No feedback was received on the draft Plan Update, although it was given on the public survey, and all relevant information was incorporated into the Plan Update. Public input was utilized to assist in identifying hazards that were of most concern to the citizens of the City and what actions they felt should be included and prioritized.

The Plan Update will be advertised and posted on the City of Baytown's website upon approval from FEMA and a copy will be kept in the City of Baytown Office of Emergency Management.

UNDERSERVED COMMUNITIES / VULNERABLE POPULATIONS

A goal of the Planning Team was building equity into the planning process. Including organizations that aid underserved communities and socially vulnerable populations to participate in the plan helps ensure equitable access to the planning process and the meaningful participation of all residents. In addition, these groups can make sure that the interests of vulnerable populations are accurately represented and act as a valuable resource to share information with those vulnerable populations.

The Planning Team worked to identify local agencies, organizations, and community leaders that focus on reaching vulnerable populations and underserved communities. These organizations were included in the planning process as stakeholders and were invited to participate in the planning process via email. These agencies were encouraged to post public planning meetings as well as solicit feedback via the public survey.

All stakeholders and planning team members were invited to participate in the development of the Plan during this process, including all public meetings, and surveys. All stakeholders are listed in Table 2-5 below. Some stakeholders have been detailed below along with the agency's mission, including:

- Eternal Word of Life Ministry – Provides support services such as food distribution initiatives, in coordination with other organizations such as the Houston Food Bank. The Ministry's mission is to reach the world with the word of God, and winning souls for the kingdom of God.
- New Horizon Family Center - A non-profit organization committed to ending interpersonal and sexual violence through education, counseling, emergency shelter, and prevention services to create a better future for all. The Center offers free crisis intervention services, including counseling and legal services, to survivors of domestic violence and sexual assault. NHFC is committed to providing a structured, non-judgmental environment that reflects the rights of each client.
- Stand Up for Kids – An organization that fights to end youth homelessness by providing resources to homeless and at-risk kids. Resources range from basic hygiene, healthcare, counseling, mentoring, and drug and alcohol rehabilitation to support through four core programs: Street Outreach, Mentoring, Outreach Centers and Apartment Support. Additionally, Stand Up for Kids provides a caring community who values all homeless and at-risk youth. Mentors and volunteers establish non-threatening relationships with youth and provide them with the love and support of family. Their mission is to end the cycle of youth homelessness throughout the United States through volunteers who go to the streets in order to find, stabilize and help homeless kids.

In addition, public notices were posted on public bulletin boards at Baytown's City Hall, City Clerk Office, Public Works and Engineering Department and Library, distributed via Baytown's alert mass notification system, as well as posted on the City of Baytown's website and social media platforms. For a sample of these postings, please see Appendix G. In addition to public meetings, the Planning and Consultant Teams developed a public survey designed to solicit public input during the planning process from citizens and stakeholders and to obtain input and feedback on the Plan Update. For each form of engagement, all efforts were made to reach the City of Baytown's underserved communities and vulnerable populations throughout the planning process. Additional survey information is provided at the end of this section.

STAKEHOLDER INVOLVEMENT

Stakeholder involvement is essential to hazard mitigation planning since a wide range of stakeholders can provide input on specific topics and from various points of view. Throughout the planning process, members of community groups, local businesses, neighboring jurisdictions, schools, universities, and hospitals were invited to participate in development of the Plan Update. The Stakeholder Group (Table 2-6) included a broad range of representatives from both the public and private sectors and served as a key component in the City's outreach efforts for development of the Plan Update. Documentation of stakeholder meetings is found in Appendix G. A list of organizations invited to attend via email is found in Table 2-6. Those that participated in the public meetings are identified with a plus symbol (+) next to their stakeholder type.

Table 2-6. Stakeholders

AGENCY	TITLE	STAKEHOLDER TYPE
ADL Assisted Living Inc.	Administrator	Residential Facilities / Vulnerable Populations
ADL Assisted Living Inc. #2	Administrator	Residential Facilities / Vulnerable Populations
American Red Cross	Gulf Coast Region Representative	Regional / Community Organization
Babies in Baytown	Community Systems Senior Manager	Community Organization
Bay Area Homeless Services	Executive Director	Community Organization
Bayou City Water	Waterkeeper	Utility Provider +
Baytown Area Water Authority (BAWA)	Administrative Assistant	Utility Provider
Baytown Arts, Culture, and Entertainment District (ACE)	President	Community Organization
Baytown Chambers of Commerce	President	Community Organization
Baytown Municipal Development District (MDD)	Finance Director	Utility Provider
Baytown-West Chambers Economic Development Foundation	President / CEO	Community Organization
Baytown Sun	Reporter	Community Organization

AGENCY	TITLE	STAKEHOLDER TYPE
Burning Tree Living Center	Area Administrator	Residential Facilities / Vulnerable Populations
Center Point Energy	Engineer	Utility Provider
Chambers County	Emergency Management Coordinator	Neighboring Community
Deer Park, City of	Emergency Services Director	Neighboring Community
Environmental Protection Agency (EPA)	Deputy Regional Administrator	Federal Agency
Environmental Protection Agency (EPA)	Director of Superfund an Emergency Management Division	Federal Agency
Environmental Protection Agency (EPA)	Regional Administrator	Federal Agency
Faith Family Church	Homeless Outreach Team	Community / Religious Organization
Focused Care at Allenbrook	Chief Operating Officer	Residential Facilities / Vulnerable Populations
Focused Care at Burnet Bay	Chief Operating Officer	Residential Facilities / Vulnerable Populations
Focused Care at Cedar Bayou	Chief Operating Officer	Residential Facilities / Vulnerable Populations
Galveston Bay Foundation	President	Community Organization
Gold Star Living	Founder	Residential Facilities / Vulnerable Populations
Goose Creek Consolidated ISD	Assistant Superintendent of Operations	Academia
Goose Creek Consolidated ISD	Superintendent	Academia
Gulf Coast Protection District	Director / Chambers County Representative	Community Organization
Gulf Coast Protection District	President / Harris County Representative	Community Organization
Harris County	Emergency Management Coordinator	Neighboring Community
Harris County ESD #75	Board President	Community Organization

AGENCY	TITLE	STAKEHOLDER TYPE
Harris County Flood Control District	Director of Planning	Utility Provider
Harris County Flood Control District	Flood Warning System Manager	Utility Provider
Harris County Flood Control District	Risk Mitigation Manager	Utility Provider
Harris County Municipal Development District (MDD) #213	Customer Service Representative	Utility Provider
Harris County Municipal Development District (MDD) #459	Office Supervisor	Utility Provider
Hearts and Hands of Baytown	Executive Director	Community Organization
Houston-Galveston Area Council (H-GAC) Initiative for Cedar Bayou Initiative	Emergency Preparedness Program Representative	Regional Organization
La Porte, City of	Emergency Management Coordinator	Neighboring Community
Lee College	President	Academia
Lee College	Emergency and Safety Manager	Academia
The Lodge at Pine Creek	General Facility Representative	Residential Facilities / Vulnerable Populations
Maplewood Living Center	Area Administrator	Residential Facilities / Vulnerable Populations
Memorial Baptist Church	Senior Pastor	Community / Religious Organization
Mont Belvieu, City of	Fire Chief / Emergency Management Coordinator	Neighboring Community
National Weather Service (NWS)	Houston / Galveston Regional Representative	Federal Agency
NOAA	Chief of Policy, Planning & Communications	Federal Agency
Olive Living Center	Area Administrator	Residential Facilities / Vulnerable Populations

AGENCY	TITLE	STAKEHOLDER TYPE
Pasadena, City of	Emergency Management Coordinator	Neighboring Community
Rollingbrook Rehabilitation and Healthcare Center	Administrator	Residential Facilities / Vulnerable Populations
San Jacinto River Authority (SJRA)	Water Resources and Flood Management Division Manager	Utility Provider
Second Baytown	Administrative Pastor	Community / Religious Organization
Spring Meadows Municipal Development District (MDD)	Customer Service Representative	Utility Provider
St. James House of Baytown	Administrator	Residential Facilities / Vulnerable Populations
St. John Catholic Church	Disaster Preparedness Committee Chair	Community / Religious Organization
State Legislature	House District 23	State Legislature
State Legislature	House District 128	State Legislature
State Legislature	House District 143	State Legislature
State Senate	Senate District 6	State Senate
State Senate	Senate District 11	State Senate
Sterling Municipal Library	Library Director	Community Organization
Swan Manor Assisted Living Facility	General Facility Representative	Residential Facilities / Vulnerable Populations
Texas A&M AgriLife Extension	District 9 County Coordinator	State Agency
Texas A&M Forest Service	Program Coordinator - Mitigation & Prevention	State Agency
Texas Commission on Environmental Quality (TCEQ) - Region 12	Executive Assistant	State Agency
Texas Commission on Environmental Quality (TCEQ) - Region 12	Regional Director	State Agency
Texas Department of Health and Human Services, Region 6	Regional Director	State Agency

AGENCY	TITLE	STAKEHOLDER TYPE
Texas Department of Homeland Security	Media Representative	State Agency
Texas Department of Housing and Community Affair	Director of Single-Family and Homeless Program	State Agency
Texas Department of Housing and Community Affair	Manager of Single-Family Program	State Agency
Texas Department of Transportation (TXDOT)	District Engineer	State Agency
Texas Division of Emergency Management (TDEM), Region 4	Chambers County CLO	State Agency +
Texas Division of Emergency Management (TDEM), Region 4	District 16 Chief	State Agency
Texas Division of Emergency Management (TDEM), Region 4	Regional Mitigation Coordinator	State Agency +
Texas Division of Emergency Management (TDEM), Region 4	Recovery and Mitigation Section Chief	State Agency
Texas Division of Emergency Management (TDEM), Region 4	Regional Mitigation Coordinator	State Agency +
Texas State Soil & Water	Regional Office Program Supervisor	State Agency
Texas Water Development Board (TWDB)	Communications Representative	State Agency
Texas Windstorm Insurance Association	General Representative	State Agency
United Way	Disaster Recovery Committee Chair	Community Organization +
U.S. Army Corps of Engineers / Texas Silver Jackets	Regional Representative for Fort Worth/Galveston Office	Federal Agency
U.S. Fish & Wildlife	Southwest Regional Representative	Federal Agency
The Waterford at Baytown	General Facility Representative	Residential Facilities / Vulnerable Populations

Stakeholders and participants from neighboring communities that attended the Planning Team and public meetings played a key role in the planning process. For example, public meeting attendees expressed concern about potential land subsidence incidents, so the City included a mitigation action to continue to enforce groundwater regulations to reduce the impacts of land subsidence.

PUBLIC MEETINGS

A series of public meetings were held throughout the planning area to collect public and stakeholder input. Topics of discussion included the purpose of hazard mitigation, discussion of the planning process, and types of natural hazards. The City of Baytown released information regarding the public meetings in their area to increase public participation in the Plan Update development process, through posting on their website, on social media sources including Facebook and Instagram, through the local media, mass text alerts, and/or posting the information on bulletin boards in public facilities. A sampling of these notices can be found in Appendix G, along with the documentation on the public meetings.

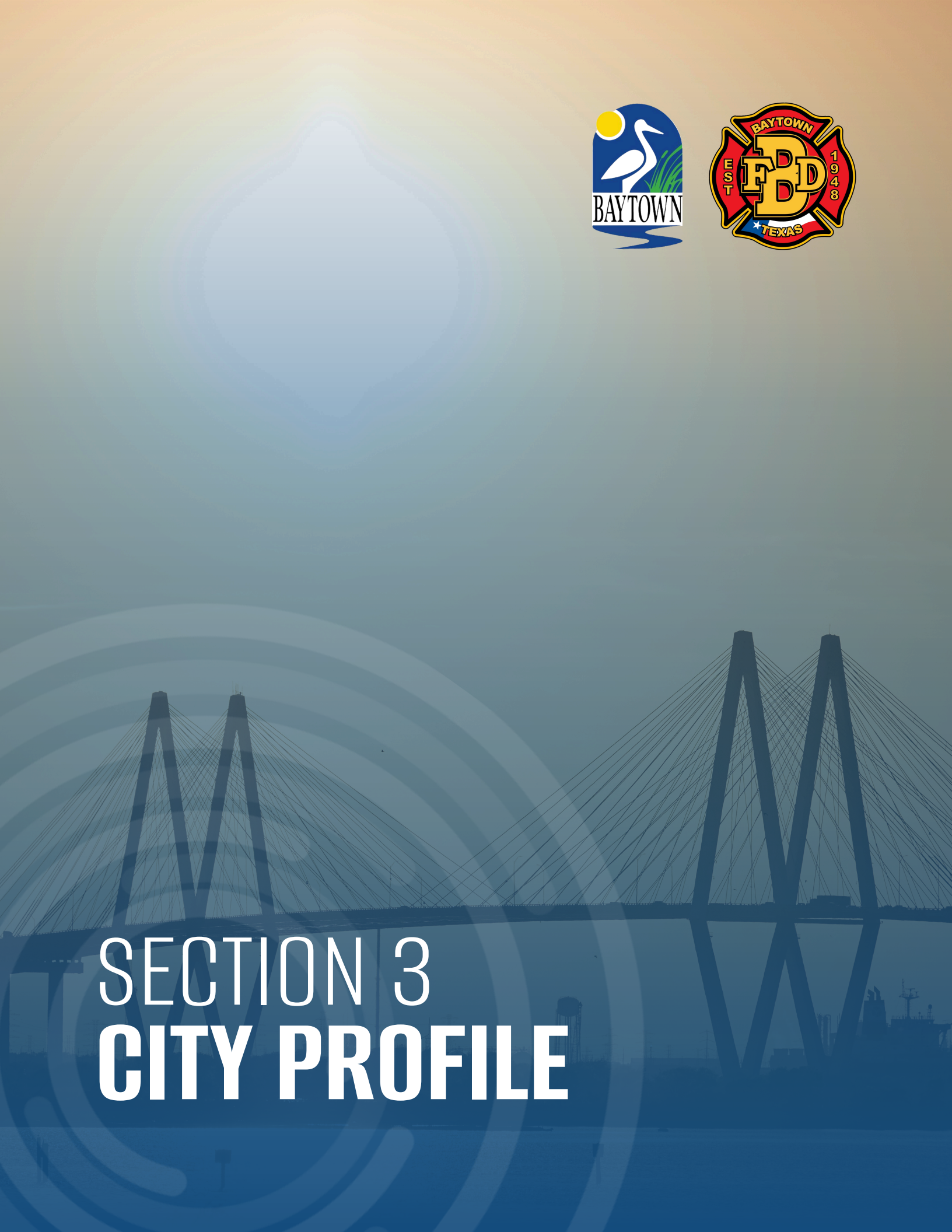
Public meetings were held on the following dates and locations:

- October 23, 2024, at the Baytown Community Center
- January 8, 2025, at the Baytown Community Center

PUBLIC PARTICIPATION SURVEY

In addition to public meetings, the Planning and Consultant Teams developed a public survey designed to solicit public input during the planning process from citizens and stakeholders to obtain data regarding the identification of any potential hazard mitigation actions or problem areas. The survey was promoted by local officials and a link to the survey was posted on the City of Baytown's website. A total of 36 surveys were completed online. The survey results are analyzed in Appendix E. The Planning Team reviewed the input from the surveys and decided which information to incorporate into the Plan as hazard mitigation actions. For example, results indicate that hurricane / tropical storms and floods are the hazards of highest concern for the public. Constructing, maintaining, and protecting infrastructure as well as protecting and improving the reliability of utilities were the two main actions indicated that the local government should take to mitigate risk to these hazards. As a result, the Planning Team has included mitigation actions to implement drainage and infrastructure projects to mitigate flooding and protect residential property, along with enhancing and elevating generators at identified critical city facilities, utilities and infrastructure systems. Additional actions have been included

to develop and implement policies that encourage the inclusion of green infrastructure into City Development Projects to mitigate natural hazards.



SECTION 3
CITY PROFILE

SECTION 3: CITY PROFILE

Overview 1
Population and Demographics 4
Population Growth 5
Economic Impact 6
Natural, Cultural, and Historic Resources 7
Existing Land Use and Development Trends 10
Changes in Vulnerability 11
Future Growth and Development 12

OVERVIEW

The City of Baytown is located thirty miles east of Houston. The City resides in two counties, with the majority of the City located in Harris County and a small portion in Chambers County. Harris County handles most city governances since the majority of Baytown is within their county limits. The part of the City in Chambers County follows their county regulations. The Baytown Police Department covers the entire city with Harris and Chambers County Sheriffs handling their respective areas. While the impact is relatively minor for most residents, businesses and government agencies must navigate these complexities to ensure smooth operations across both counties.

Among its first settlers were Nathaniel Lynch, who in 1822 set up a ferry crossing at the junction of the San Jacinto River with Buffalo Bayou that is still in operation, and William Scott, who received a land grant in 1824. His two leagues and one labor of land, over 9,000 acres, covered most of the area of present Baytown. A settlement started to grow in the area including the opening of a small store and a sawmill. It was called Bay Town.

In 1836 the surrounding area became the site of the Battle of San Jacinto during the Texas Revolution with the ferry playing a pivotal role in helping Texans to safety. The area remained largely undeveloped and isolated into the twentieth century. A rough county road ran from Crosby to Cedar Bayou, a small community of stores, shipyards, and brickyards. The only other entry into the area was by boat. Then, in 1908, after two unsuccessful drilling attempts, an oil strike was made beside Tabbs Bay. In 1916 the Goose Creek oilfield became famous as the first offshore drilling operation in Texas and the third-largest producing field, after the Humble and Sour Lake oilfields.

The towns of Pelly and Goose Creek were developed near the oilfield in 1917. In 1917 Ross S. Sterling and his associates decided to build a refinery near the Goose Creek

field and founded the Humble Oil and Refining Company. They bought 2,200 acres in the William Scott survey and called their site Baytown. They began construction in the fall of 1919.

The City of Baytown was built around the refinery. The first community was a collection of army tents and barracks, with some shacks throughout. In 1923 streets were created, utilities were provided, lots were sold, and home financing became available, financed by the Humble Oil and Refining Company. Employees had a large community building for recreation and some had homes provided. The creation of a special management-labor Joint Conference handled work-related problems and later this group began to discuss municipal problems, eventually becoming the city council for the community. The community of Baytown was not incorporated; this allowed the community of Pelly to annex the territory of Baytown in 1945. There was a vote in 1947 to consolidate between the communities of Pelly and Goose Creek, however the citizens opted for the name of Baytown as their new combined city.

On January 24, 1948, the City of Baytown was established. The City grew from 7 ½ square miles to more than thirty two, with boundaries that include the former communities of Cedar Bayou and Wooster[1].

Figure 3-1 shows the general location of the City of Baytown.

[1] Source: https://www.tshaonline.org/handbook/entries/baytown-tx

SECTION 3: CITY PROFILE

Figure 3-1. Location of the City of Baytown

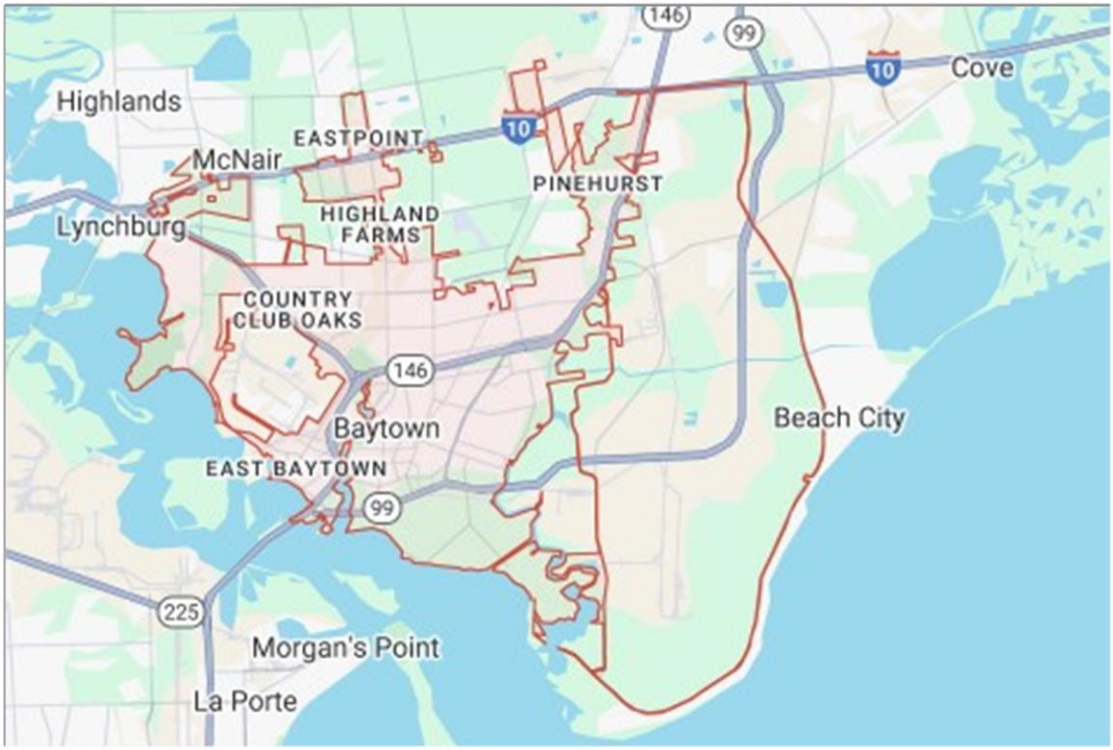
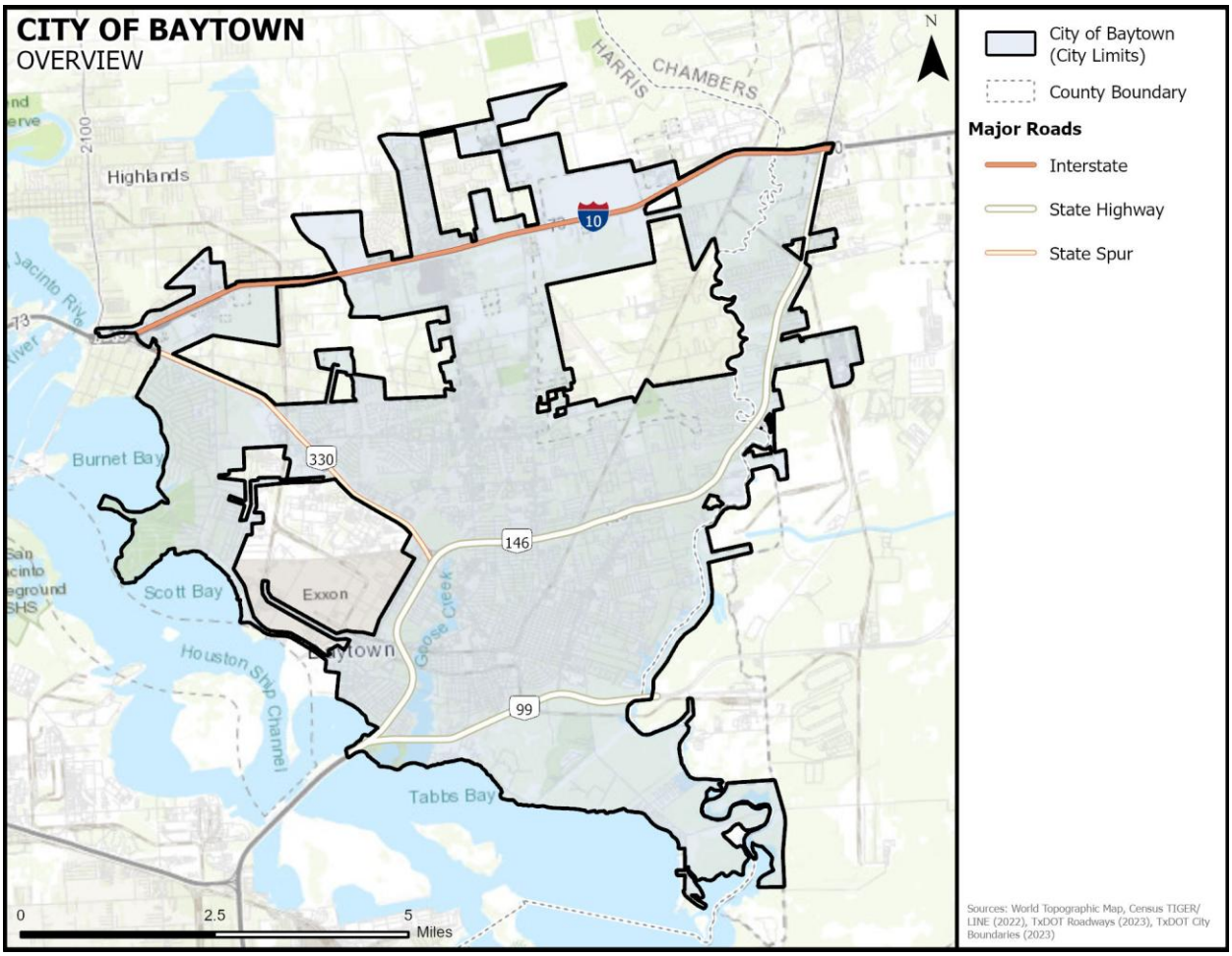


Figure 3-2 shows the city limits of the City of Baytown, which makes up the planning area. All areas of the city's corporate limits are covered in the risk assessment analysis of the Plan Update.

Figure 3-2. the City of Baytown Planning Area



POPULATION AND DEMOGRAPHICS

According to the 2020 Census, the City of Baytown has an official population of 83,701 residents, a 17 percent increase since the 2010 census. Table 3-1 shows the population distribution in the City of Baytown in 2010, 2020 (Census population count), and 2023 (2023 American Community Survey (ACS) five-year estimates). Note that in some cases, the 2023 ACS estimates may differ from the 2020 census counts: the ACS estimates are used throughout this section for consistency.[2]

[2] Source: https://demographics.texas.gov/Data/Decennial/2010/, https://www.census.gov/en.html and https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2023/

Table 3-1. Population Distribution

JURISDICTION	TOTAL 2010 POPULATION	TOTAL 2020 POPULATION (Census)	PERCENT CHANGE 2010-2020	TOTAL 2023 POPULATION (ACS Estimates)	PERCENT CHANGE 2010-2023
City of Baytown	71,802	83,701	17%	84,538	18%

Table 3-2 summarizes select characteristics of vulnerable or sensitive populations in the City of Baytown and the participating jurisdictions using data from the U.S. Census Bureau 2023 American Community Survey (ACS) five-year estimates.

Between official U.S. Census population counts, the estimate uses a formula based on new residential building permits and household size. It is simply an estimate, and many variables are involved in achieving an accurate estimation of the number of people living in a given area at a given time.

Table 3-2. Populations at Greater Risk

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

POPULATION GROWTH

The official 2020 City of Baytown population is 83,701. Overall, the City of Baytown experienced a population increase of 31 percent between 1990 and 2020, or 19,851 residents. Table 3-3 provides historical growth rates in the City of Baytown.

Table 3-3. Population Growth 1990-2020[3]

JURISDICTIONS	1990	2000	2010	2020	POP CHANGE 1990-2020	PERCENT OF CHANGE	POP CHANGE 2010-2020	PERCENT OF CHANGE
City of Baytown	63,850	66,430	71,802	83,701	19,851	31%	11,899	17%

[3] U.S. Census Bureau

ECONOMIC IMPACT

Building and maintaining infrastructure depends on the economy, and therefore, protecting infrastructure from risk due to natural hazards in the planning area is important to the participating jurisdictions within the City of Baytown. Whether it is expanding culverts under a road that washes out during flash flooding, shuttering a fire station, or flood-proofing a wastewater facility, infrastructure must be mitigated from natural hazards in order to continue providing essential utility and emergency response services in a fast-growing planning area.

Based on the American Community Survey 2023 estimates, 65 percent of the population 16 years and over is employed in the labor force. The per capita income is $29,831 and the median household income countywide is $57,421. Families with incomes below the poverty level in 2023 made up 13 percent of all families. Of families that have children under 18 years old, 22 percent are below the poverty level.

Tables 3-4 and 3-5 show the various occupations and industries within the City of Baytown, according to the 2023 estimates by the American Community Survey.

Table 3-4. Occupations of Employed Population in City of Baytown[4]

OCCUPATION	ESTIMATE	PERCENT
Civilian employed population 16 years and over	37,088	
Management, business, science, and arts occupations	9,807	26.40%
Production, transportation, and material moving occupations	7,296	19.70%
Sales and office occupations	6,992	18.90%
Service occupations	6,540	17.60%
Natural resources, construction, and maintenance occupations	6,453	17.40%

[4] 2023 American Community Survey 5-Year Estimates Data Profiles.

Table 3-5. Industries of Employed Population in City of Baytown[5]

INDUSTRY	ESTIMATE	PERCENT
Civilian employed population 16 years and over	37,088	
Educational services, and health care, and social assistance	7,015	18.9%
Construction	5,787	15.6%
Manufacturing	4,939	13.3%
Arts, entertainment, and recreation, and accommodation and food services	4,064	11.0%
Retail trade	3,882	10.5%
Professional, scientific, and management, and administrative and waste management services	2,985	8.0%
Transportation and warehousing, and utilities	2,719	7.3%
Other services, except public administration	1,670	4.5%
Finance and insurance, and real estate and rental and leasing	1,284	3.5%
Public administration	890	2.4%
Wholesale trade	899	2.4%
Agriculture, forestry, fishing and hunting, and mining	702	1.9%
Information	252	0.7%

NATURAL, CULTURAL, AND HISTORIC RESOURCES

The City of Baytown is located to the north of Galveston Bay near the outlets of the San Jacinto River and Buffalo Bayou. Six bays and the Houston Ship Channel surround Baytown. Some of the largest oil, rubber, and chemical petrochemical complexes are established in the city.

Some rare species of birds can be found at Baytown's Nature Center. This site is known for the Great Texas Coastal Birding Trail and provides a habitat for 317 species of resident and neo-tropical migrant birds. Lynchburg Ferry, the oldest operating ferry in

[5] 2023 American Community Survey 5-Year Estimates Data Profiles.

Texas, connects Baytown to La Porte. The ferry offers a tour of the San Jacinto Battleground State Historic Site. The ferry played a pivotal role in the battle and transported Texans to safety.

Calypso Cove, Pirates Bay Waterpark, and a splash pad at Edna Mae Washington Park provide aquatic outdoor recreation to residents and visitors to the city. Fresh and saltwater fishing is offered at six locations with options for boat, kayak, or bank fishing. Multiple parks, sports fields, and trails can be found throughout the city for outdoor recreation use.

To further understand natural resources that may be vulnerable to a hazard event and those that need consideration when implementing mitigation activities, it is important to identify at-risk species (i.e., endangered species) in the planning area. A federally endangered species is any species of fish, plant life, or wildlife that is in danger of extinction throughout all or most of its range. A threatened species is a species that is likely to become an endangered species within the near future throughout all or a significant portion of its range. Both endangered and threatened species are protected by federal law, and any future hazard mitigation projects are subject to these laws. Candidate species are plants and animals that have been proposed as endangered or threatened but are not currently listed.

According to the U.S. Fish and Wildlife Service, as of January 2025, there are eight federally endangered, threatened, or candidate species in Harris County, listed in Table 3-6. Additionally, one species is listed as being recovery (bald eagle), one is listed as under review (western chicken turtle), and three species are listed as resolved taxon's (plains spotted skunk, Sprague's pipit, and smooth pimpleback). For Chambers County there are 12 federally endangered, threatened, or candidate species listed in Table 3-7. Additionally, two species are listed as being recovery (bald eagle and brown pelican), one is listed as under review (western chicken turtle), three species are listed as resolved taxon's (plains spotted skunk, Sprague's pipit, and Bay skipper), there is one species listed as a species of concern (golden eagle), and one species that is classified as not listed (saltmarsh topminnow)

Table 3-6. Endangered Species in Harris County[6]

TYPE of SPECIES	COMMON NAME	SCIENTIFIC NAME	SPECIES STATUS
Flowering Plants	Texas Prairie Dawn-Flower	Hymenoxys texana	Endangered
Birds	Whooping Crane	Grus americana	Endangered
Mammals	Tricolored Bat	Perimyotis subflavus	Proposed Endangered
Birds	Rufa Red Knot	Calidris canutus rufa	Threatened
Mammals	West Indian Manatee	Trichechus manatus	Threatened
Birds	Eastern Black Rail	Laterallus jamaicensis ssp. jamaicensis	Threatened
Insects	Monarch Butterfly	Danaus plexippus	Proposed Threatened
Reptiles	Alligator Snapping Turtle	Macrochelys temminckii	Proposed Threatened

Table 3-7. Endangered Species in Chambers County[7]

TYPE of SPECIES	COMMON NAME	SCIENTIFIC NAME	SPECIES STATUS
Reptiles	Hawksbill Sea Turtle	Eretmochelys imbricata	Endangered
Reptiles	Kemp's Ridley Sea Turtle	Lepidochelys kempii	Endangered
Birds	Whooping Crane	Grus americana	Endangered
Mammals	Tricolored Bat	Perimyotis subflavus	Proposed Endangered
Birds	Rufa Red Knot	Calidris canutus rufa	Threatened
Birds	Piping Plover	Charadrius melodus	Threatened
Reptiles	Loggerhead Sea Turtle	Caretta caretta	Threatened
Reptiles	Green Sea Turtle	Chelonia mydas	Threatened
Mammals	West Indian Manatee	Trichechus manatus	Threatened
Birds	Eastern Black Rail	Laterallus jamaicensis ssp. jamaicensis	Threatened

[6] Source: https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=48201
[7] Source: https://ecos.fws.gov/ecp/report/species-listings-by-current-range-county?fips=48071

TYPE of SPECIES	COMMON NAME	SCIENTIFIC NAME	SPECIES STATUS
Insects	Monarch Butterfly	Danaus plexippus	Proposed Threatened
Reptiles	Alligator Snapping Turtle	Macrochelys temminckii	Proposed Threatened

The City of Baytown has a rich history that is preserved through its designated historic buildings and sites. Throughout the City there are two properties that are designated by the National Register of Historic Places. Historic buildings are vulnerable to natural hazards as their construction pre-dates modern building codes. There are also historic preservation considerations and requirements for historic structures when they are included in mitigation or recovery projects.

Table 3-8. Historic Properties on the National Register[8]

PROPERTY NAME	LOCATION	ADDRESS
Cedar Bayou Archeological District	City of Baytown	Address Restricted
K'nesseth Israel Synagogue	City of Baytown	100 West Sterling Avenue

EXISTING LAND USE AND DEVELOPMENT TRENDS

A zoning ordinance sets forth regulations and standards related to the extent of land and structure uses that are allowed in certain areas. A zoning map shows the areas within a community where the various zoning districts and standards are located and gives an overall picture of what types of development are located in a community and how a community intends to continue to grow.

A review of building permits can also give a picture of the built environment and the number of buildings being constructed in the county and each jurisdiction. Table 3-9 lists the number of residential buildings and total units authorized through a permit from each jurisdiction, where data was available, between 2019 and 2023. The data includes total buildings and total units permitted. Permits are reported annually in September, and the data includes information from 2019 through 2023 to demonstrate growth. Of the residential building permits issued in this period, almost all were for single family homes,

[8] National Register of Historic Places

with less than 1 percent of permits being issued for multi-family buildings. Housing type can also be an indication of an individual's ability to recover from a disaster.

Table 3-9. Building Permits, 2019-2023[9]

JURISDICTION	2019		2020		2021		2022		2023	
	Total Buildings	Total Units	Total Buildings	Total Units	Total Buildings	Total Units	Total Buildings	Total Units	Total Buildings	Total Units
City of Baytown	311	312	283	283	309	309	154	154	140	140

Certain types of housing found in the City of Baytown planning area are more vulnerable than typical site-built, newly constructed residential structures. This includes mobile or manufactured homes, of which 2,038 (6 percent of total housing stock) are in the City. Additionally, single-family residences (SFR) built before 1980 are typically built to lower or less stringent construction standards than newer construction, making these homes more susceptible to damage during hazard events. These older homes comprise 49 percent (16,575 structures) of housing stock. Table 3-10 includes housing inventory data for the City per the 2023 American Community Survey five-year estimates.

Table 3-10. Housing Inventory and Vulnerable Structures[10]

JURISDICTION	TOTAL HOUSING UNITS	BUILT PRIOR TO 1980	MOBILE HOME
City of Baytown	33,865	16,575	2,038

CHANGES IN VULNERABILITY

The City of Baytown experienced an overall population increase of 17 percent between 2010 and 2020. The American Community Survey estimates the 2023 total housing units for the planning area to be 33,685. The total building permits issued between 2019 and 2023 represent approximately 3.5 percent of the total housing units available. The overall population increase, combined with the in housing units increasing, indicates a slight increase in vulnerability to all hazards in terms of populations and the built environment (Table 3-11).

[9] U.S. Census Bureau, Building Permit Survey, 1992-2023, https://www.census.gov/construction/bps/

[10] The Housing Inventory and Vulnerable Structures are based off the 2023 American Community Survey 5-Year Estimates Data Profiles.

Table 3-11. Changes in Vulnerability

JURISDICTION	POPULATION TREND	HOUSING TREND	OVERALL VULNERABILITY CHANGES
City of Baytown	Increasing	Increasing	Increasing

Changes in vulnerability are applicable to all natural hazards. While flood and wildfire hazards feature geographical boundaries, increases in population and building inventory can increase overall vulnerability for these hazards even when the trends occur outside of the known hazard boundary. Development decreases permeable surface areas and increases runoff, increasing flood risk. As population density increases, the Wildland Urban Interface (WUI) typically increases. WUI growth often results in more wildfire ignitions, which puts more houses and lives at risk.

FUTURE GROWTH AND DEVELOPMENT

To better understand how future growth and development in the City of Baytown might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. This section includes an analysis of the projected population change and economic impacts.

Population projections from 2020 to 2050 are listed in Table 3-12, provided by the Office of the State Demographer, Texas State Data Center, and the Institute for Demographic and Socioeconomic Research. Population projections are based on a 0.5 scenario growth rate, which is 50 percent of the population growth rate from 2000-2010. This information is only available at the county level; however, the population projection shows an increase in population density for the county, which would mean overall growth for the county.

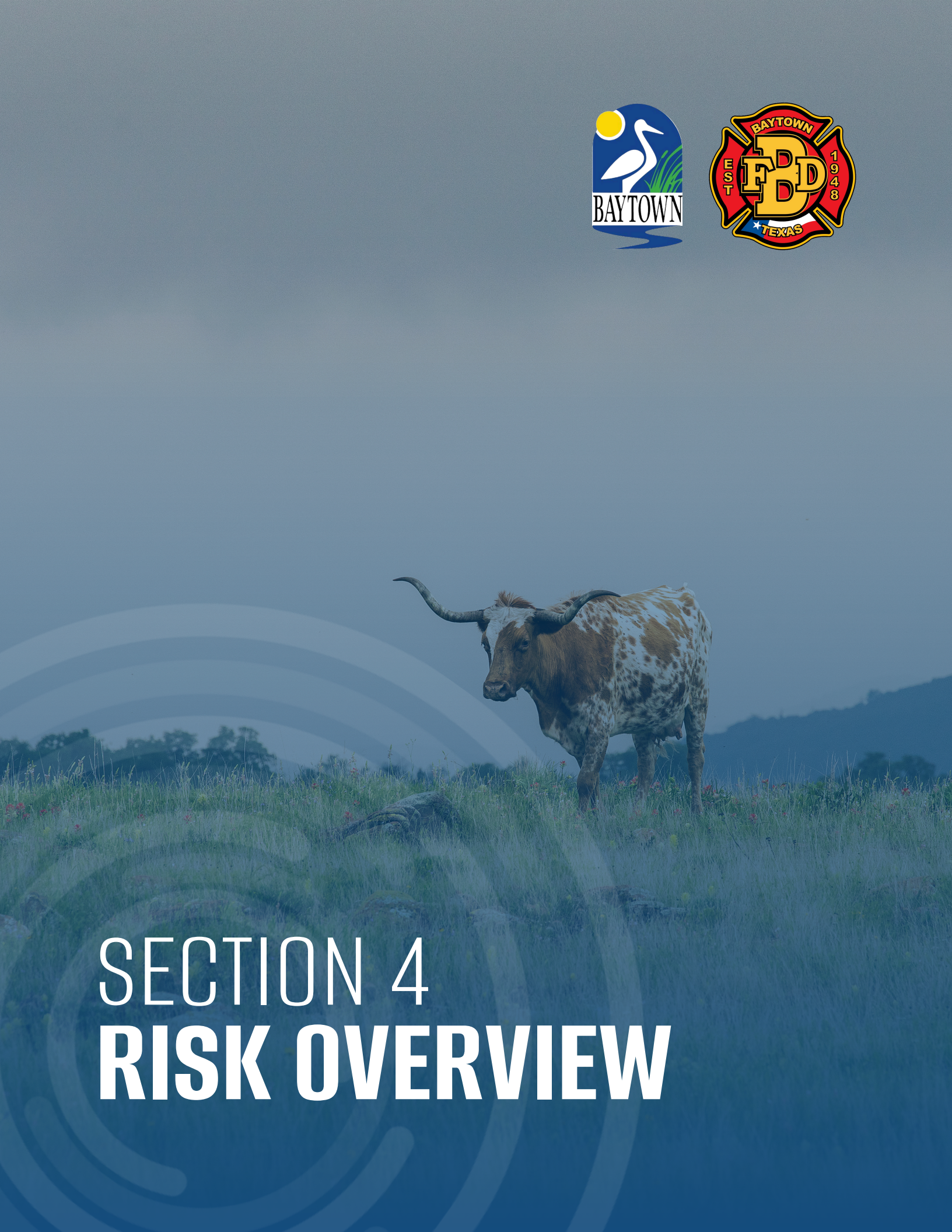
Table 3-12. County Population Projections[11]

COUNTY	LAND AREA (square miles)	2020		2030		2040		2050	
		Population							
		Total Number	Density (Land Area, sq. mi.)	Total Number	Density (Land Area, sq. mi.)	Total Number	Density (Land Area, sq. mi.)	Total Number	Density (Land Area, sq. mi.)
Chambers County	871	32,865	37.7	32,345	37.1	31,198	35.8	29,996	34.4
Harris County	1,707	4,731,145	2,771.6	5,114,328	2,996.1	5,422,550	3,176.7	5,633,164	3,300.0

Comprehensive Plans are guiding documents in a community that set forth a vision, goals, policies, and guidelines to direct future physical, social, and economic development within a jurisdiction. They are part of a continuous process to provide an environment for citizens and consider the general desire of the community to conserve, preserve, and protect the natural environment of their jurisdiction. These plans guide staff, decision-makers, and citizens in making decisions that affect the community with an understanding of the long-term effects.

The City of Baytown has a comprehensive plan that was adopted May 26, 2022. The most recent comprehensive plan runs through 2040. This plan contains the future vision for the City and recommendations on areas such as growth and community character, updated infrastructure and critical services, land use and development, economic development, zoning opportunities, mobility, and community facilities and services. Refer to the Capability Assessment in Appendix H for a complete list of the plans, ordinances, and other resources for the City of Baytown.

[11] Office of the State Demographer, Texas State Data Center, and the Institute for Demographic and Socioeconomic Research



SECTION 4
RISK OVERVIEW

SECTION 4: RISK OVERVIEW

Hazard Description 1
Disaster Declaration History 5
Natural Hazards and Climate Change 9
Overview of Hazard Analysis 12
Hazard Ranking 14
Risk Assessment Resources and Data Limitations 15
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HAZARD DESCRIPTION

Section 4 is the first phase of the Risk Assessment, providing background information for the hazard identification process and descriptions of the hazards identified. The Risk Assessment continues with Sections 5 through 17, which include hazard descriptions and vulnerability assessments.

Upon a review of the full range of natural hazards suggested under FEMA planning guidance, participating jurisdictions within City of Baytown identified 13 natural hazards that are addressed in the Hazard Mitigation Plan Update, and were identified as significant, as shown in Table 4-1. The hazards were identified through input from Planning Team members and a review of the current 2023 State of Texas Hazard Mitigation Plan (State Plan). Readily available online information from reputable sources such as federal and state agencies was also evaluated and utilized to supplement information as needed.

In general, there are three main categories of natural hazards: atmospheric, hydrologic, and technological. Atmospheric hazards are events or incidents associated with weather-generated phenomena. The following have been identified as significant for the planning area: extreme heat, hail, hurricane / tropical storm, lightning, thunderstorm wind, tornado, and winter storm (Table 4-1).

Hydrologic hazards are events or incidents associated with water-related damage and account for over 75 percent of federal disaster declarations in the United States. Hydrologic hazards identified as significant for the planning area include coastal erosion, flood, and drought.

For the Risk Assessment, earthquake, land subsidence, and wildfire hazards are considered “other” since these hazards are not considered atmospheric, hydrologic, or technological.

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Human-caused hazards are events or incidents caused by human intent, human error, or failed systems. They can be caused or exacerbated by accidental or intentional human actions that result in the loss of life or property. Appendix A will include additional human-caused hazards identified as significant for the City: aviation accident, cyber attack, disruption of services, hazardous materials (fixed and mobile), infectious disease, and terrorism.

Table 4-1. Hazard Descriptions

HAZARD	DESCRIPTION
ATMOSPHERIC	
Extreme Heat	Extreme heat is the condition whereby temperatures hover ten degrees or more above the average high temperature in a region for an extended period of time.
Hail	Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and subsequent cooling of the air mass.
Hurricane / Tropical Storm	A hurricane is an intense tropical weather system of strong thunderstorms with a well-defined surface circulation and maximum sustained winds of 74 mph or higher.
Lightning	Lightning is a sudden electrostatic discharge that occurs during an electrical storm. This discharge occurs between electrically charged regions of a cloud, between two clouds, or between a cloud and the ground.
Thunderstorm Wind	A thunderstorm occurs when an observer hears thunder. Radar observers use the intensity of the radar echo to distinguish between rain showers and thunderstorms. Lightning detection networks routinely track cloud-to-ground flashes, and therefore thunderstorms.
Tornado	A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. Its vortex rotates cyclonically with wind speeds ranging from as low as 40 mph to as high as 300 mph. The destruction caused by tornadoes ranges from light to catastrophic, depending on the location, intensity, size, and duration of the storm.

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HAZARD	DESCRIPTION
Winter Storm	Severe winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Blizzards, the most dangerous of all winter storms, combine low temperatures, heavy snowfall, and winds of at least 35 mph, reducing visibility to only a few yards. Ice storms occur when moisture falls and freezes immediately upon impact on trees, power lines, communication towers, structures, roads, and other hard surfaces. Winter storms and ice storms can down trees, cause widespread power outages, damage property, and cause fatalities and injuries to human life.
HYDROLOGIC	
Coastal Erosion	The process by which the local sea level rise, strong wave action, and coastal flooding wear down or carry away rocks, soils, and/or sands along the coast. All coastlines are affected by storms or other natural events that cause erosion.
Drought	A prolonged period of less than normal precipitation such that the lack of water causes a serious hydrologic imbalance. Common effects of drought include crop failure, water supply shortages, and fish and wildlife mortality.
Flood	The accumulation of water within a body of water, which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding. Most floods fall into the following three categories: riverine flooding, coastal flooding, and shallow flooding.
OTHER	
Earthquake	An earthquake is the sudden, rapid, shaking of the earth, caused by the breaking and shifting of subterranean rock as it releases strain that has accumulated over a long time. Initial mild shaking may strengthen and become extremely violent within seconds.
Land Subsidence	Land subsidence occurs when land sinks into underground voids. These voids may occur naturally or through human-driven or technologically exacerbated circumstances. When the void can no longer support the weight of the earth above it, it collapses, causing a sinkhole depression in the landscape.

HAZARD	DESCRIPTION
Wildfire	A wildfire is an uncontrolled fire burning in an area of vegetative fuels such as grasslands, brush, or woodlands. Heavier fuels with high continuity, steep slopes, high temperatures, low humidity, low rainfall, and high winds all work to increase the risk for people and property located within wildfire hazard areas or along the urban/wildland interface. Wildfires are part of the natural management of forest ecosystems, but most are caused by human factors.

Hazards that were not considered significant and were not included in the Plan Update are located in Table 4-2, along with the evaluation process used for determining the significance of each of these hazards. Hazards not identified for inclusion at this time may be addressed during future evaluations and updates.

Table 4-2. Other Hazards Deferred

HAZARD CONSIDERED	REASON FOR DETERMINATION
Expansive Soils	The planning area has no historical land subsidence occurrences, and it is in an area where occurrences are considered rare. Land subsidence has not impacted critical structures, systems, populations, or other community assets or vital services in the past, and none is expected in the future.

The City of Baytown Hazard Mitigation Action Plan Update 2025 will be utilized when the City of Baytown applies for reaccreditation through the Emergency Management Accreditation Program (EMAP). The Plan Update profiles natural hazards that pose a risk to the City, and Appendix A provides details pertaining to human-caused hazards by outlining their risk for the City along with vulnerability. A Consequence Analysis for all of the identified natural and human-caused hazards can be found in Appendix B.

Table 4-3. Comprehensive List of Hazards

NATURAL	HUMAN-CAUSED	TECHNOLOGICAL
• Coastal Erosion • Drought • Earthquake • Extreme Heat • Flood • Hail • Hurricane / Tropical Storm • Land Subsidence • Lightning • Severe Winter Storm • Thunderstorm Wind • Tornado • Wildfire	• Disruption of Services • Infectious Disease	• Aviation Accident • Cyber Attack • Hazardous Materials • Terrorism

DISASTER DECLARATION HISTORY

One method of understanding hazards that pose a risk to City of Baytown is to identify past hazard events that triggered federal or state disaster declarations. Federal and state declarations may be granted when the severity and magnitude of an event surpass the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. Tables 4-4 and 4-5 list state and federal disaster declarations received by City of Baytown which is located in both Harris County and Chambers County. Many of the disaster events were regional or statewide.

Between 1953 and 2024, Harris County received 41 federal disaster declarations. The largest share (12) was related to hurricanes, followed by declarations for floods (12), severe storm (8), fire (3), biological (2), severe ice storm (2), coastal storm (1), and tornado (1). During this same time period, between 1953 and 2024, Chambers County received 23 federal disaster declarations. The largest share (12) was related to hurricanes, followed by declarations for floods (3), severe ice storm (2), biological (2), severe storm (1), coastal storm (1), fire (1) and other (1).

In addition to the 41 (Harris County) and 23 (Chambers County) federally declared disaster there have been 23 (Harris County) and 13 (Chambers County) U.S. Department of Agriculture (USDA) Secretarial disaster designations between 2012 and 2024. The Secretary of Agriculture is authorized to designate counties as disaster areas to make

emergency loans available to producers suffering losses in those counties and in counties that are contiguous to a designated county.[1] Of the 23 USDA designations for Harris County, many listed multiple factors as having caused the disaster area designation. The leading cause was drought, which was included in 19 designations. Other factors listed include excessive heat (7 designations), high wind (6), fire / wildfire (6), insects (6), excessive rain (2), and hurricane (1). Of the 13 USDA designations for Chambers County, many listed multiple factors as having caused the disaster area designation. The leading cause was drought, which was included in 11 designations. Other factors listed include excessive heat (6 designations), high wind (4), fire / wildfire (4), insects (4), and excessive rain (1).

Table 4-4. Disaster Declaration History of Harris County, 1953-2024

YEAR	DECLARATION TITLE	HAZARD	DECLARATION TYPE	DISASTER No.
1973	Severe Storms and Flooding	Flood	DR	DR-398
1976	Severe Storms and Flooding	Flood	DR	DR-510
1979	Severe Storms, Tornadoes, and Flooding	Severe Storm	DR	DR-580
1979	Severe Storms and Flooding	Flood	DR	DR-603
1983	Hurricane Alicia	Hurricane	DR	DR-689
1984	Severe Storms and Flooding	Flood	DR	DR-727
1989	Severe Storms, Tornadoes, and Flooding	Severe Storm	DR	DR-828
1989	Tropical Storm Allison	Flood	DR	DR-836
1992	Severe Storms and Flooding	Flood	DR	DR-937
1992	Severe Storms and Tornadoes	Tornado	DR	DR-970

[1] United States Department of Agriculture https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/emergency_disaster_designation_declaration_process-factsheet.pdf

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YEAR	DECLARATION TITLE	HAZARD	DECLARATION TYPE	DISASTER No.
1994	Severe Thunderstorms and Flooding	Flood	DR	DR-1041
1998	Tropical Storm Charley	Severe Storm	DR	DR-1239
1998	Tropical Storm Frances	Severe Storm	DR	DR-1245
1998	Severe Storms, Tornadoes, and Flooding	Flood	DR	DR-1257
1999	Extreme Fire Hazards	Fire	EM	EM-3142
2001	Severe Storms and Flooding	Coastal Storm	DR	DR-1379
2002	Severe Storms, Tornadoes, and Flooding	Severe Storm	DR	DR-1439
2005	Hurricane Katrina	Hurricane	EM	EM-3216
2005	Hurricane Rita	Hurricane	EM	EM-3261
2005	Hurricane Rita	Hurricane	DR	DR-1606
2006	Extreme Wildfire Threat	Fire	DR	DR-1624
2007	Hurricane Dean	Hurricane	EM	EM-3277
2007	Tropical Storm Erin	Severe Storm	DR	DR-1730
2008	Hurricane Gustav	Hurricane	EM	EM-3290
2008	Hurricane Ike	Hurricane	EM	EM-3294
2008	Hurricane Ike	Hurricane	DR	DR-1791
2011	Forest Brooke Fire	Fire	FM	FM-2924
2015	Severe Storms, Tornadoes, Straight-line and Flooding	Severe Storm	DR	DR-4223
2015	Severe Storms, Tornadoes, Straight-line and Flooding	Severe Storm	DR	DR-4245
2016	Severe Storms and Flooding	Flood	DR	DR-4269

YEAR	DECLARATION TITLE	HAZARD	DECLARATION TYPE	DISASTER No.
2016	Severe Storms and Flooding	Flood	DR	DR-4272
2017	Hurricane Harvey	Hurricane	DR	DR-4332
2019	Tropical Storm Imelda	Flood	DR	DR-4466
2020	Covid-19	Biological	DR	DR-3458
2020	Covid-19 Pandemic	Biological	DR	DR-4485
2020	Hurricane Hana	Hurricane	EM	EM-3530
2020	Tropical Storm Marco and Laura	Hurricane	EM	EM-3540
2021	Severe Winter Storm	Severe Ice Storm	EM	EM-3554
2021	Severe Winter Storm	Severe Ice Storm	DR	DR-4586
2024	Severe Storms, Tornadoes, Straight-line and Flooding	Flood	DR	DR-4781
2024	Hurricane Beryl	Hurricane	DR	DR-4798

Table 4-5. Disaster Declaration History of Chambers County, 1953-2024

YEAR	DECLARATION TITLE	HAZARD	DECLARATION TYPE	DISASTER No.
1979	Texas Storms, Flash Floods	Flood	DR	DR-595
1983	Hurricane Alicia	Hurricane	DR	DR-689
1994	Severe Thunderstorms and Flooding	Flood	DR	DR-1041
1998	Tropical Storm Charley	Severe Storm	DR	DR-1239
1999	Extreme Fire Hazards	Fire	EM	EM-3142
2001	Severe Storms and Flooding	Coastal Storm	DR	DR-1379
2003	Loss of the Space Shuttle Columbia in Texas	Other	EM	EM-3171
2005	Hurricane Katrina	Hurricane	EM	EM-3216

YEAR	DECLARATION TITLE	HAZARD	DECLARATION TYPE	DISASTER No.
2005	Hurricane Rita	Hurricane	EM	EM-3261
2005	Hurricane Rita	Hurricane	DR	DR-1606
2006	Extreme Wildfire Threat	Fire	DR	DR-1624
2007	Hurricane Dean	Hurricane	EM	EM-3277
2008	Hurricane Gustav	Hurricane	EM	EM-3290
2008	Hurricane Ike	Hurricane	EM	EM-3294
2008	Hurricane Ike	Hurricane	DR	DR-1791
2017	Hurricane Harvey	Hurricane	DR	DR-4332
2019	Tropical Storm Imelda	Flood	DR	DR-4466
2020	Covid-19	Biological	DR	DR-3458
2020	Covid-19 Pandemic	Biological	DR	DR-4485
2020	Tropical Storm Marco and Laura	Hurricane	EM	EM-3540
2021	Severe Winter Storm	Severe Ice Storm	EM	EM-3554
2021	Severe Winter Storm	Severe Ice Storm	DR	DR-4586
2024	Hurricane Beryl	Hurricane	DR	DR-4798

NATURAL HAZARDS AND CLIMATE CHANGE

Climate change is defined as a long-term shift in temperature and weather patterns. These shifts can increase or decrease the risk of natural hazards. Global climate change is expected to exacerbate the risks of certain types of natural hazards impacted by rising sea levels, warmer ocean temperatures, higher humidity, the possibility of stronger storms, and an increase in wind and flood damage due to storm surges. Texas is considered one of the more vulnerable states in the U.S. to both abrupt climate changes and the impact of gradual climate changes on the natural and built environments.

Climate change is expected to lead to an increase in average temperatures as well as an increase in the frequency, duration, and intensity of extreme heat events. With no

reductions in emissions worldwide, the state of Texas is projected to experience an additional 30 to 60 days per year above 100°F than what is experienced now.[2]

The State Climatologist's *Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036* identifies ongoing and likely future trends through 2036 based on analysis of historic observations of temperatures, precipitation, and extreme weather. Table 4-6 highlights future trends in extreme weather from the report.

Table 4-6. Future Trends in Extreme Weather in Texas[3][4]

HAZARDS	EXPECTED TRENDS
Extreme Temperatures	• The average annual surface temperature in 2036 is expected to be 3.0°F warmer than the 1950-1999 average and 1.8°F warmer than the 1991-2020 average. • Nearly double the number of 100°F days by 2036 compared to 2001-2020. • Higher frequency of 100°F days in urban areas. • The number of nighttime temperatures below 32°F are expected to decrease. • The number of frost days per year are expected to decrease. • The coolest days of the summer are expected to continue becoming warmer. • The number of heatwaves per year and number of days per year classified as heatwaves are expected to increase.
Precipitation	• Precipitation has increased by 10 percent or more in eastern Texas, but little trend is present in western Texas. • Precipitation trends to 2036 are likely to be dominated by natural variability. • Extreme precipitation is expected to increase in intensity on average statewide by 6-10 percent compared to the 1950-1999 averages and 2-3 percent relative to the 2001-2020 averages.

[2] Kloesel, K., B. Bartush, J. Banner, D. Brown, J. Lemery, X. Lin, C. Loeffler, G. McManus, E. Mullens, J. Nielsen-Gammon, M. Shafer, C. Sorensen, S. Sperry, D. Wildcat, and J. Ziolkowska, 2018: Southern Great Plains. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 987–1035. doi: 10.7930/NCA4.2018.CH23. https://nca2018.globalchange.gov/chapter/23/

[3] Nielsen-Gammon, John, Holman, Sara, Buley, Austin and Jorgensen, Savannah. Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, 2021 Update. Texas A&M University Office of the Texas State Climatologist. October 7, 2021. https://climatexas.tamu.edu/files/ClimateReport-1900to2036-2021Update

[4] University of Texas at Austin, February 2023, Austin Future Climate, Climate Change Predictions for the City of Austin 2022, Technical Report.

HAZARDS	EXPECTED TRENDS
	• This translates to an increase in the frequency of extreme rain of 30-50 percent relative to the climatological expected frequency in 1950-1999 and 10-15 percent relative to 2001-2020. • Annual precipitation is projected to increase while the number of extreme precipitation (>2") will remain relatively consistent.
Drought	• Increasing temperatures, rainfall variability, and other factors will decrease water availability, but impact changes will vary strongly across applications. • Impact trends to be highly sector-specific, with the impacts possibly smaller for agriculture than for surface water supply.
Flood	• No long-term river flooding trend has been identified in the observations, nor is such a trend projected at this point, except perhaps for the most extreme floods and areas with normally high rainfall. • Urban flooding is projected to increase, both as a simple matter of urban population increase and because of the projected increase of precipitation intensity, which drives flooding in fast-response drainages like those usually found in urban areas. • The climate-driven trend in urban flood frequency should be similar to the climate-driven trend in extreme precipitation frequency: 30-50 percent in 2036 relative to 1950-1999 and 10-15 percent relative to 2001-2020. • Areas already experiencing flooding are likely to see an increase in the frequency and magnitude of events.
Winter Weather	• As the climate warms, the likelihood of winter weather decreases. • Both extreme cold and snowfall either become less frequent or are expected to do so. • Widespread snowfall events in Texas, such as the one that took place in February 2021, are extremely rare. • Fewer cold spells are projected to occur per year, but the length of cold spells will be longer when they do occur.
Thunderstorms (Wind, Hail, Lightning)	• Historical trend data is unreliable. • Indirect evidence supports an increase in the number of days capable of producing severe thunderstorms and an increase in the frequency of very large hail in early springtime. Still, these possible trends are too uncertain to quantify.

HAZARDS	EXPECTED TRENDS
Wildfire	• Weather and climate drivers of wildfire risk are projected to increase the risk of wildfires throughout the state, primarily due to increased drying rates and fuel load.

OVERVIEW OF HAZARD ANALYSIS

The methodologies utilized to develop the Risk Assessment are a historical analysis and a statistical approach. Both methodologies provide an estimate of potential impact by using a common, systematic framework for evaluation.

Records retrieved from the National Centers for Environmental Information (NCEI) and the National Oceanic and Atmospheric Administration (NOAA) were reported for the City of Baytown. The remaining records identifying the occurrence of hazard events in the planning area and the maximum recorded magnitude of each event were also evaluated.

Geographic information system (GIS) technology was used to identify and assess risks for the City of Baytown and evaluate community assets and their vulnerability to hazards.

The four general parameters that are described for each hazard in the Risk Assessment include frequency of return, approximate annualized losses, a description of general vulnerability, and a statement of the hazard's impact.

The frequency of return was calculated by dividing the number of events in the recorded time period for each hazard by the overall time period that the resource database was recording events. Frequency of return statements are defined in Table 4-7, and impact statements are defined in Table 4-8 below.

Table 4-7. Frequency of Return Statements

PROBABILITY	DESCRIPTION
Highly Likely	Event is probable in the next year.
Likely	Event is probable in the next three years.
Occasional	Event is probable in the next five years.
Unlikely	Event is probable in the next ten years.

Table 4-8. Impact Statements

POTENTIAL SEVERITY	DESCRIPTION
Substantial	Multiple deaths. Complete shutdown of facilities for 30 days or more. More than 50 percent of property destroyed or with major damage.
Major	Injuries and illnesses resulting in permanent disability. Complete shutdown of critical facilities between one and four weeks. More than 25 percent of property destroyed or with major damage.
Minor	Injuries and illnesses do not result in permanent disability. Complete shutdown of critical facilities for up to one week. More than 10 percent of property destroyed or with major damage.
Limited	Injuries and illnesses are treatable with first aid. Shutdown of critical facilities and services for 24 hours or less. Less than 10 percent of property destroyed or with major damage.

Each of the hazard profiles includes a description of a general Vulnerability Assessment. Vulnerability is the total of assets that are subject to damage from a hazard based on historic recorded damages. Assets in the region were inventoried and defined in hazard zones where appropriate. The total amount of damage, including property and crop damages, for each hazard is divided by the total number of assets (building value totals) in that community to determine the percentage of damage that each hazard can cause to the community. Risk and consequences will be addressed and covered within each hazard profile under the Vulnerability and Impact section as well as under the Assessment of Impact sections, where applicable.

To better understand how future growth and development in the City of Baytown region might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. Hazard vulnerability for the City of Baytown was reviewed based on recent development changes that occurred throughout the planning area. The population of City of Baytown has grown by 17 percent between 2010 and 2020, according to the U.S. Census Bureau. Therefore, the vulnerability to the population,

infrastructure, and buildings has increased for hazards that do not have a geographical boundary.

Once loss estimates and vulnerability were known, an impact statement was applied to relate the potential impact of the hazard on the assets within the area of impact.

HAZARD RANKING

During the 2024-2025 planning process, the Planning Team conducted a risk ranking exercise to get input from the Planning Team and stakeholders. Table 4-9 portrays the results of the risk assessment analysis, including the frequency of occurrence and potential severity and the Planning Team's self-assessment for hazard ranking based on local knowledge of past hazard events and impacts for each identified hazard. The definitions for frequency of occurrence and potential severity can be found in Table 4-7 and Table 4-8.

Table 4-9. Hazard Risk Ranking

HAZARD	FREQUENCY OF OCCURRING	POTENTIAL SEVERITY	RANKING
NATURAL HAZARDS			
Drought	Highly Likely	Limited	High
Extreme Heat	Highly Likely	Substantial	High
Flood	Highly Likely	Substantial	High
Hurricane / Tropical Storm	Highly Likely	Substantial	High
Lightning	Highly Likely	Substantial	High
Thunderstorm Wind	Highly Likely	Substantial	High
Tornado	Likely	Minor	High
Coastal Erosion	Highly Likely	Limited	Moderate
Hail	Highly Likely	Limited	Moderate
Land Subsidence	Likely	Limited	Moderate
Severe Winter Storm	Highly Likely	Substantial	Moderate
Wildfire	Occasional	Limited	Moderate
Earthquake	Unlikely	Limited	Low

RISK ASSESSMENT RESOURCES AND DATA LIMITATIONS

The risk and vulnerability assessment relies heavily on the content of the National Oceanic and Atmospheric Administration (NOAA) National Center for Environmental Information (NCEI) Storm Events Database. This database covers weather-related hazards that affect the planning area and that are profiled in this plan including winter weather (extreme cold and winter storm), drought, earthquake, hail, lightning, thunderstorm wind, flood, extreme heat, hurricane / tropical storm, and tornado. Other hazards were analyzed using databases containing more comprehensive historical data specific to Texas such as the Texas Forest Service (TFS) for wildfires, the Texas General Land Office CEPRA report for coastal erosion, or the Texas Speleological Society for land subsidence hazards.

The NCEI Storm Events Database Is a rich centralized repository of nationwide weather-related hazard events. Among other things, it is the source used by NOAA to populate its monthly storm data publication. The database contains recorded weather events of significance based on a range of potential criteria including intensity, duration, damages, injuries, or other otherwise notable events. The history of data available in the NCEI database allows the study of impacts of individual hazards over an extended period of time. This data contributes to the framework for understanding relative risks over time.

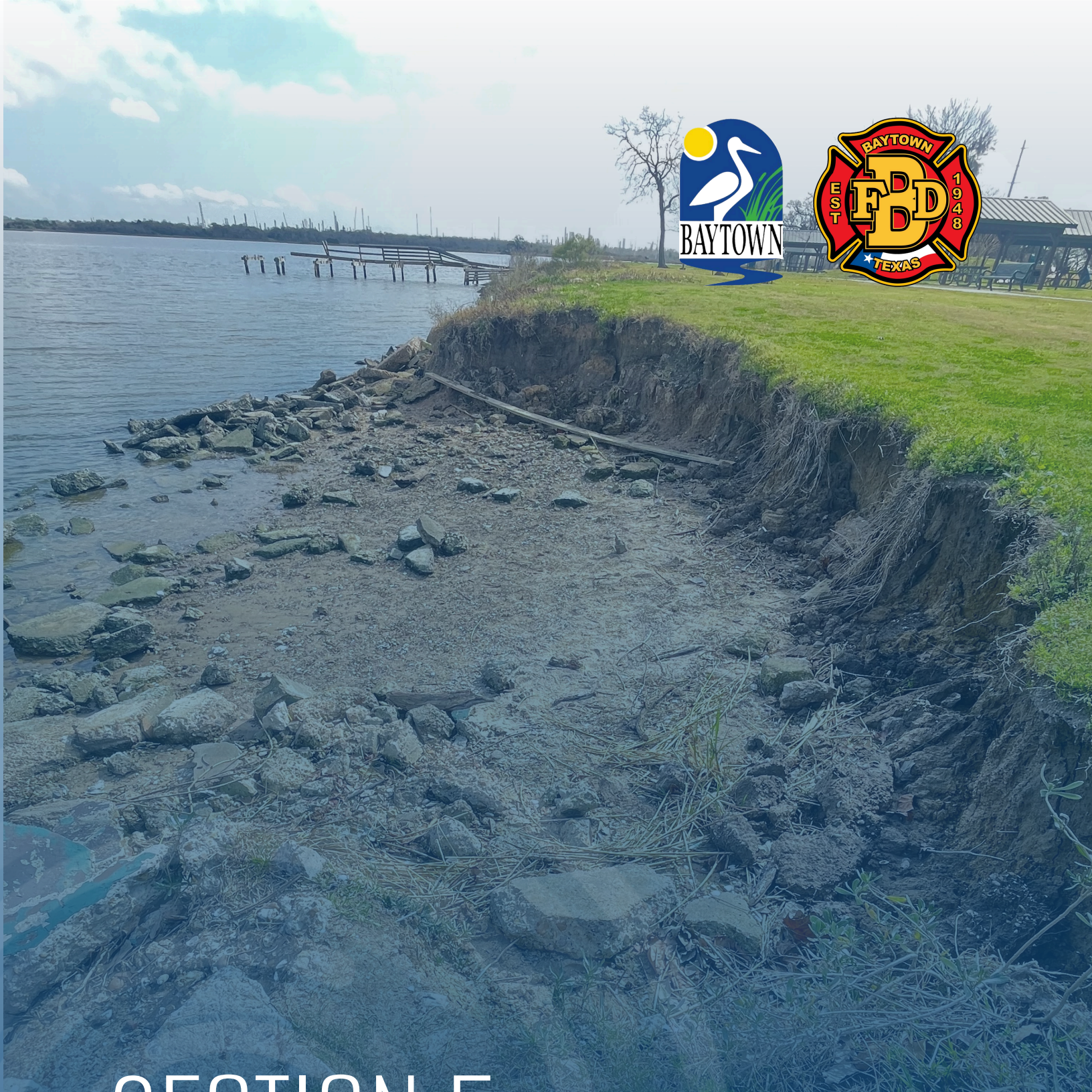
While the NCEI is considered as one of the most comprehensive national historical event databases it is not without limitations. Records of historical occurrences in the state shows significant variations in the number of events recorded from one county to the next. Further research shows that the variations are more attributable to under-reporting of events than variations in weather occurrences. Only the events that have been reported or recorded in the database are factored into the risk assessment when no other reliable resources are available. It is accurate to assume that additional natural hazard occurrences have gone unreported or have been underreported. The risk assessment in this plan is considered the baseline for estimating potential future losses and frequency of events, which are assumed to be the minimum the planning area can anticipate. Additionally, significant events may be reported by both the county and local jurisdictions. This is due to reports from various locations impacted by a given event.

Finally, damages are not reported for the majority of events recorded in the NCEI as property damage estimates are not always available. Natural hazard event damages are often covered by private insurance and statistical insurance data is not readily available in the public domain. The NWS regional forecast coordinators utilize the resources

available to them to describe damages or impacts of events. However, local input is key to assigning damages to historical events.

ASSUMPTIONS

Event data is often reported at the county level only. This is primarily due to the nature of most natural hazards impacting areas larger than a single municipality. Winter storms or extreme heat, for example, impact large regions and are not confined to a single location. NWS regional coordinators typically gather event data from countywide or regional reporting and record it accordingly. Some exceptional events are captured by NWS regional coordinators when the impact of the event is severe or catastrophic. However, most events recorded at the municipality level are conveyed by local officials. Event data at the municipality level is often limited as a result. Due to the more robust reporting at the county level and limited reporting at the local level, summary vulnerability statements are formulated using both local and countywide event data. These vulnerability assessments assume that events impacting the county similarly impact the jurisdictions within that county. Therefore, the countywide assessment is considered similar for all participating jurisdictions unless stated otherwise. Future risk and vulnerability assessments at the local, county and state level will benefit significantly from increased, detailed event reporting.



SECTION 5
COASTAL EROSION

SECTION 5: COASTAL EROSION

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HAZARD DESCRIPTION



Coastal erosion is the slow deterioration of land and loss of beach, shoreline, or dune material due to natural coastal processes or manmade influences. Erosion occurs when storms, flooding, wave action, sea-level rise, and human activities wear away beaches and bluffs. All beaches are affected by storms and other natural events that cause erosion; however, the extent and severity of the problem differs in different parts of the country. The two major erosion mechanisms are wind and water. Wind that blows across sparsely vegetated or disturbed lands can cause erosion by picking up soil, carrying it through the air, and displacing it in another place. Water erosion affects land, streams, and coastal areas, often intensifying during storms due to high winds, heavy surf, and storm surge. Human activities, such as construction and development in coastal and riparian regions, can also exacerbate erosion.

While coastal erosion affects all regions of the United States, erosion rates and potential impacts are highly localized. Texas has one of the longest coastlines in America coupled with some of the highest rates of coastal erosion in the nation. Eighty percent of the Gulf shoreline is eroding at greater than 2 feet per year. Some areas experience erosion exceeding 8 feet per year, including sections of Galveston Island, Matagorda Peninsula,

North and South Padre Island, and Brazos Island. The overall average rate of erosion along the Texas coast is 4.17 feet per year, and this rate is increasing over time.[1]

LOCATION

The City of Baytown planning area is a coastal community located on the northern shore of Galveston Bay on the Texas Gulf Coast. As shown in Figure 5-1, the City of Baytown's shoreline includes bay-margin marsh, tidal flats, low bluffs (clay or sandy clay), and high bluffs (clay or sandy clay). Common bay shoreline types and their susceptibility to coastal erosion by sea-level rise, storm surges, and waves are also provided in Table 5-1.[2] Due to its location along the Texas Gulf coast and geography, it is vulnerable to impacts related to coastal erosion resulting from sea level rise and extreme hazards such as hurricane and tropical storm events. The most common time for such extreme storm events to impact the planning area is from June to November, the official Atlantic U.S. hurricane season.

[1] Texas General Land Office. Texas Coastwide Erosion Response Plan. December 2020. https://www.glo.texas.gov/sites/default/files/resources/glo/coast/coastal-management/forms/files/2020coastwide-erosion-response-plan_2020_final.pdf.

[2] Tiffany L. Caudle and Jeffery G. Paine. Bureau of Economic Geology. Historical Shoreline Movement in Galveston, Trinity, East and West Bay on the Upper Texas Gulf Coast. March 2024.

SECTION 5: COASTAL EROSION

Figure 5-1. Location of Jurisdiction and Shoreline Materials[3]

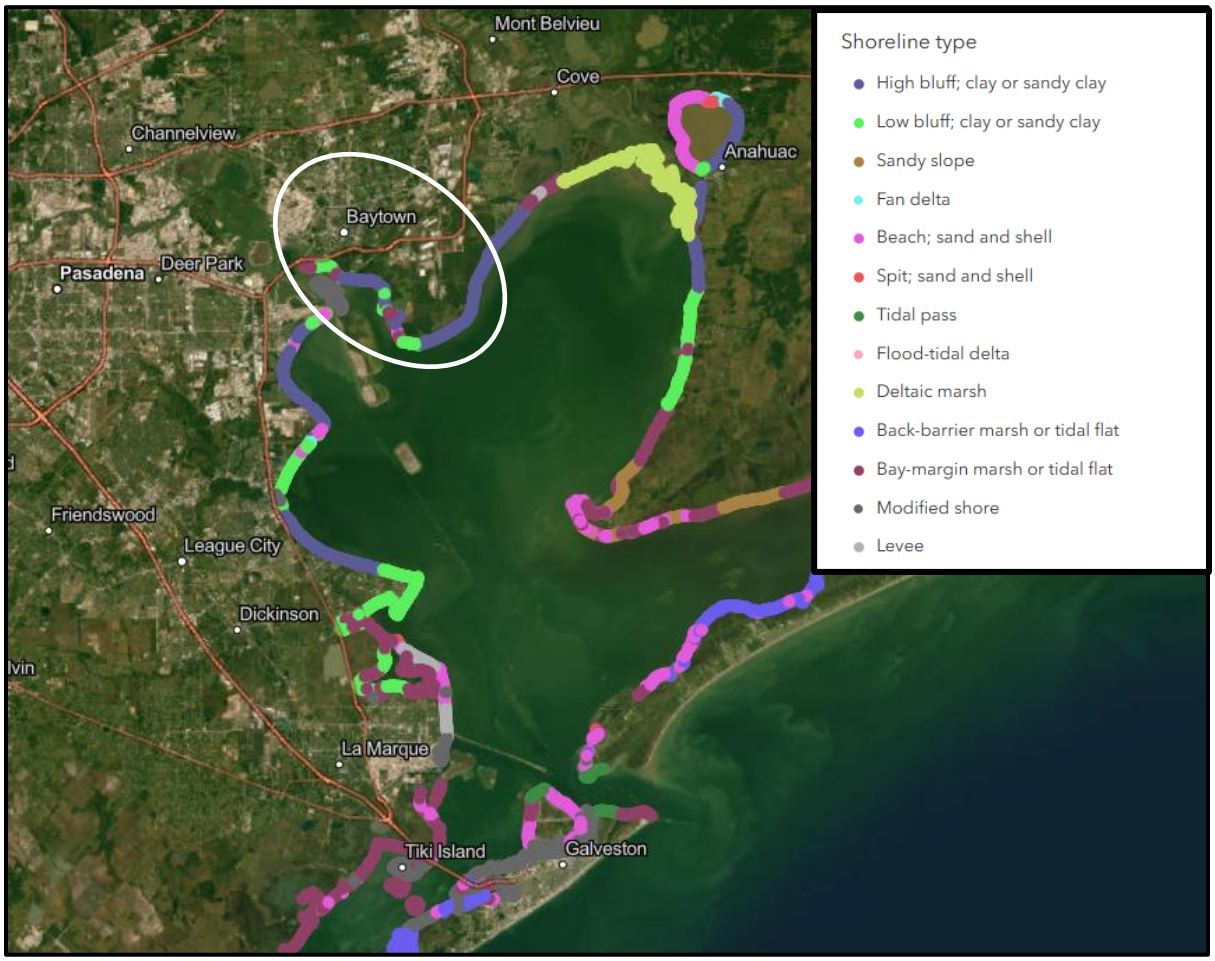


Table 5-1. Shoreline Types and Susceptibility[4]

SHORELINE TYPE	RELATIVE SEA-LEVEL RISE	STORM SURGE AND WAVES	NON-STORM WAVE ACTION
High Bluff*	Low	High	Moderate
Low Bluff*	Low	High	Moderate
Sandy Slope	Low	High	Moderate
Fan Delta	Moderate	Moderate	High
Beach	Moderate	Moderate	High
Spit	Moderate	Moderate	High

[3] Bureau of Economic Geology, Texas General Land Office, U.S. Fish and Wildlife Service. Shoreline Change Map. https://coastal.beg.utexas.edu/shorelinechange_bays/.

[4] The asterisk designates the shoreline types found in the City of Baytown.

SECTION 5: COASTAL EROSION

SHORELINE TYPE	RELATIVE SEA-LEVEL RISE	STORM SURGE AND WAVES	NON-STORM WAVE ACTION
Tidal Pass	High	High	High
Flood-tidal Delta	High	High	High
Deltaic Marsh	High	Low	High
Bay-margin Marsh or Tidal Flat*	High	Low	High
Back-barrier Marsh or Tidal Flat	High	Low	High

EXTENT

Extent of coastal erosion is typically measured by the rate of shoreline change. However, this rate varies by location as some areas are experiencing erosion while other areas are gaining land.

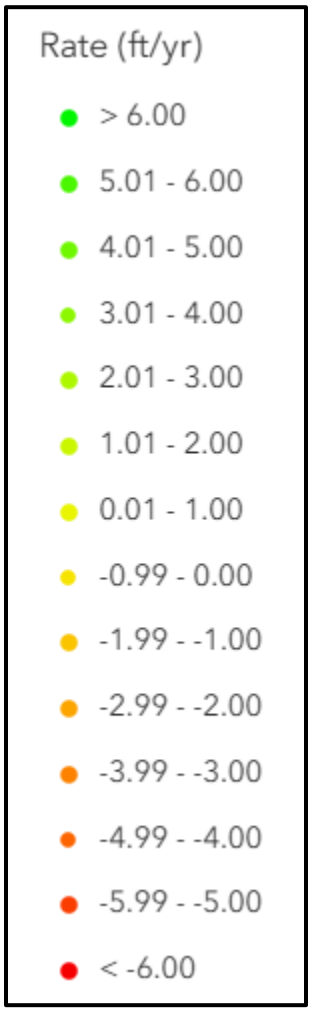
Figures 5-2 and 5-3 present maps from the Bureau of Economic Geology (BEG) and the Texas General Land Office (GLO) depicting Texas Coastwide Shoreline Change between 1930 and 2022. This map illustrates shoreline change rates in the City of Baytown, ranging from erosion (land loss) greater than 6 feet per year to accretion (land gain) exceeding 6 feet per year, depending on exact location.

According to the 2024 BEG Historical Shoreline Movement Report, the average rate of shoreline movement for the entire Galveston Bay area from 1930 to 2022 was -2.53 feet (-0.77 meters) per year.

Figure 5-2. Shoreline Rate of Change Map for City of Baytown, 1930-2022



Figure 5-3. Shoreline Rate of Change Legend[5]



HISTORICAL OCCURRENCES

The NCEI does not report coastal erosion events. Local governments typically lack the capabilities to monitor or report statistical data for coastal erosion, especially since it is an ongoing, slow moving hazard. Coastal erosion is typically measured and tracked as an average annual shoreline change rate in linear feet. Between 1930 and 2022, the average rate of shoreline movement for the entire Galveston Bay area was -2.53 feet per year.

Figure 5-4 below shows the City of Baytown shoreline position in the 1850s (outlined in orange), the 1930s (outlined in blue), and in 2022 (outlined in red) according to the Shoreline Change Map provided by the BEG and GLO. By comparatively assessing where

[5] Green colors indicate where the area is gaining shoreland.

the shoreline was mapped between the 1850s and in 2022, it is evident that significant land loss has occurred over time, impacting the City of Baytown's shoreline.

Figure 5-4. City of Baytown Shoreline Assessment 1850's, 1930's, and 2022



SIGNIFICANT EVENTS

August 25-29, 2017 – Hurricane Harvey

Coastal erosion is a long term process, however, severe storm systems that bring an excess of rain, such as hurricanes, can have cascading impacts such as coastal erosion. Hurricane Harvey made landfall on the Texas Gulf coast and brought catastrophic flooding to Harris County and the City of Baytown planning area.

According to the 2020 Texas Coastwide Erosion Response Plan, Hurricane Harvey's flood sedimentation was the equivalent to seven years of normal sedimentation. In 2017, post-storm shoreline impacts were assessed, and the hurricane notably caused significant erosion at Galveston Island. However, bay shorelines were also impacted and

experienced accelerated erosion. The plan notes that in several nearby areas, including Sylvan Beach, federal funds were used to repair some of the erosion damage caused by Hurricane Harvey.

PROBABILITY OF FUTURE EVENTS

Based best available data, the average coastal erosion rate for the entire Galveston Bay area is -2.53 feet per year. Certain areas of the City of Baytown shore also experience erosion up to or greater than 6 feet per year (Figure 5-2). This rate supports a "Highly Likely" probability of future events, with an event probable in the next year.

CLIMATE CHANGE CONSIDERATIONS

Climate change is expected to intensify coastal erosion. As global temperatures increase, thermal expansion of seawater contributes to rising sea levels, allowing waves to extend further inland. This is especially prevalent during storms, which leads to higher rates of coastal erosion. According to the United States Environmental Protection Agency, the sea level is rising more rapidly along the Texas coast due to groundwater pumping than climate change itself. However, both are contributing factors. According to key findings from Climate Central's Surging Seas Risk Finder and the National Climate Assessments intermediate-high sea level rise scenario, the City of Baytown is projected to have a 5.3 foot rise by 2100.

Increasing storm intensity also exacerbates coastal erosion. As discussed in Section 11, Texas anticipates an increase in the intensity of major hurricanes, even as overall hurricane frequency is projected to remain stable or potentially decrease. However, severe flooding and other storm events, as seen with Hurricane Harvey, have demonstrated the capacity to significantly accelerate local rates of coastal erosion. As these events intensify, the risk of erosion events increases.

VULNERABILITY AND IMPACT

The City of Baytown is continuously subject to coastal erosion. While usually a slow-evolving hazard, coastal erosion presents a serious threat to the City of Baytown. As a densely populated bay area, the City of Baytown faces increased vulnerability to hurricanes, coastal storms, and above-average tidal events with any loss of land. The loss

of beach or marshland, which provides valuable protection from coastal storm events, results in greater vulnerability.

The City is prone to erosion as detailed in the sections above. Erosion-related land loss impacts residential neighborhoods, roadways, and critical infrastructure. Shoreline retreat increases the risk of flooding and storm surge, particularly for homes and businesses near the bay area. Industrial facilities near the shoreline, including refineries and chemical plants, are at risk of increased flooding due to land loss over time, leading to unwanted cascading impacts. Additionally, transportation infrastructure, such as the Fred Hartman Bridge and major highways, especially those closest to the shoreline, could be damaged by coastal erosion.

Table 5-2 includes the comprehensive critical facilities identified in Appendix F that were considered the most important to the planning area that are subject to a range of impacts due to coastal erosion. For a comprehensive list of identified critical facilities, please see Appendix F.

Table 5-2. Critical Facilities for Coastal Erosion

CRITICAL FACILITY TYPES	POTENTIAL IMPACTS
Emergency Response Departments (EOC, Fire, Police, EMS), Hospitals	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency facilities can be damaged by erosion. • Evacuations routes may be obstructed, eroded, or completely damaged, limiting access for emergency response vehicles. • Damaged roads and bridges can impede emergency response vehicle access to areas. • Increased number of rescues needed as areas become more vulnerable to storm surges or high tides due to erosion.
Airport, Academic Institutions, Community Residential Facilities, Day Care Facilities, Evacuation Centers & Shelters, Governmental Facilities	• Coastal erosion can undermine the foundation of buildings, causing damage or destruction to structures. • Backup power sources could be damaged by erosion or inundated, making them inoperable. • Evacuation may be necessary due to infrastructure damage or facility inundation caused by coastal erosion. • The erosion of nearby roads and bridges can delay access for emergency responders and personnel. • Increased vulnerability of shelters and evacuation centers to storm surge and high tides due to coastal erosion. • Damaged or destroyed highway infrastructure may substantially increase the need for airport operations.

CRITICAL FACILITY TYPES	POTENTIAL IMPACTS
Commercial Suppliers (food, gas, etc.)	• Facilities or infrastructure may be damaged, destroyed or otherwise inaccessible. • Essential supplies like medicines, water, food, and equipment deliveries may be significantly delayed due to obstructed or damaged routes. • Facility damage could lead to extended shortages of essential resources, impacting the community.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and services may be significantly impacted due to damaged facilities, power lines, and/or loss of communication towers. • Erosion can damage water treatment and sewage systems, leading to contamination and health hazards. • The loss of key infrastructure may make it difficult for emergency vehicles to reach critical locations, delaying response times.

As land is lost, property values in susceptible areas may decrease, leading to decreased tax revenue. The petrochemical industry in the City of Baytown, which includes the ExxonMobil Baytown Complex, one of the largest integrated and most technologically advanced refining and petrochemical complexes in the world, is a significant factor in the community's economic health. These facilities face potential disruptions due to erosion-related infrastructure damage. Additionally, tourism and recreational activities along the waterfront may suffer if public access areas and natural attractions deteriorate.

Notably, coastal erosion can have significant environmental implications with cascading impacts. The Baytown Nature Center is listed on the Great Texas Coastal Birding Trail, providing habitat for 317 species of resident and neo-tropical migrant birds. Numerous other animals also call the Nature Center home. In addition, it's an important nursery area for a variety of aquatic species, including shrimp, crab and fish. Wildlife has an important role in the community and in local tourism. As the shoreline retreats, vital ecosystems deteriorate, reducing habitat availability for local wildlife.

Other environmental impacts include the loss of natural vegetation and barriers that protect against storm surge and flooding, as well as a diminished natural flood absorption capacity. This increases flood risk, making storm surges and heavy rainfall events more destructive.

The potential severity of impact from coastal erosion for the City of Baytown planning area is classified as "Limited", meaning injuries and illnesses are treatable with first aid,

the shutdown of critical facilities and services for 24 hours or less, and less than 10 percent of property destroyed or with major damage.

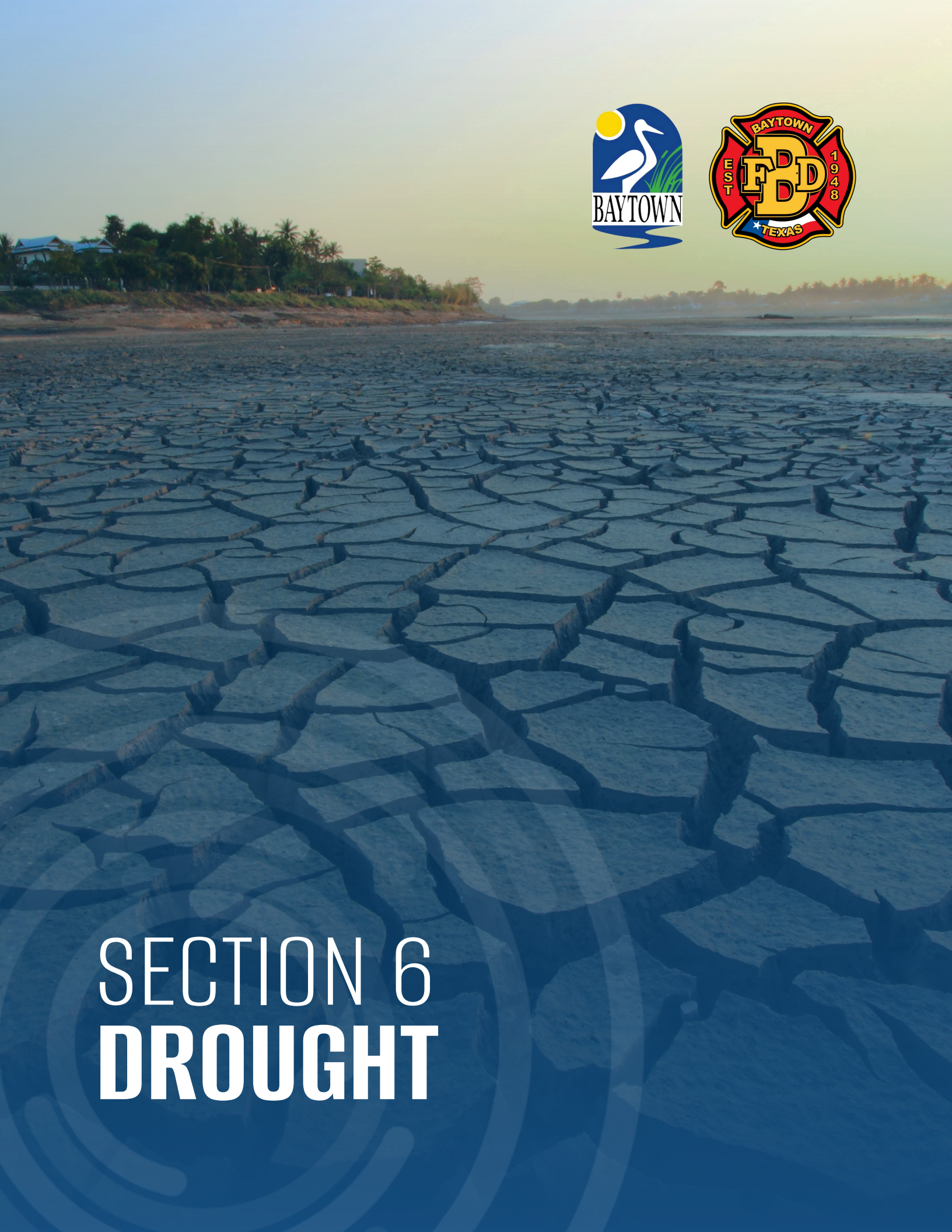
ASSESSMENT OF IMPACTS

Coastal erosion events have the potential to pose a significant risk to structures, infrastructure and the local economy. Impacts to the planning area can include:

- Structures and infrastructure can be damaged or destroyed. Extreme erosion, typically resulting from a significant storm event, will result in uninhabitable parcels where structures cannot be rebuilt.
- Coastal communities can suffer substantial damage, requiring immediate shelter and long term displacement assistance.
- Damaged roads and bridges could prevent or delay emergency response, strand or prevent entry of tourists, commuters, supply delivery, or goods and services for extended periods.
- Coastal erosion may dramatically hinder rebuilding and recovery efforts.
- Beaches may be less desirable, reducing tourism and negatively impacting the economy.
- Economic disruption reduces community programs and services due to short- and long-term revenue loss.
- Some businesses not directly damaged by coastal erosion could suffer financial losses while access roads or beachfront properties undergo repairs.
- Some residents will be forced to migrate inland to safer areas or may leave the region entirely due to economic and safety concerns.
- Loss of protective natural barriers, such as wetlands and dunes, increases vulnerability to future flooding and storm surge.
- Critical infrastructure, including water treatment plants, power stations, and stormwater drainage systems, may be damaged by saltwater intrusion and erosion.
- Erosion can disrupt breeding grounds for fish and shellfish, leading to long-term declines in commercial and recreational fishing industries.
- Increased insurance costs and reduced property values may make it difficult for homeowners and businesses to recover financially.
- Cemeteries, historic landmarks, and meaningful community spaces could be lost due to coastal retreat.

The economic and financial impacts of coastal erosion on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-

event planning done by the community, local businesses and citizens will also reduce the impacts of coastal erosion.



SECTION 6
DROUGHT

SECTION 6: DROUGHT

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HAZARD DESCRIPTION

Drought is a period of time without substantial rainfall that persists from one year to the next. Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Droughts can be classified as meteorological, hydrologic, agricultural, and socioeconomic. Table 6-1 presents definitions for these different types of droughts.

Droughts are one of the most complex of all natural hazards as it is difficult to determine their precise beginning or end. In addition, droughts can lead to other hazards such as extreme heat and wildfires. Their impact on wildlife and area farming is enormous, often killing crops, grazing land, edible plants, and even in severe cases, trees. A secondary hazard to drought is wildfire because dying vegetation serves as a prime ignition source. Therefore, a heat wave combined with a drought is a very dangerous situation.

Table 6-1. Drought Classification Definitions[1]

METEOROLOGICAL DROUGHT	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
HYDROLOGIC DROUGHT	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
AGRICULTURAL DROUGHT	Soil moisture deficiencies relative to water demands of plant life, usually crops.

[1] Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA

SECTION 6: DROUGHT

SOCIOECONOMIC DROUGHT	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

LOCATION

Droughts occur regularly throughout Texas and the City of Baytown, and they are considered a normal condition. However, they can vary greatly in terms of their intensity and duration. The U.S. Drought Monitor, produced through a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration, shows the planning area is currently experiencing no (none) drought conditions (Figure 6-1). However, the planning area has experienced a range of conditions from normal (none) to exceptional drought conditions over the last decade (Figure 6-2). Drought has no distinct geographic boundary and can occur anywhere within the City of Baytown planning area.

Figure 6-1. U.S. Drought Monitor, February 2025

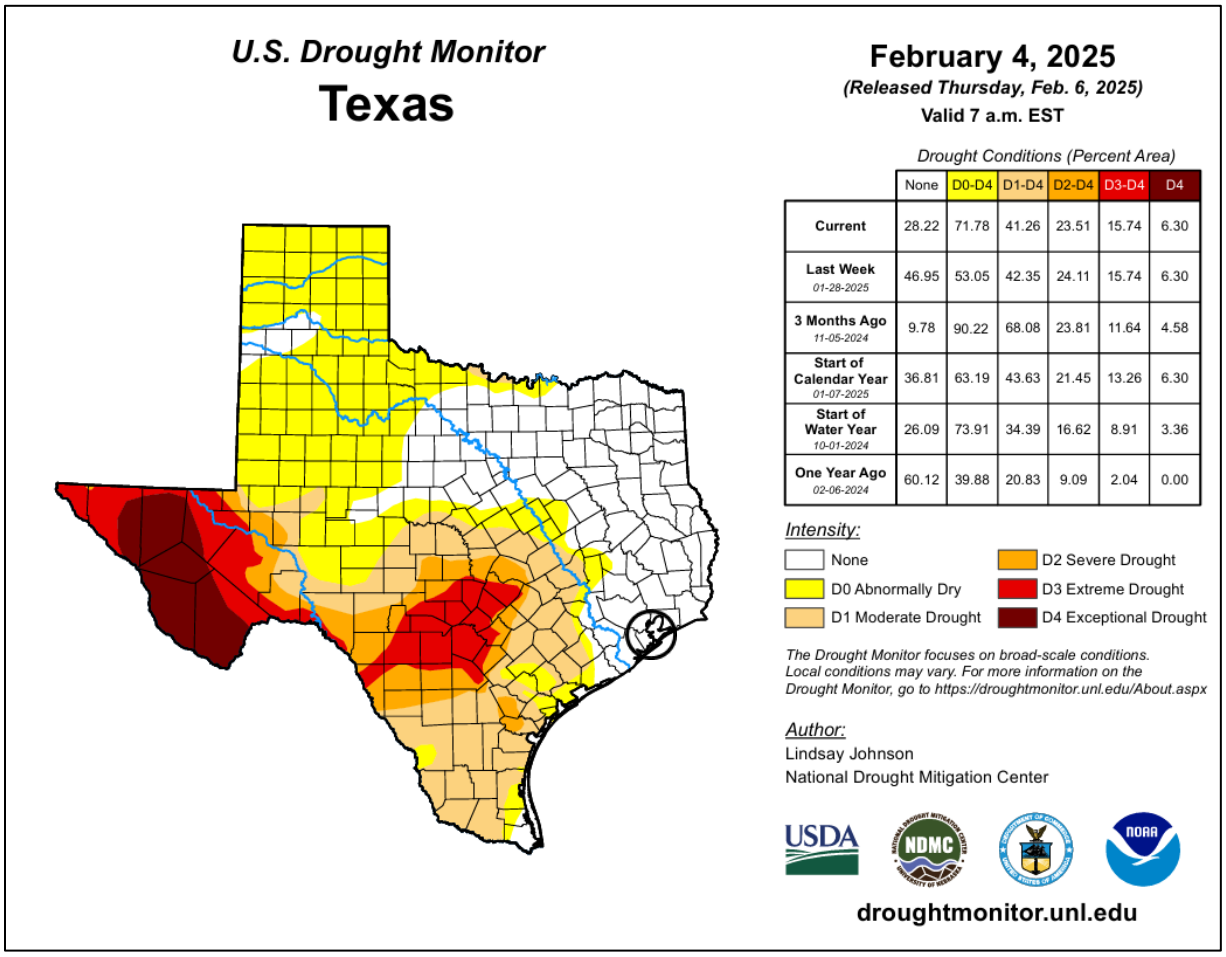
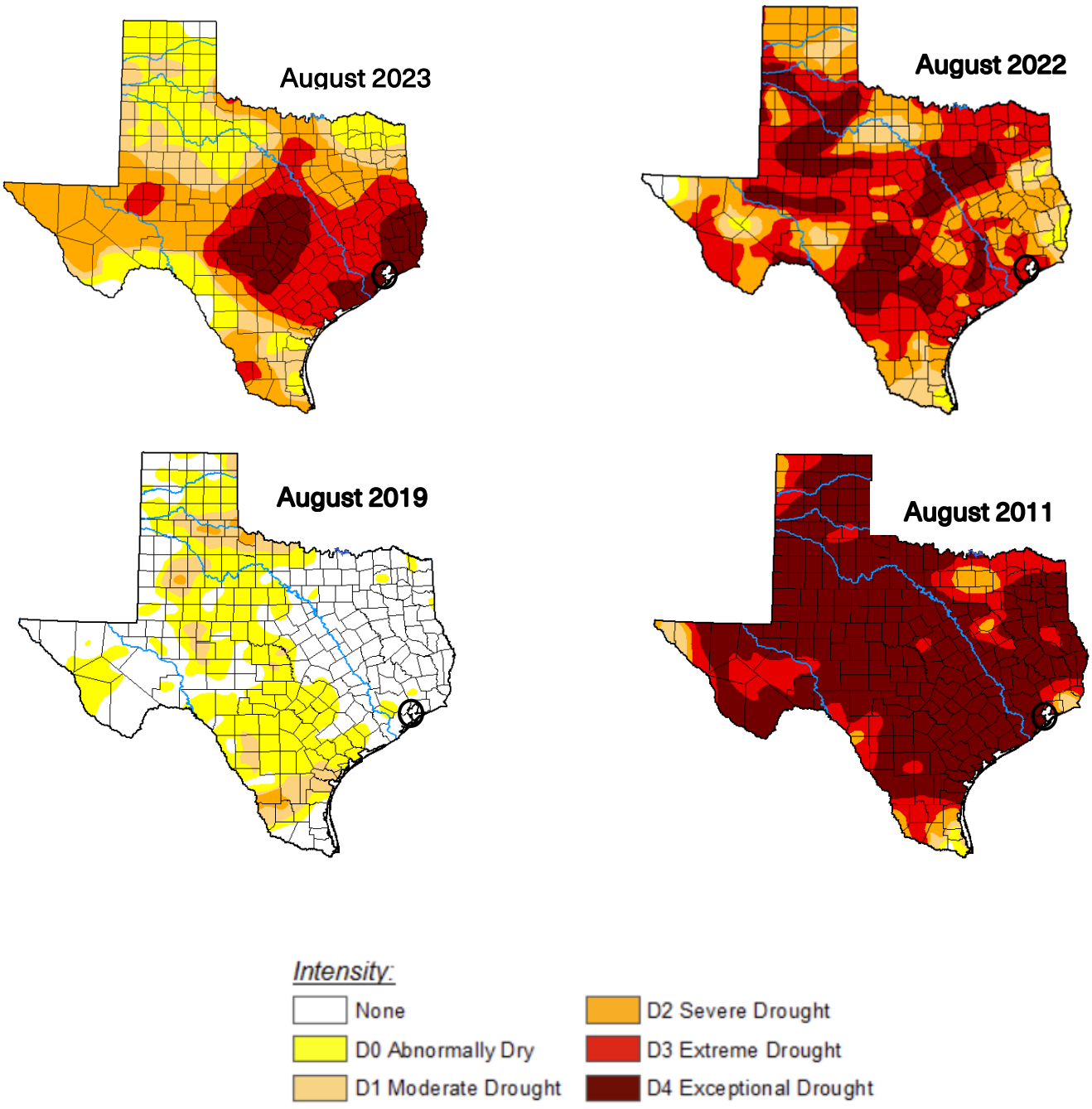


Figure 6-2. U.S. Drought Monitor, August 2011, August 2019, August 2022, August 2023



SECTION 6: DROUGHT

EXTENT

The Palmer Drought Index is used to measure the extent of drought by measuring the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, with the intensity of drought during the current month dependent upon the current weather patterns plus the cumulative patterns of previous months. The hydrological impacts of drought (e.g., reservoir and groundwater levels) take longer to develop. Table 6-2 depicts the magnitude of drought, while Table 6-3 describes the classification descriptions.

Table 6-2. Palmer Drought Index

DROUGHT INDEX	DROUGHT CONDITION CLASSIFICATIONS						
	Extreme	Severe	Moderate	Normal	Moderately Moist	Very Moist	Extremely Moist
Z Index	-2.75 and below	-2.00 to -2.74	-1.25 to -1.99	-1.24 to +.99	+1.00 to +2.49	+2.50 to +3.49	N/A
Meteorological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above
Hydrological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above

Table 6-3. Palmer Drought Category Descriptions[2]

CATEGORY	DESCRIPTION	POSSIBLE IMPACTS	PALMER DROUGHT INDEX
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.	-2.0 to -2.9

[2] Source: National Drought Mitigation Center

CATEGORY	DESCRIPTION	POSSIBLE IMPACTS	PALMER DROUGHT INDEX
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Drought conditions are monitored nationwide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the U.S. and correspond to the intensity of drought.

Based on the historical occurrences of drought and the location of the City of Baytown, the city can anticipate the full range of drought from abnormally dry (D0) to exceptional drought (D4), based on the Palmer Drought Category. The entire planning area has experienced exceptional drought conditions. This is the highest level of drought severity the planning area may experience.

The Baytown Area Water Authority (BAWA) provides water to the City of Baytown. The Drought Contingency Plan was developed by BAWA and will notify the planning area about the conditions under which each stage of the plan is to be implemented. Table 6-4 presents the stages of the BAWA Drought Contingency Plan.

Table 6-4. Stages of the BAWA Drought Contingency Plan

TARGET	TRIGGER	RESTRICTIONS
Stage 1 (Mild): Achieve a voluntary 5 percent reduction in daily water demand.	• Temporary interruption in the flow of the Coastal Water Authority Canal. • Any unforeseen conditions that cause BAWA to notify of abnormal conditions.	• Water customers will be requested to voluntarily reduce water use and will be informed of specific steps that can be taken to reduce water use. • Water customers will be requested to voluntarily limit the use of water for non-essential purposes, including watering on odd numbered days if the address is odd numbered or even numbered days if the

TARGET	TRIGGER	RESTRICTIONS
		address is even numbered during the hours 8:00 p.m. and 10:00 a.m.
Stage 2 (Moderate): Achieve a voluntary 10 percent reduction in daily water demand.	• Short- term interruption in the flow of the Coastal Water Authority Canal, that may affect supply of raw water. • Average treatment plant flow is required in excess of 85% of the plant's capacity for three (3) consecutive days. • Continually falling storage tank levels that do not refill before reaching a critical level. • Major line breaks that require an extended repair time. • Pump system failure that causes loss of capability to provide service. • Any unforeseen conditions that cause BAWA to notify of abnormal conditions.	• Promote voluntary conservation efforts. • Inform customers that Stage 2 of the Drought Contingency Plan and advise them of ways to conserve water. • Recommended on a voluntary basis that commercial, industrial, and residential irrigation by use of sprinkler systems for lawns, gardens, landscaped areas, trees, shrubs or other plants be permitted only on odd- numbered days if the address is odd numbered or even numbered days if your address is even numbered during the hours of 8:00 p.m. to 10:00 a.m.
Stage 3 (Severe): Achieve a voluntary 15 percent reduction in daily water demand.	• Extended interruption in the flow of the Coastal Water Authority Canal. • Average treatment plant flow at BAWA in excess of 85% of the plant's capacity for five (5) consecutive days. • Continually falling storage tank levels that do not fully recover overnight. • Major line breaks that severely interrupt the supply of water. • Pump system failure that causes loss of capability. • Any unforeseen conditions that cause BAWA to notify of abnormal conditions.	• Inspect lines daily and repair leaks. • Flushing is prohibited except for dead end mains. • Monitor water usage of residential and commercial entities. • Commercial, industrial and residential irrigation permitted only on odd-numbered days or even numbered days depending on address during the hours of 8:00 p.m. to 10:00 a.m. Irrigation is permitted at any time by means of a hand-held hose, bucket, drip irrigation system, or watering can of five (5) gallons or less. Soaker hoses are prohibited during Stage 3, except when used to water the foundation of structures. • Washing of any motor vehicle is prohibited except on designated watering days between the hours of 8:00 p.m. and 10:00 a.m.

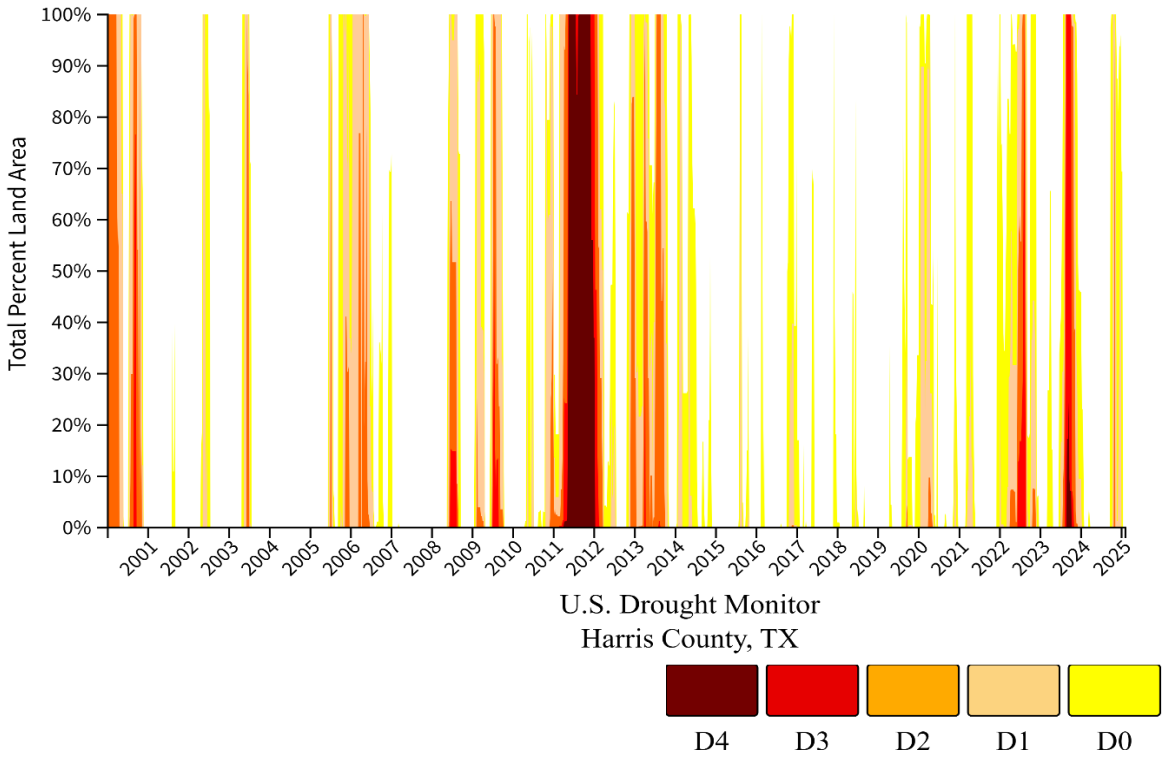
TARGET	TRIGGER	RESTRICTIONS
		Washing shall be done with a hand-held bucket or a hand-held hose. • Vehicle washing may be done at a commercial car wash or service station. Washing may be exempted from these regulations for the health, safety, and welfare of the public, such as washing garbage trucks and vehicles used to transport food and perishables. • Use of water for any type of swimming pools is prohibited except on designated watering days between the hours of 8:00 p.m. and 10:00 a. m. Operation of any ornamental fountain or pond is prohibited except where necessary. • Hydrants or flush valves shall be limited to usage for maintaining public health, safety, and community welfare. • The irrigation of golf courses, parks, and green belt areas is prohibited except for handheld hose and only on designated days between the hours 8:00 p.m. and 10: 00 a.m. • Other non-essential water uses prohibited (washing of hard surfaces areas, dust control, flushing gutters, failure to repair leak, and use of soaker hoses).
Stage 4 (Emergency): No specific target identified.	• Loss of capability to provide water service from BAWA for an extended period of time. • Water supply totally dependent on the customer's wells. • Contamination of the water supply.	• All outdoor use of water is prohibited. • Irrigation of landscaped areas is absolutely prohibited. • Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle is absolutely prohibited.

HISTORICAL OCCURRENCES

The City of Baytown planning area may experience an extreme drought in any given year. According to the U.S. Drought Monitor, between 2000 and 2024, the City of Baytown planning area spent 1,022 weeks (39%) in some level of drought defined as Abnormally

Dry (D0) or worse conditions. The longest drought during this period lasted 94 weeks (1.8 years).[3] Harris County has received 19 USDA disaster designations and Chambers County has received 11 USDA disaster designations for drought from 2012 through 2024.

Figure 6-3. City of Baytown Drought Intensity, 2000-2024[4]



Drought event data from the NCEI for both Chambers and Harris counties has been incorporated to ensure the most comprehensive dataset possible. This is because data is only reported at the county level and the City of Baytown spans both counties. While drought events occur on a regional scale, recorded impacts, such as property and crop damages, are reported at the county level and may include incidents within the City. This approach provides the most accurate representation of the area's drought impact. Table 6-5 lists historical events that have occurred in the planning area as reported in the

[3] Data from the U.S. Drought Monitor is provided for Harris County only to help maintain the accuracy of the statistical drought analysis.

[4] U.S. Drought Monitor

National Centers for Environmental Information Storm Events Database (NCEI). Table 6-6 below presents a breakdown by jurisdiction.

A total of 36 drought impacts were reported in the NCEI over 28 drought periods in Chambers County and Harris County, including the City of Baytown, from 1996 through 2024. Historical drought events reported in the NCEI database for the two counties, including the City of Baytown, over the 29-year reporting period resulted in a total of $31,332,400 (2024 dollars) in property and crop damages.

Historical drought information shows drought activity across a multi-county forecast area for each event. The appropriate percentage of the total property and crop damage reported for the entire forecast area has been allocated to each county impacted by the event. Historical drought data is provided on a county-wide basis per the NCEI Storm Events database. Historical drought data for the City of Baytown is provided on a county-wide basis.

Table 6-5. Historical Drought Events, 1996–2024[5]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Chambers County	8/1/1998	0	0	$1,887,500	$13,778,700
Harris County	8/1/1998	0	0	$1,887,500	$13,778,700
Total Losses		**0**	**0**	**$3,755,000**	**$27,557,400**

Table 6-6. Historical Drought Events Summary, 1996–2024

JURISDICTION	DROUGHT IMPACTS	INJURIES	DEATHS	PROPERTY DAMAGE	CROP DAMAGE
Chambers County	17	0	0	$1,887,500	$13,778,700
Harris County	19	0	0	$1,887,500	$13,778,700
Total Losses		**0**	**0**	**$31,332,400**	

Based on the historical drought events for the City of Baytown planning area, 18 drought events were reported to the NCEI since the 2020 Plan.

[5] NOAA, NCEI Storm Events Database

SECTION 6: DROUGHT

SIGNIFICANT EVENTS

August 1, 1998

Months of extreme heat and dry conditions affected southeast Texas. During this period, over 20 people across the region lost their lives due to extreme heat. Relief arrived late in August with much needed rainfall and slightly cooler temperatures. However, between May and August 1998, significant property and crop damages were reported across the region. The total estimated losses for Chambers and Harris Counties, including the City of Baytown, amounted to $31,332,400 (2024 dollars).

October 2010 - July 2012

According to the U.S. Drought Monitor, Harris County, which includes a majority of the City of Baytown, experienced its longest period of drought between October of 2010 and July of 2012. During this time, the planning area experienced all levels of drought between D0 (abnormally dry) and D4 (exceptional drought).

The summer of 2011 is on the record books as being one of the hottest and driest summers in history for the southern plains. Although records of this event are not provided in the NCEI, numerous all-time high temperature records were broken during this time. The prolonged heat and drought had drastic effects on the region's agriculture and farming communities, as well as causing numerous wildfires, and heat related illnesses and deaths.

PROBABILITY OF FUTURE EVENTS

Based on available records of historic events, there have been 36 reported drought impacts in the NCEI over 28 unique drought periods within a 29-year reporting period, which provides a probability of approximately one event every year. This frequency supports a “Highly Likely” probability of future events for the City of Baytown planning area.

CLIMATE CHANGE CONSIDERATIONS

With the range of factors influencing drought conditions, it is impossible to make quantitative statewide projections of drought trends; however, many factors point toward increased drought severity. Drought conditions will primarily depend on precipitation variability over multiple decades, with long-term precipitation changes expected to be minimal. Other factors affecting drought impacts, such as increased temperatures and

improved plant water use efficiency, can affect water availability. These impacts could cause drought impact trends to be highly sector-specific, with the impacts possibly smaller for agriculture than for surface water supply.[6]

It is projected that future changes to City of Baytown will include increased temperatures, which according to the U.S. Climate Explorer, the planning area may experience a 5°F increase in average extreme heat temperatures. Historically, high temperatures averaged 96°F in the City of Baytown, but between 2035 and 2064 the average will be 101°F, increasing the severity and frequency of drought events. Some projections show an even higher increase; however, the severity will be dependent on overall future emissions and is subject to change.

VULNERABILITY AND IMPACT

Loss estimates were based on 29 years of statistical data from the NCEI and the U.S. Drought Monitor. A drought event frequency-impact was then developed to determine an impact profile on agriculture products and estimate potential losses due to drought in the area. All existing and future buildings, facilities, and populations are exposed to this hazard and could be impacted. However, drought impacts are mostly experienced in water shortages or crop and livestock losses on agricultural lands and typically have minimal impact on buildings.

The City of Baytown Planning Team identified the following critical facilities as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by drought events. For a comprehensive list, please see Appendix F.

Table 6-7. Critical Facilities Vulnerable to Drought Events

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS, Hospitals)	• Increased law enforcement activities may be required to enforce water restrictions. • Firefighters may have limited water resources to aid in firefighting and suppression activities, increasing risk to lives and property.

[6] Cleaveland, M. K., T. H. Votteler, D. K. Stahle, R. C. Casteel, and J. L. Banner, 2011: Extended Chronology of Drought in South Central, Southeastern and West Texas. Texas Water Journal, 2, 54-96, as cited in as cited in Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 update.

CRITICAL FACILITIES	POTENTIAL IMPACTS
	• Potential for increased number of emergency calls as drought events can lead to cascading hazard events such as wildfires and flash flooding.
Airport, Academic Institutions, Community Residential Facilities, Day Care Facilities, Evacuation Centers & Shelters, Governmental Facilities	• Strain on staff as drought may cause health problems related to low water flows and poor water quality. • Operations dependent on water supply may be adversely impacted.
Commercial Suppliers (food, gas, etc.)	• Operations dependent on water supply may be adversely impacted. • There may be reduced food availability due to widespread agricultural losses.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Potential for increased number of emergency calls as drought events can lead to cascading hazard events such as wildfires. • Operations dependent on water supply may be adversely impacted.

Historic loss estimates due to drought are presented in Table 6-8 below. Since the City of Baytown spans both Chambers and Harris Counties, an assessment of all relevant data was included in the frequency calculation. The average annualized loss (Table 6-8) is provided separately for each county; however, it is important to note that a portion of the damages reported at the county level are likely associated with the City of Baytown.

Table 6-8. Average Annualized Losses by County, 1996-2024

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
Chambers County	$15,666,200	$540,200
Harris County	$15,666,200	$540,200
TOTALS	$31,332,400	$1,080,400

Even with the planning area relying on multiple water utility providers, high demand can still deplete these resources during extreme drought conditions. According to the Harris-Galveston Subsidence District 2023 Annual Groundwater Report, agricultural irrigation saw a 49% increase in groundwater withdrawal over the previous year that was attributed primarily to extreme drought conditions for the regulatory area that includes Baytown.

As resources are depleted, potable water is in short supply and overall water quality can suffer, elevating health concerns for all residents but especially vulnerable populations – typically children, the elderly, and the ill. In addition, potable water is used for drinking, sanitation, patient care, sterilization, equipment, heating and cooling systems, and many other essential functions in medical facilities.

The average person will survive only a few days without potable water, and this timeframe can be drastically shortened for those people with more fragile health – typically children, the elderly, and people with disabilities. During summer drought, or hot and dry conditions, elderly persons, small children, infants, those with disabilities, or who do not have adequate cooling units in their homes may become more vulnerable to injury and/or death. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures.

The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level and 16 percent of the population speaks English 'less than very well' (Table 6-9).

Table 6-9. Populations at Greater Risk

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

The planning area is also vulnerable to food shortages when drought conditions exist, and potable water is in short supply. All residents in the City of Baytown planning area could be adversely affected by drought conditions, which could limit water supplies and present health threats.

SECTION 6: DROUGHT

The economic impact of droughts can be significant as they produce a complex web of impacts that spans many sectors of the economy and reach well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services. If droughts extend over several years, the direct and indirect economic impact can be significant.

Crop production can also suffer greatly during extreme drought conditions, limiting fresh local food supplies, driving up costs, and negatively impacting the local economy. Drought conditions could adversely affect the agricultural industry throughout the City of Baytown planning area.

There are no reports of injuries or fatalities due to drought in the City of Baytown planning area. However, $31,332,400 (2024 dollars) of property and crop damages have been reported for Chambers and Harris Counties, indicating significant exposure for the planning area. It is assumed that a portion of the reported damages are likely associated with the City of Baytown, though the extent of those damages specific to the planning area are unknown. Impacts of past droughts experienced in the City of Baytown planning area support a "Limited" severity of impact meaning injuries and illnesses are treatable with first aid, the shutdown of critical facilities and services for 24 hours or less, and less than 10 percent of property destroyed or with major damage.

ASSESSMENT OF IMPACTS

The Drought Impact Reporter was developed in 2005 by the University of Nebraska-Lincoln to provide a national database of drought impacts. Droughts can have an impact on agriculture, business and industry; energy; fire; plants and wildlife; relief, response, and restrictions; society and public health; tourism and recreation; and water supply and quality. The reports are submitted by Federal, State, and local agencies, as well as the public. Table 6-10 lists the drought impacts to the City of Baytown from 2005 to 2024 based on reports received by the Drought Impact Reporter.

Table 6-10. Drought Impacts, 2005-2024[7]

DROUGHT IMPACTS 2005-2024	
Agriculture	360
Business & Industry	38

[7] Based on impacts recorded for Harris County only. Similar drought impacts are assumed for the planning area.

SECTION 6: DROUGHT

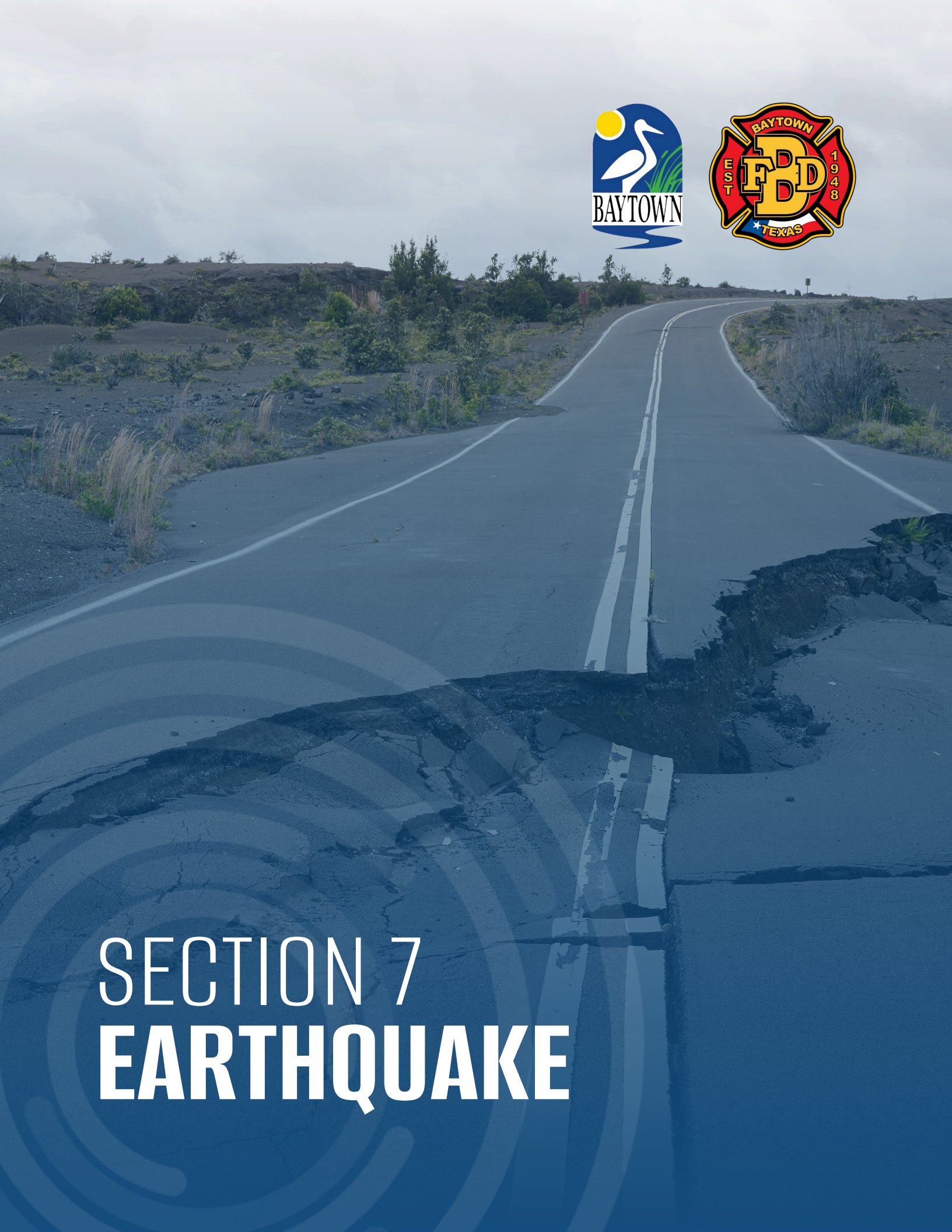
DROUGHT IMPACTS 2005-2024	
Energy	13
Fire	138
Plants & Wildlife	150
Relief, Response & Restrictions	138
Society & Public Health	114
Tourism & Recreation	13
Water Supply & Quality	69

Drought has the potential to impact people in the City of Baytown planning area. While it is rare that drought itself rarely poses a direct risk to the health and safety of people in the U.S., severe water shortages could result in inadequate supply for human needs. Based on historical population trends, the City of Baytown population is projected to increase. According to the Baytown Comprehensive Plan 2040, the City of Baytown's population could increase by 28.4 percent by 2040. Future growth may strain existing water infrastructure and increase demand. Severe drought conditions can be frequently associated with a variety of impacts, including:

- The number of health-related low-flow issues (e.g., diminished sewage flows, increased pollution concentrations, reduced firefighting capacity, and cross-connection contamination) will increase as the drought intensifies.
- Public safety from forest / range / wildfires will increase as water availability and/or pressure decreases.
- Respiratory ailments may increase as the air quality decreases.
- There may be an increase in disease due to wildlife concentrations (e.g., rabies, Rocky Mountain spotted fever, Lyme disease).
- Residents may disagree with the City over water use / water rights, creating conflict.
- Political conflicts may increase between municipalities, counties, states, and regions.
- Water management conflicts may arise between competing interests.
- Increased law enforcement activities may be required to enforce water restrictions.
- Severe water shortages could result in inadequate supply for human needs as well as lower quality of water for consumption.

- Firefighters may have limited water resources to aid in firefighting and suppression activities, increasing risk to lives and property.
- During drought there is an increased risk for wildfires and dust storms.
- The community may need increased operational costs to enforce water restriction or rationing.
- Prolonged drought can lead to increases in illness and disease related to drought.
- Utility providers can see decreases in revenue as water supplies diminish.
- Utilities providers may cut back energy generation and service to their customers to prioritize critical service needs.
- Hydroelectric power generation facilities and infrastructure would have significantly diminished generation capability. Dams simply cannot produce as much electricity from low water levels as they can from high water levels.
- Fish and wildlife food and habitat will be reduced or degraded over time during a drought and disease will increase, especially for aquatic life.
- Wildlife will move to more sustainable locations creating higher concentrations of wildlife in smaller areas, increasing vulnerability, and further depleting limited natural resources.
- There are 8 federally endangered, threatened or candidate species in Harris County, and 12 federally endangered, threatened or candidate species in Chambers County. Severe and prolonged drought can result in the reduction of a species or cause the extinction of a species altogether.
- Plant life will suffer from long-term drought. Wind and erosion will also pose a threat to plant life as soil quality will decline. The urban tree canopy, including city parks, are vulnerable to the impacts of prolonged drought.
- Dry and dead vegetation will increase the risk of wildfire.
- Drought poses a significant risk to annual and perennial crop production and overall crop quality leading to higher food costs.
- Drought-related declines in production may lead to an increase in unemployment.
- Drought may limit livestock grazing resulting in decreased livestock weight, potential increased livestock mortality, and increased cost for feed.
- Negatively impacted water suppliers may face increased costs resulting from the transport water or developing supplemental water resources.
- Long term drought may negatively impact future economic development.

The economic and financial impacts caused by periods of drought is dependent on its extent and duration. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a drought event.



SECTION 7
EARTHQUAKE

SECTION 7: EARTHQUAKE

Hazard Description 1
Location 2
Extent 4
Historical Occurrences 7
Probability of Future Events 8
Climate Change Considerations 8
Vulnerability and Impact 9

HAZARD DESCRIPTION

An earthquake is the sudden movement of the Earth's surface caused by the release of stress accumulated within or along the edge of the Earth's tectonic plates, volcanic eruption, or by a manmade explosion. The majority of earthquakes occur along faults; however, earthquakes can occur within plate interiors. Over geologic time, plates move and plate boundaries change, pushing weakened boundary regions to the interior part of the plates. These areas of weakness within the continents can cause earthquakes in response to stresses that originate at the edges of the plate or in the deeper crust.

Earthquake locations are described by the focal depth and geographic position of the epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter is the point on the Earth's surface directly above the hypocenter. Earthquakes usually occur without warning, with their effects impacting great distances away from the epicenter.

According to the U.S. Geological Society (USGS) Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may influence an individual's normal activities. Table 7-1 describes definition of examples.

Table 7-1. Definitions of Earthquake Hazards[1]

HAZARD	DESCRIPTION
Surface Faulting	Displacement that reaches the earth's surface during slip along a fault. Commonly occurs with shallow earthquakes, those with an epicenter less than 20 kilometers.

[1] Source: USGS, 2012

SECTION 7: EARTHQUAKE

HAZARD	DESCRIPTION
Ground Motion (shaking)	The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.
Landslide	A movement of surface material down a slope.
Liquefaction	A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking.
Tectonic Deformation	A change in the original shape of a material due to stress and strain.
Tsunami	A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or exploding volcanic islands.
Seiche	The sloshing of a closed body of water from earthquake shaking.

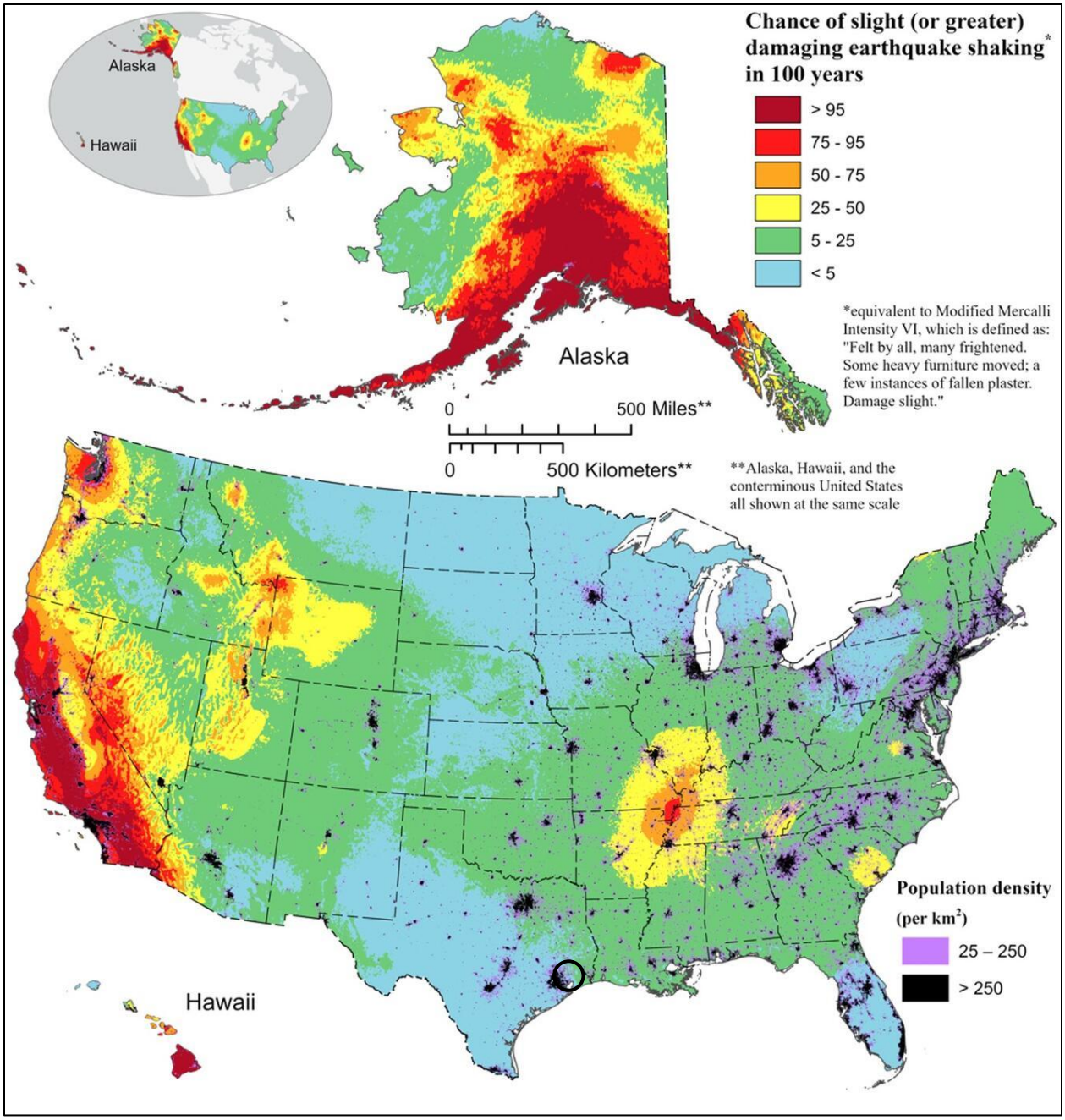
LOCATION

Earthquake hazard areas are mapped by the USGS's National Seismic Hazard Model (NSHM). Figure 7-1 shows the most recent 2023 iteration of this USGS model. The NSHM defines the potential for earthquake ground shaking for various probability levels across the United States. The 2023 NSHM is an update to the previous 2018 version, and compiles data and findings from a number of sources including earthquake catalogs, geodetic- and geologic-based fault and deformation models, and ground motion models (GMMs), among others.[2] The map shows the percent chance that a given area will experience a category VI (or stronger) earthquake in 100 years, as defined by the Modified Mercalli Intensity (MMI) Scale (Table 7-3). The likelihood of a significant earthquake event is signified by the color-coding on the map. Densely populated areas

[2] A comprehensive overview of the modelling process can be found at the USGS website, https://www.usgs.gov/programs/earthquake-hazards/science/2023-50-state-long-term-national-seismic-hazard-model-0#overview

are also highlighted on the map (purple and black dotting) to indicate areas of elevated vulnerability in relation to higher seismic risk. The City of Baytown planning area, as identified in Figure 7-1, is located in a low hazard area, with less than five percent chance of experiencing a strong earthquake every 100 years.

Figure 7-1. U.S. Map of Peak Ground Acceleration[3]

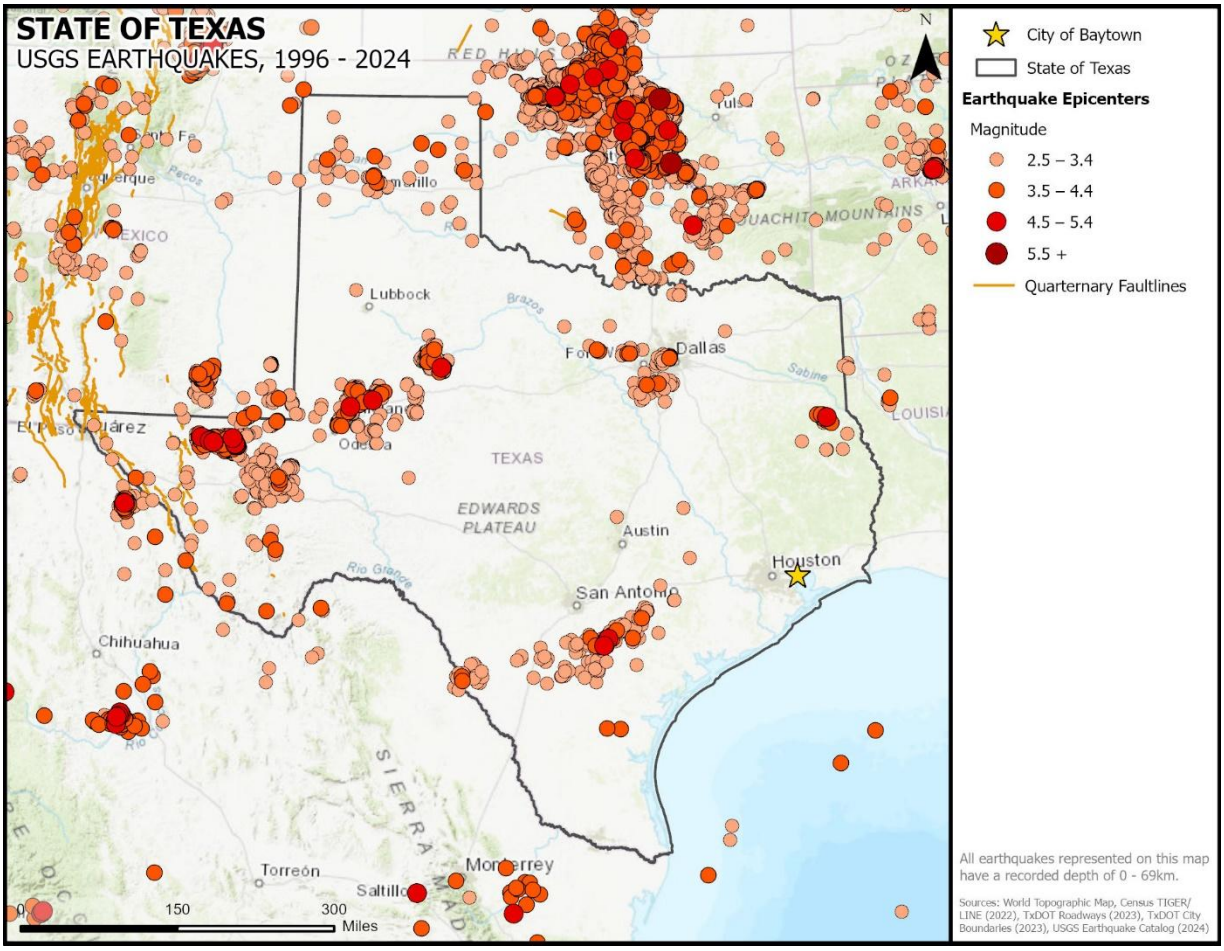


[3] City of Baytown is indicated by the black circle.

SECTION 7: EARTHQUAKE

Figure 7-2 maps historic earthquake epicenters across Texas between 1996 and 2024.

Figure 7-2. Historic Earthquake Epicenters in Texas, 1996-2024



EXTENT

Earthquakes are measured in terms of magnitude and intensity. The prevalent magnitude measurement in use today is based on the Moment Magnitude Scale (MMS). MMS measures the movement of rock along the fault. It accurately measures larger earthquakes, which can last for minutes, affect a much larger area, and cause more damage. Magnitudes are based on a logarithmic scale (base 10), meaning that for each whole number you go up on the magnitude scale, the amplitude of the ground motion recorded by a seismograph goes up ten times. Using this scale, a magnitude 5 earthquake would result in ten times the level of ground shaking as a magnitude 4

earthquake (and about 32 times as much energy would be released).[4] The USGS reports earthquake magnitudes above 4.0 as "moment magnitude," often described in the press as "Richter" magnitude. Table 7-2 shows the magnitude levels for the current Richter/Moment Magnitude scale.

Table 7-2. Richter / Moment Magnitude Scale[5]

MAGNITUDE	CATEGORY	DESCRIPTION OF EFFECTS	EVENTS PER YEAR
< 3.0	Micro	Usually not felt, but can be recorded by seismograph	+100,000
3.0 – 3.9	Minor	Often felt, but causes no damage	12,000 - 100,000
4.0 – 4.9	Light	Felt by all, minor breakage of objects	2,000 - 12,000
5.0 – 5.9	Moderate	Some damage to weak structures	200 – 2,000
6.0 – 6.9	Strong	Moderate damage in populated areas	20 – 200
7.0 – 7.9	Major	Serious damage over large areas with loss of life expected	3 – 20
> 7.9	Great	Severe destruction and loss of life over large areas	Less than 3

Earthquake intensity measurement is an on-the-ground description. The measurement qualitatively explains the severity of earthquake shaking and its effects on people and their environment. Intensity measurements will differ depending on each location's proximity to the epicenter or point on the surface of the earth directly above the focus where the earthquake started. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and total destruction. There can be multiple intensity measurements associated with an earthquake as opposed to one magnitude measurement.[6] The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to

[4] (n.d.). How Do We Measure Earthquake Magnitude? Michigan Tech. https://www.mtu.edu/geo/community/seismology/learn/earthquake-measure/#:~:text=The%20moment%20magnitude%20scale%20is,the%20earthquake%20at%20multiple%20stations.

[5] (n.d.). Earthquakes. Britannica. https://www.britannica.com/science/earthquake-geology

[6] Wood, H. O., and Neumann, Frank (1931). Modified Mercalli Intensity Scale of 1931: Seismological Society of America Bulletin, v. 21, no. 4, p. 277-283.

the effects actually experienced at a specific location. The scale provides the intensity of the earthquake in values ranging from I to X. Table 7-3 describes the typical effects and intensities associated with earthquakes of various magnitudes. The intensity and effects depend on multiple factors (earthquake depth, epicenter location, site geology, population density, to name a few) and can vary widely.

Table 7-3. Magnitude and Modified Mercalli Intensity (MMI) Scale[7]

INTENSITY	CATEGORY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER MAGNITUDE
I	Not Felt	Not felt except by a very few under especially favorable conditions	< 2.0
I	Not Felt	Felt only by a few persons at rest, especially on upper floors of buildings.	2.0 – 2.9
II – III	Weak	Felt quite noticeably by persons indoors, with shaking of indoor objects. Rarely causes damages.	3.0 – 3.9
IV – V	Light to Moderate	Noticeable shaking of indoor objects and rattling noises. Felt by most people in the affected area. Generally, no to minimal damage	4.0 – 4.9
VI – VII	Strong to Very Strong	Significant damages to poorly constructed buildings. Limited to moderate damages to well-built structures.	5.0 – 5.9
VIII – IX	Severe to Violent	Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures.	6.0 – 6.9
VIII +	Severe to Extreme	Damage considerable in specially designed structures. Damage substantial to most buildings, with partial or complete collapse. Felt across great distances with major	7.0 – 7.9

[7] Source: USGS

INTENSITY	CATEGORY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER MAGNITUDE
		damage mostly limited to 250 km from Epicenter.	
VIII – IX	Severe to Violent	Major damage to buildings, structures likely to be destroyed; will cause moderate to heavy damage to sturdy or earthquake-resistant buildings; damaging in large areas; felt in extremely large regions.	8.0 – 8.9
VIII +	Severe to Extreme	At or near total destruction. Severe damage or collapse to all buildings; heavy damage and shaking extends to distant locations and permanent changes in ground topography.	9.0+

Taking into consideration the possible extent of an earthquake for the area, by reviewing Tables 7-2 and 7-3 in conjunction with no significant previous occurrences, as depicted in Figure 7-2, the City of Baytown planning area experiences on average less than 3.0 magnitude or Levels II-III (weak impact) on the Modified Mercalli Intensity scale. This is the greatest extent the entire planning area can anticipate in the future, based on historic records.

HISTORICAL OCCURRENCES

According to USGS, and the National Geophysical Data Center (NGDC), there are no "significant" earthquakes on record for the State of Texas and the entire City of Baytown planning area from 2150 B.C. to present. A significant earthquake, as defined by NGDC, is one that has caused at least moderate damage (approximately $1 million or more), has resulted in 10 or more deaths, has registered as a magnitude 7.5 or greater, has registered as Modified Mercalli Intensity (MMI) Scale X or greater, or generated a tsunami. None of these criteria have been met by any seismic activity known to have impacted the planning area.

However, events which resulted in some level of damage have occurred in Texas, such as the August 16, 1931, earthquake in the Town of Valentine, Texas which registered as a 5.8 magnitude earthquake on the MMI scale. This earthquake was felt across most of

Texas; however, its epicenter was more than 800 miles from the planning area and did not result in any known impacts in the City of Baytown beyond mild-intensity shaking.

The USGS has a database that tracks all earthquakes with a magnitude 2.5 or greater across the United States. According to the database between 1996 and 2024, there were no earthquakes reported within the planning area or within a 50-mile radius of the planning area. One earthquake did occur within a 100-mile radius of the planning area during that time, a 2.8 magnitude earthquake which occurred on April 2, 2024. This earthquake is considered a Level I on the MMI Scale, an earthquake that is typically not felt or damaging. While it is possible for the planning area to feel stronger earthquakes that occur inside City boundaries, or within the 100-mile area around the planning area, at this time, there are no known damages associated with these events for the City of Baytown planning area.

PROBABILITY OF FUTURE EVENTS

Earthquake Hazard Maps show the distribution of earthquake shaking levels that have a certain probability of occurring over a given period. According to the USGS, the entire City of Baytown planning area has a less than five percent chance of a slightly damaging (or greater) earthquake within 100 years. Based on historical records, the probability of an earthquake affecting the planning area is “Unlikely”, meaning that an event is probable in the next 10 years.

CLIMATE CHANGE CONSIDERATIONS

Damaging earthquakes are rare within the State of Texas, including the City of Baytown planning area. Changing conditions of weather patterns and climate change has not been established as having a direct impact on earthquake intensity or frequency.

According to the USGS, statistically there is an approximately equal distribution of earthquakes in all cold weather, hot weather, rainy weather, etc. Very large low-pressure changes associated with major storm systems, like typhoons and hurricanes, are known to trigger episodes of fault slip or slow earthquakes in the Earth’s crust and may also play a role in triggering some damaging earthquakes. However, the numbers are small and are not statistically significant.[8]

[8] (n.d.). *Natural Hazards*. United Stated Geological Survey. https://www.usgs.gov/faqs/there-earthquake-weather

SECTION 7: EARTHQUAKE

The City of Baytown planning area is located outside of any known earthquake hazard areas and is not located on or near any active fault lines. Climate change is assumed to have no impact on the probability or intensity of potential earthquakes in the planning area.

VULNERABILITY AND IMPACT

Little warning is usually associated with earthquakes and can impact areas a great distance away from the epicenter. The amount of damage depends on the density of population and buildings, and infrastructure construction in the affected area. Some places may be more vulnerable than others based on soil type, building age, and building codes in the City of Baytown planning area.

The City of Baytown Planning Team identified the following critical facilities as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by earthquake events. For a comprehensive list, please see Appendix F.

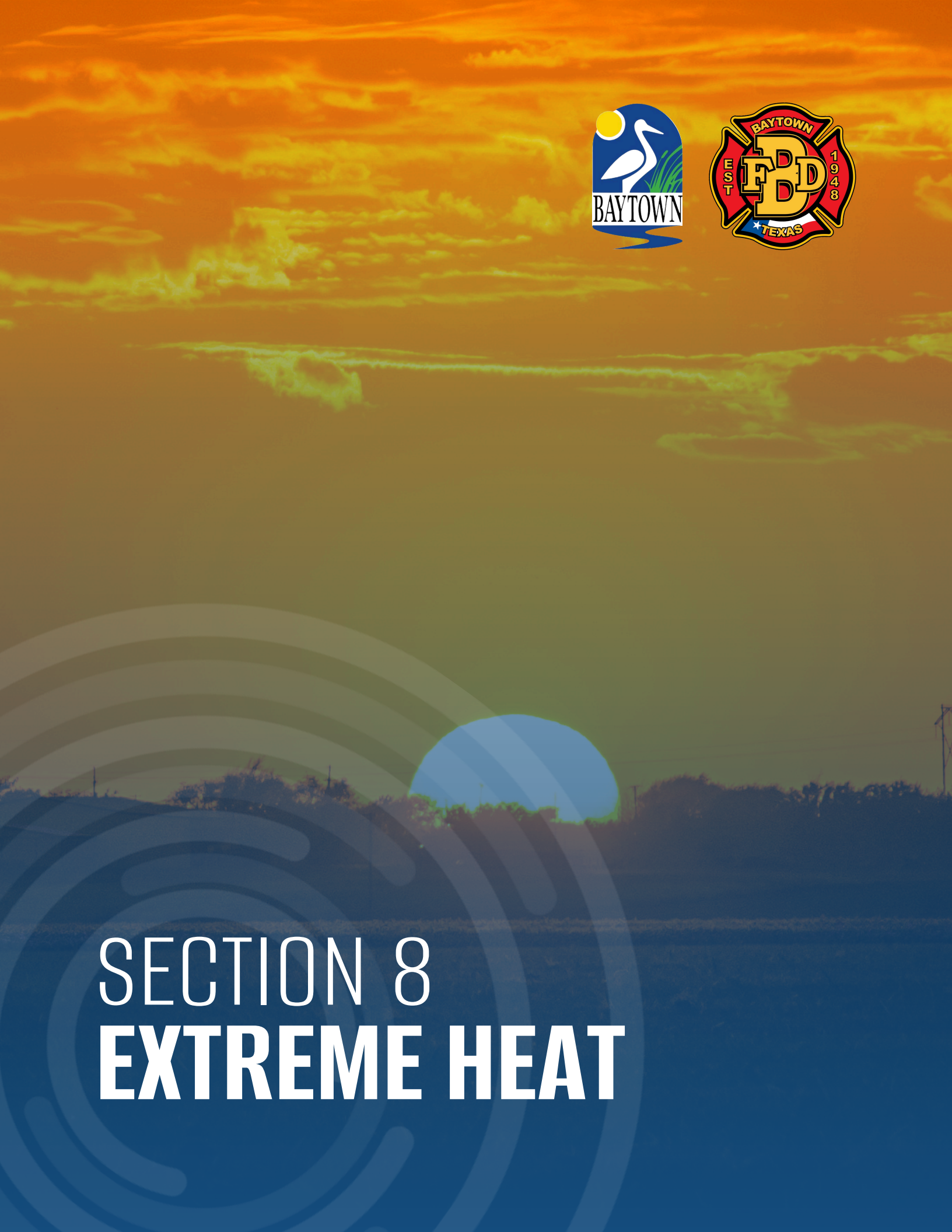
Table 7-4. Critical Facilities Vulnerable to an Earthquake

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to power outages, damaged facilities, fires and/or loss of communications. Impact can impede emergency response vehicle access to areas. • Power outages could disrupt communications, delaying emergency response times. • Extended power outages may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/ Assisted Living Facilities	• Power outages could disrupt critical care. • Backup power sources could be damaged. • Evacuations may be necessary due to extended power outages or other associated damages to facilities. • Economic disruption due to power outages negatively impact airport services as well as area businesses reliant on airport operations.

SECTION 7: EARTHQUAKE

CRITICAL FACILITIES	POTENTIAL IMPACTS
Commercial Supplier (food, fuel, etc.)	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and critical services may be significantly impacted due to power outages, damaged facilities, and/or loss of communications. Impact can impede emergency service vehicle access to areas. • Power outages could disrupt communications, delaying emergency response times further straining the capacity and resources of emergency service personnel.

With no significant historical events recorded, neither annualized loss-estimates or a breakdown of potential dollar losses of critical facilities and infrastructure from earthquakes are available. The potential severity of impact from an earthquake for the entire City of Baytown planning area is classified as “Limited”, meaning injuries and illnesses are treatable with first aid, less than 10 percent of property destroyed or with major damage, and critical facilities being shut down for 24 hours or less.



SECTION 8
EXTREME HEAT

SECTION 8: EXTREME HEAT

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HAZARD DESCRIPTION



Extreme heat is a prolonged period of excessively high temperatures and humidity. Extreme heat during the summer months is a common occurrence throughout the State of Texas, and the City of Baytown planning area is no exception. The City typically experiences extended heat waves and is often accompanied by high humidity.

Although heat can damage buildings and facilities, it presents a more significant threat to the safety and welfare of citizens. The major human risks associated with extreme heat include heat cramps; sunburn; dehydration; fatigue; heat exhaustion; and even heat stroke. The most vulnerable population to heat casualties are children and the elderly or infirmed who frequently live on low fixed incomes and cannot afford to run air-conditioning on a regular basis. This population is sometimes isolated, with no immediate family or friends to look out for their well-being.

Critical infrastructure can also be damaged or impacted by extreme heat. High temperatures may cause a rise in electricity consumption as homes, schools, and businesses try to regulate the temperature. This may lead to energy shortages and possible blackouts.

LOCATION

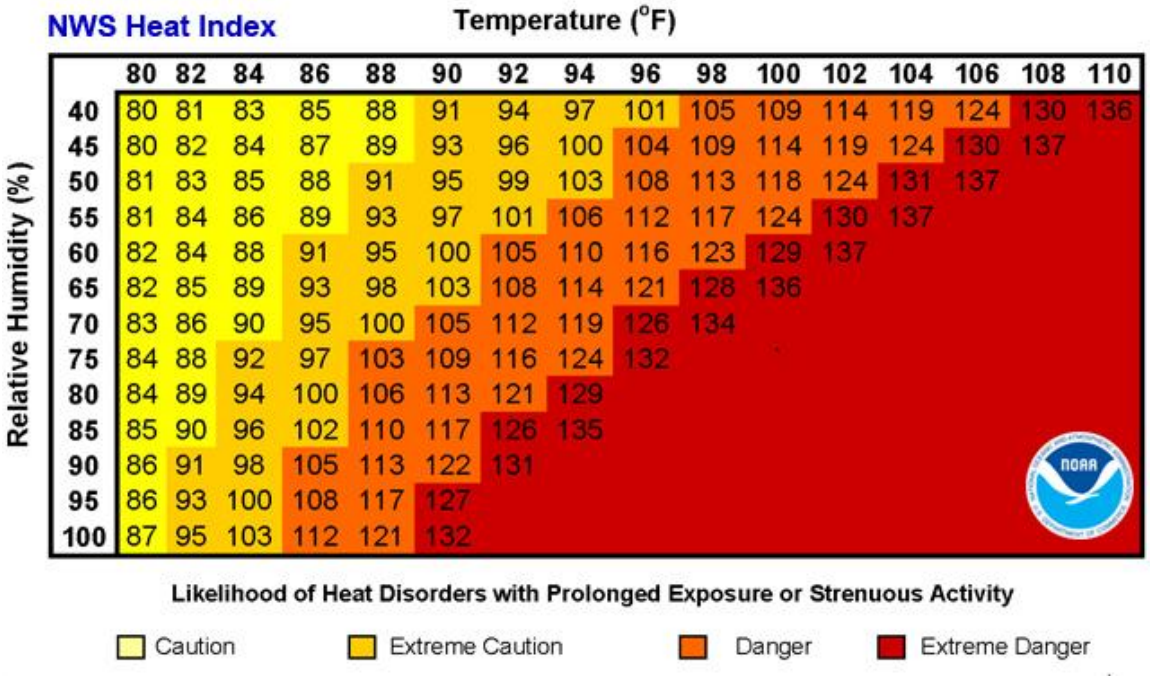
Extreme heat events can occur anywhere throughout the City of Baytown planning area, as there is no specific geographic scope to the extreme heat hazard.

SECTION 8: EXTREME HEAT

EXTENT

The magnitude or intensity of an extreme heat event is measured according to temperature in relation to the percentage of humidity. According to the National Oceanic Atmospheric Administration (NOAA), this relationship is referred to as the "Heat Index" and is depicted in Figure 8-1. This index measures how hot it feels outside when humidity is combined with high temperatures.

Figure 8-1. Extent Scale for Extreme Heat[1]



The index in Figure 8-1 displays varying categories of caution depending on the relative humidity combined with the temperature. For example, when the temperature is at 90 degrees Fahrenheit (°F) or lower, caution should be exercised if the humidity level is at or above 40 percent.

The shaded zones on the chart indicate varying symptoms or disorders that could occur depending on the magnitude or intensity of the event. "Caution" is the first category of intensity, and it indicates when fatigue due to heat exposure is possible. "Extreme Caution" indicates that sunstroke, muscle cramps, or heat exhaustion are possible, and a "Danger" level means that these symptoms are likely. "Extreme Danger" indicates that

[1] Source: NOAA

heat stroke is likely. The National Weather Service (NWS) initiates alerts based on the Heat Index as shown in Table 8-1.

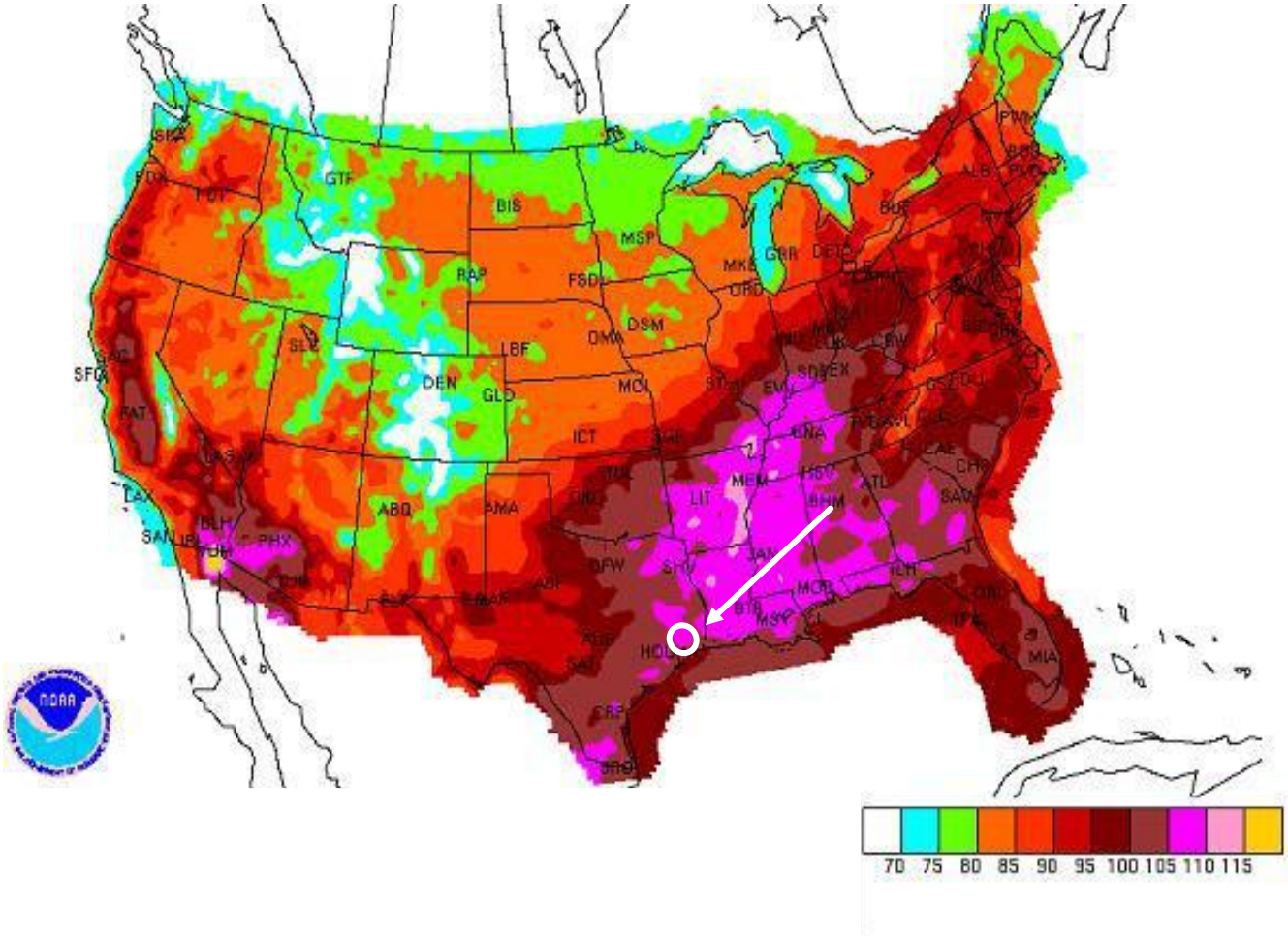
Table 8-1. Heat Index and Warnings

CATEGORY	HEAT INDEX	POSSIBLE HEAT DISORDERS	WARNING TYPE
Extreme Danger	125°F and higher	Heat stroke or sun stroke likely.	An Excessive Heat Warning is issued if the Heat Index rises above 105°F at least 3 hours during the day or above 80°F at night.
Danger	103 – 124°F	Sunstroke, muscle cramps, and/or heat exhaustion are likely. Heatstroke possible with prolonged exposure and/or physical activity.	An Excessive Heat Warning is issued if the Heat Index rises above 105°F at least 3 hours during the day or above 80°F at night.
Extreme Caution	90 – 103°F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.	A Heat Advisory will be issued to warn that the Heat Index may exceed 105°F.
Caution	80 – 90°F	Fatigue is possible with prolonged exposure and/or physical activity.	A Heat Advisory will be issued to warn that the Heat Index may exceed 105°F.

Due to its geography and its warm, sunny, and humid subtropical climate, the City of Baytown planning area can expect an extreme heat event each summer. Citizens, especially children and the elderly, should exercise caution by staying out of the heat for prolonged periods when a heat advisory or excessive heat warning is issued. In addition, those working or remaining outdoors for extended periods of time are at greater risk.

Figure 8-2 displays the daily maximum heat index as derived from NOAA based on data compiled from 1838 to 2015. The white circle shows the City of Baytown planning area. The planning area is represented in a pink color across the City. The pink color indicates an average daily heat index of 105°F to 110°F. Therefore, City of Baytown could experience dangerous heat from 105°F to 110°F and should mitigate to the extent of "Danger," which can include sunstroke, muscle cramps, heat exhaustion and potential heat stroke. This is the average maximum temperature the planning area can anticipate based on historical events.

Figure 8-2. Average Daily Maximum Heat Index Days[2]



HISTORICAL OCCURRENCES

The National Centers for Environmental Information (NCEI) Storm Events database is a national data source organized under the National Oceanic and Atmospheric Administration (NOAA). The NCEI is the largest archive available for historic storm events data. Previous occurrences for extreme heat are derived from the NCEI database, which identifies extreme heat events at the county level for each event.

[2] NRDC and the white circle indicates the City of Baytown planning area.

SECTION 8: EXTREME HEAT

Extreme heat event data for both Chambers and Harris Counties has been incorporated to ensure the most comprehensive dataset possible, as the City of Baytown spans both counties. Although extreme heat events occur regionally, recorded impacts, including injuries or fatalities, are reported at the county level and may reflect incidents within the City of Baytown. This approach provides an accurate representation of the area's extreme heat impact. Table 8-3 presents a breakdown by jurisdiction.

According to heat related incidents located within the two counties, which include the City of Baytown, there are 95 extreme heat events on record (Table 8-2). Historical extreme heat information, as provided by the NCEI, shows extreme heat activity across a multi-county forecast area for each event, the appropriate percentage of the total property and crop damage reported for the entire forecast area has been allocated to each county impacted by the event.

Historical data for the City of Baytown is provided on a county-wide basis per the NCEI database from January of 1996 through 2024. No damages were reported to the NCEI; however, extreme heat events have resulted in 137 fatalities across the two counties, including two fatalities in the City of Baytown.

Only reported extreme heat events have been factored into this Risk Assessment. It is highly likely additional extreme heat occurrences went unreported before and during the recording period. Due to the limited number of reported events, average high temperatures have been analyzed in order to determine the probability of future events.

Table 8-2. Historical Extreme Heat Events, 1996–2024[3]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/9/1998	1	0	$0	$0
Harris County	6/9/1998	1	0	$0	$0
Harris County	7/13/1998	1	0	$0	$0
Harris County	7/14/1998	1	0	$0	$0
Harris County	7/15/1998	1	0	$0	$0
Harris County	7/21/1998	1	0	$0	$0
Harris County	7/26/1998	1	0	$0	$0

[3] NOAA, NCEI Storm Events Database

SECTION 8: EXTREME HEAT

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	7/27/1998	1	0	$0	$0
Harris County	7/29/1998	1	0	$0	$0
Harris County	7/29/1998	1	0	$0	$0
Harris County	8/2/1998	1	0	$0	$0
Harris County	8/2/1998	1	0	$0	$0
Harris County	8/3/1998	1	0	$0	$0
Harris County	8/3/1998	1	0	$0	$0
Harris County	8/3/1998	1	0	$0	$0
Harris County	8/5/1998	1	0	$0	$0
Harris County	8/5/1998	1	0	$0	$0
Harris County	8/5/1998	1	0	$0	$0
Harris County	8/6/1998	1	0	$0	$0
Harris County	6/7/1999	1	0	$0	$0
Harris County	6/26/1999	3	0	$0	$0
Harris County	7/10/1999	1	0	$0	$0
Harris County	8/1/1999	6	0	$0	$0
Harris County	7/6/2000	17	0	$0	$0
Harris County	7/29/2000	1	0	$0	$0
Harris County	7/31/2000	1	0	$0	$0
Harris County	8/3/2000	1	0	$0	$0
Harris County	8/7/2000	2	0	$0	$0
Harris County	8/9/2000	1	0	$0	$0
Harris County	8/10/2000	1	0	$0	$0
Harris County	8/11/2000	2	0	$0	$0
Harris County	8/12/2000	1	0	$0	$0
Harris County	8/29/2000	3	0	$0	$0
Harris County	9/1/2000	5	0	$0	$0

SECTION 8: EXTREME HEAT

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	9/10/2000	1	0	$0	$0
Harris County	6/11/2001	1	0	$0	$0
Harris County	6/14/2001	1	0	$0	$0
Harris County	6/27/2001	1	0	$0	$0
Harris County	7/5/2001	1	0	$0	$0
Harris County	7/7/2001	1	0	$0	$0
Harris County	7/11/2001	1	0	$0	$0
Harris County	7/12/2001	1	0	$0	$0
Harris County	7/19/2001	1	0	$0	$0
Harris County	8/1/2001	1	0	$0	$0
Harris County	8/2/2001	1	0	$0	$0
Harris County	8/3/2001	1	0	$0	$0
Harris County	8/5/2001	1	0	$0	$0
Harris County	8/6/2001	1	0	$0	$0
Harris County	8/8/2001	1	0	$0	$0
Harris County	8/9/2001	1	0	$0	$0
Harris County	8/12/2001	1	0	$0	$0
Harris County	8/13/2001	1	0	$0	$0
Harris County	8/14/2001	1	0	$0	$0
Harris County	8/16/2001	1	0	$0	$0
Harris County	8/22/2001	1	0	$0	$0
Harris County	6/28/2004	1	0	$0	$0
Harris County	8/25/2004	1	0	$0	$0
Harris County	9/21/2005	34	0	$0	$0
Chambers County	9/22/2005	1	0	$0	$0
Harris County	8/4/2011	1	0	$0	$0
Harris County	7/13/2015	1	0	$0	$0

SECTION 8: EXTREME HEAT

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	8/21/2017	1	0	$0	$0
Harris County	6/4/2018	1	0	$0	$0
Harris County	7/19/2018	1	0	$0	$0
Harris County	6/12/2023	1	0	$0	$0
Harris County	6/16/2023	1	0	$0	$0
Harris County	6/16/2023	2	0	$0	$0
Harris County	6/22/2023	1	0	$0	$0
Harris County	6/24/2023	2	0	$0	$0
Harris County	7/14/2023	1	0	$0	$0
Harris County	8/8/2023	1	0	$0	$0
TOTALS		137	0	$0	$0

Table 8-3. Historical Extreme Heat Events Summary, 1996–2024

JURISDICTION	NUMBER OF EVENTS	DEATH	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Chambers County	12	1	0	$0	$0
Harris County	83	136	0	$0	$0

Based on the list of historical extreme heat events for both Chambers and Harris Counties, which includes the City of Baytown planning area, 17 events were reported to the NCEI since the 2020 Plan.

SIGNIFICANT EVENTS

September 21, 2005

Many residents of City of Baytown, Harris County, Chambers County and surrounding areas needed to evacuate due to Hurricane Rita. As reported for Harris County, all 34 deaths for this event were attributed to complications during the evacuation of Hurricane Rita. Many people were stuck in traffic during extreme heat temperatures, which caused cases of hyperthermia and dehydration.

June 16, 2023

An extended period of excessive heat affected the planning area, with the first stretch reaching warning criteria in mid-June, followed by additional heat waves. On most other days, heat levels were generally at advisory criteria. An Excessive Heat Warning was issued when the maximum heat index values reached 113°F. This prolonged period of extreme heat resulted in at least advisory-level conditions for an extended time. Tragically, two residents of a mobile home in the City of Baytown died from hyperthermia during this heat wave. Maximum daytime heat index values peaked at around 114°F.

PROBABILITY OF FUTURE EVENTS

According to historical records, Chambers County has experienced 12 extreme heat events and Harris County has experienced 83 extreme heat events in a 29-year reporting period. With extreme heat events reported on a county-wide basis, it is assumed that all events impacted the planning area. Historical records in combination with an analysis of maximum average temperatures provide a probability of at least one event every year. This frequency supports a "Highly Likely" probability of future events.

CLIMATE CHANGE CONSIDERATIONS

Climate change is expected to lead to an increase in average temperatures as well as an increase in frequency, duration, and intensity of extreme heat events. With no reductions in emissions worldwide, the state of Texas is projected to experience an additional 30 to 60 days per year above 100°F than what is experienced now.[4] In terms of reducing emissions, the Baytown Carbon Capture Project will be the first full-scale implementation of carbon capture and storage (CCS) technology at a natural gas combined-cycle power plant in the U.S.[5] This project will potentially mitigate carbon dioxide emissions and reduce climate change impacts, such as extreme heat.

In addition, it is projected that future changes to City of Baytown will include increased temperatures, which according to the U.S. Climate Explorer, the planning area may

[4] Nielsen-Gammon, John, Holman, Sara, Buley, Austin and Jorgensen, Savannah. Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, 2021 Update. Texas A&M University Office of the Texas State Climatologist. October 7, 2021. https://climatexas.tamu.edu/files/ClimateReport-1900to2036-2021Update

[5] U.S. Department of Energy, The Office of Clean Energy Demonstrations. Carbon Capture Demonstration Projects Program – Baytown Carbon Capture and Storage Project. https://www.energy.gov/sites/default/files/2024-07/Baytown_CCS_Factsheet_0.pdf.

experience a 5°F increase in the average extreme heat temperatures. Historically, extreme temperatures averaged 96°F in the City of Baytown, but between 2035 and 2064 the average will be 101°F, increasing the severity and frequency of extreme heat events. Some projections show an even higher increase; however, the severity will be dependent on overall future emissions and is subject to change.

VULNERABILITY AND IMPACT

While the entirety of the City of Baytown planning area is exposed to extreme temperatures, existing buildings, infrastructure, and critical facilities are unlikley to sustain significant damage from extreme heat events. Therefore, any estimated property losses associated with the extreme heat hazard are expected to be minimal across the area.

Every summer, the hazard of heat-related illness becomes a significant public health issue throughout much of the United States. Mortality rates increase during heat waves, and excessive heat is an important contributing factor to deaths from other causes, particularly among the elderly. Extreme temperatures present a significant threat to life and safety for the population of the City as a whole. Heat casualties, for example, are typically caused by a lack of adequate air conditioning or heat exhaustion. The most vulnerable population to heat casualties are the elderly or infirmed who frequently live on fixed incomes and cannot afford to run air conditioning on a regular basis. This population is sometimes isolated, with no immediate family or friends to look out for their well-being. Children may also be more vulnerable if left unattended in vehicles. Populations living below the poverty level are often unable to run air conditioning on a regular basis and are limited in their ability to seek medical treatment.

Vulnerable and underserved populations are disproportionately impacted by extreme heat events as they may be more susceptible to health risks. The population below the poverty level is less likely to be able to afford air conditioning during the hot summer months as well as less likely to have access to medical care. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures.

The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An

estimated 18 percent of the planning area population live below the poverty level and 16 percent of the population speaks English 'less than very well' (Table 8-4).

Table 8-4. Populations at Greater Risk

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

Extremely high temperatures can have significant secondary impacts, leading to droughts, water shortages, increased fire danger, and prompt excessive demands for energy. The possibility of rolling blackouts increases with unseasonably high temperatures in what is a normally mild month with low power demands. Typically, more than 12 hours of warning time would be given before the onset of an extreme heat event.

In terms of vulnerability to structures, the impact from extreme heat is considered negligible. It is possible that critical facilities and infrastructure could be shut down for 24 hours if cooling units are running constantly, leading to a temporary power outage (Table 8-5). Less than ten percent of residential and commercial property could be damaged if extreme heat events lead to structure fires. Based on historical records, annualized property and crop losses for the City of Baytown planning area are negligible. However, with the number of reported fatalities, the potential impact of excessive summer heat is considered "Substantial", with multiple deaths and injuries possible depending on the extent and duration of the event.[6]

The City of Baytown Planning Team identified the following critical facilities as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by extreme heat events. The following critical facilities would be vulnerable to extreme heat events in the City of Baytown planning area. For a comprehensive list, please see Appendix F.

[6] The vulnerability and impact assessment accounts for damages reported for the City of Baytown, Harris County, and Chambers County as events are often reported on a county wide level only. It is assumed some of the reported impacts for both counties include occurrences within the City

Table 8-5. Critical Facilities Vulnerable to Extreme Heat Events

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS, Hospitals)	• Emergency operations, services and response times may be significantly impacted due to power outages, and/or loss of communications. • Exposure to heat can cause heat illnesses in first responders, especially for those in heavy equipment. • Roads may become impassable due to excessive heat causing asphalt roads to soften and concrete roads to shift or buckle impacting response times by emergency services. • Extended power outages due to increased usage may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Community Residential Facilities, Day Care Facilities, Evacuation Centers & Shelters, Governmental Facilities	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Power outages due to increased usage could disrupt critical care. • Backup power sources could be damaged. • Evacuations may be necessary due to extended power outages, breaks in water main lines or other associated damage to facilities. • Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Economic disruption due to power outages negatively impact airport services as well as area businesses reliant on airport operations.
Commercial Suppliers (food, gas, etc.)	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations, services and response times may be significantly impacted due to power outages, and/or loss of communications. • Roads may become impassable due to excessive heat causing asphalt roads to soften and concrete roads to shift or buckle impacting response times by emergency services. • Breaks in water main lines or other associated damage to facilities.

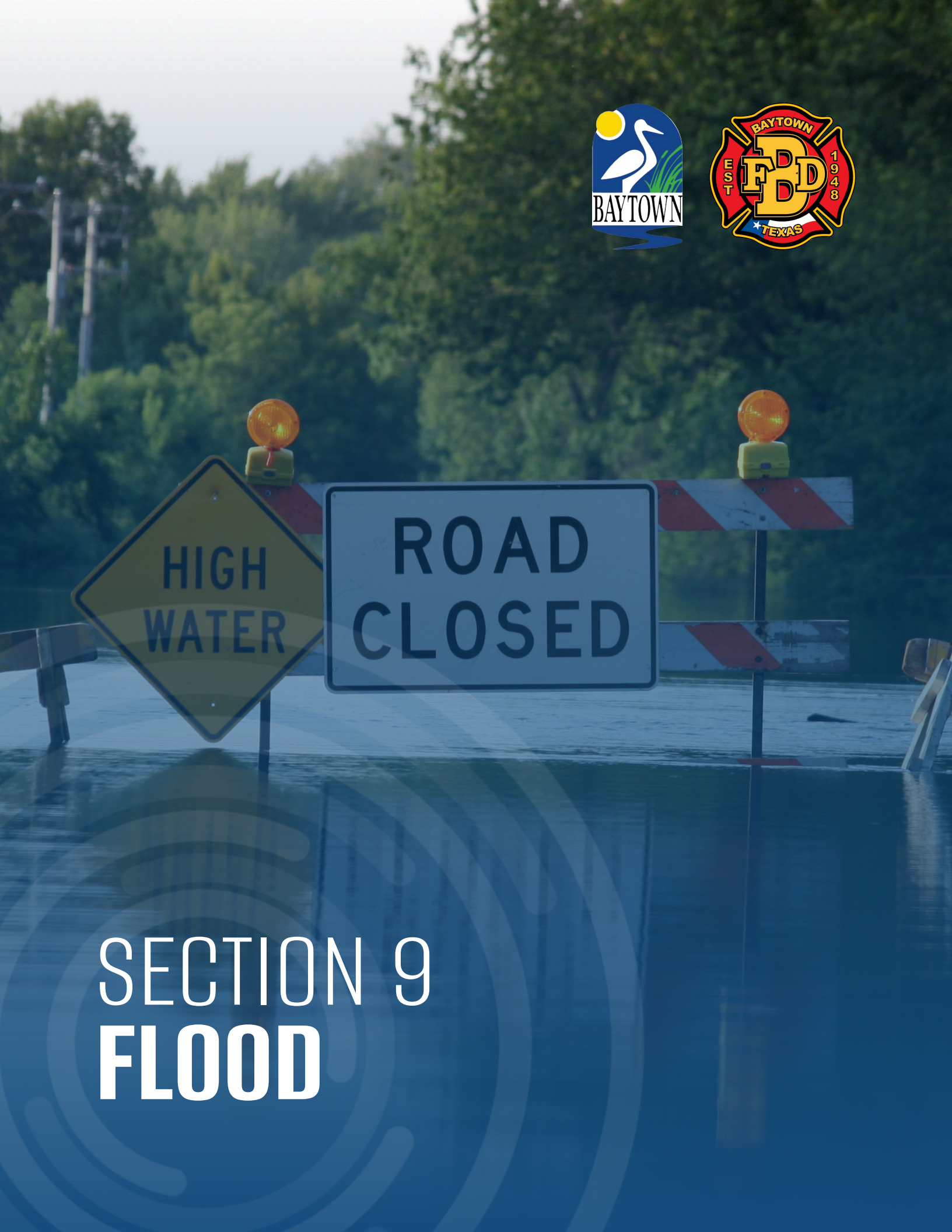
SECTION 8: EXTREME HEAT

ASSESSMENT OF IMPACTS

The greatest risk from extreme heat is to public health and safety. Extreme heat conditions can be frequently associated with a variety of impacts, including:

- Vulnerable populations, particularly the elderly (12 percent of total population), children under 5 (7 percent of total population), and those with a disability (13 percent of total population) can face serious or life-threatening health problems from exposure to extreme heat including hyperthermia, heat cramps, heat exhaustion, and heat stroke (or sunstroke).
- Response personnel, including utility workers, public works personnel, and any other professions where individuals are required to work outside, are at higher risk of extreme heat related illnesses since their exposure would typically be greater.
- High energy demand periods can outpace the supply of energy, potentially creating the need for rolling brownouts which would elevate the risk of illness among vulnerable residents.
- Highways and roads may be damaged by excessive heat causing asphalt roads to soften and concrete roads to shift or buckle.
- Vehicle engines and cooling systems typically run harder during extreme heat events resulting in increases in mechanical failures.
- Extreme heat events during times of drought can exacerbate the environmental impacts associated with drought, decreasing water and air quality and further degrading wildlife habitat.
- Extreme heat increases ground-level ozone (smog), causing a greater risk of respiratory illnesses.
- Negatively impacted water suppliers may face increased costs resulting from the transport of water resources or development of supplemental water resources.
- Tourism and recreational activities at places may be negatively impacted during extreme heat events, reducing seasonal revenue.
- Outdoor activities may see an increase in school injury or illness during extreme heat events.

The economic and financial impacts of extreme heat on the community will depend on the duration of the event, demand for energy, drought associated with extreme heat, and many other factors. The level of preparedness and the amount of planning done by the community, local businesses, and citizens will impact the overall economic and financial conditions before, during, and after an extreme heat event.



SECTION 9
FLOOD

SECTION 9: FLOOD

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HAZARD DESCRIPTION

Floods generally result from excessive precipitation. The severity of a flood event is determined by a combination of several major factors, including: stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surfaces. Typically, floods are long-term events that may last for several days.

The primary types of general flooding are inland and coastal flooding. Inland or riverine flooding is a result of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Inland or riverine flooding is overbank flooding of rivers and streams, typically resulting from large-scale weather systems that generate prolonged rainfall over a wide geographic area. Therefore, it is a naturally occurring and inevitable event. Some river floods occur seasonally when winter or spring rainfalls fill river basins with too much water, too quickly. Torrential rains from decaying hurricanes or tropical systems can also produce river flooding.

Coastal flooding occurs when normally dry, low-lying land is flooded by seawater. The extent of coastal flooding is a function of the elevation inland flood waters penetrate which is controlled by the topography of the coastal land exposed to flooding. Coastal

flooding is largely a natural event; however, human influence on the coastal environment can exacerbate coastal flooding. Extraction of water from groundwater reservoirs in the coastal zone can enhance subsidence of the land increasing the risk of flooding. Engineered protection structures along the coast such as sea walls alter the natural processes of the beach, often leading to erosion on adjacent stretches of the coast which also increases the risk of flooding.

Floods are a natural and recurrent event and take place every year, in all seasons. The City of Baytown planning area is subject to both inland and coastal flooding. The planning area experiences extreme rainfall events, often in short durations, leading to dangerous flash flooding events. In addition, coastal flooding can occur as a result of storm surges and high winds coinciding with high tides, often associated with tropical cyclones, which are covered in detail in Section 11.

LOCATION

The Flood Insurance Rate Maps (FIRMs) prepared by FEMA provide an overview of flood risk but can also be used to identify the areas of the City that are vulnerable to flooding. FIRMs are used to regulate new development and to control the substantial improvement and repair of substantially damaged buildings. Flood Insurance Studies (FIS) are often developed in conjunction with FIRMs. The FIS typically contains a narrative of the flood history of a community and discusses the engineering methods used to develop the FIRMs. The FIS also contains flood profiles for studying flooding sources and can be used to determine Base Flood Elevations (BFEs) for some areas.

The City of Baytown is included in both Harris County and Chambers County FIS. The FIS for Harris County is dated November 15, 2019. The FIS is composed of 12 volumes that compile all previous flood information including data collected on numerous waterways. This study indicates that the principal flood problems are from intense local thunderstorms of short duration, general storms extending over periods of several days, and torrential rainfall associated with tropical events. The area's flat topography and poorly draining soils also contribute to the frequent occurrence of flooding. The study notes that flooding also results from tidal surge along Galveston Bay caused by hurricanes and tropical storms.

The FIS for Chambers County is dated January 19, 2018. This study is composed of 3 volumes that compile all previous flood information including data collected on

numerous waterways. This study indicates that most floods are coastal and caused by severe hurricanes and tropical storms that bring strong storm surges.

The current effective Harris County Digital Flood Insurance Rate Map or DFIRM (map ID 48201C, panels 745, 755, 760, 765, 770, 935, 955, 960, and 970, dated January 6, 2017) and the current effective Chambers County DFIRM (map number 48071C panels 160, 170, 180, 190, 335, 345, 355, 365, 745, 755, 760, 765, 770, 935, 955, 960, 970) data provided by FEMA for the City of Baytown shows the following flood hazard areas:

- Zone A: Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance requirements and floodplain management standards apply.
- Zone AE: Areas subject to inundation by 1-percent-annual-chance shallow flooding. It is the base floodplain where BFEs are provided. AE zones are now used on new format FIRMs instead of A1-30 zones.
- Zone AO: Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone.
- Zone X: Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones.
- Zone VE: Coastal areas with a 1-percent-annual-chance of flooding and an additional hazard associated with storm waves. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. BFEs are provided.

Locations of flood zones in the City of Baytown based on the Digital Flood Insurance Rate Map (DFIRM) from FEMA are illustrated in Figure 9-1.

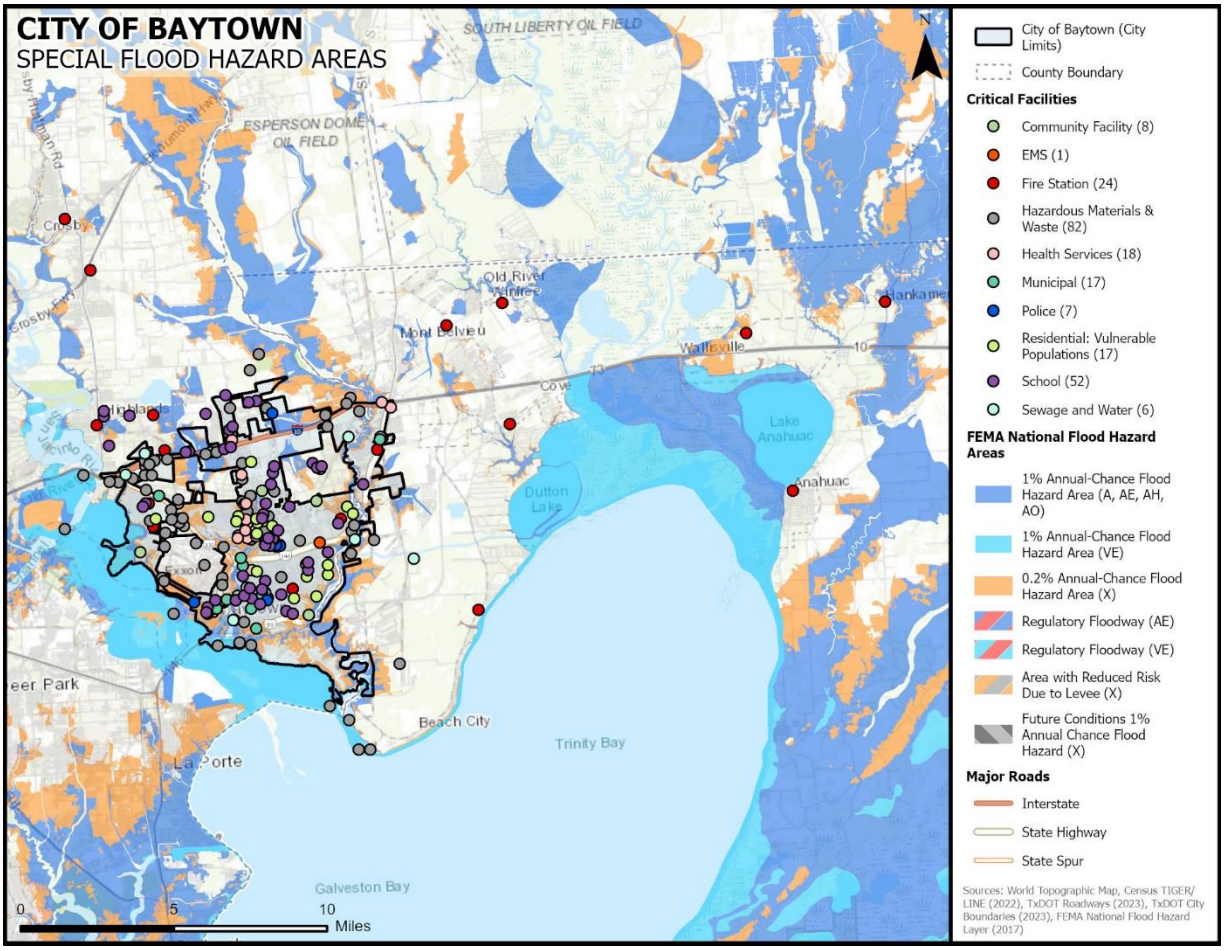
A specific location of concern is the Cedar Bayou, which is a tributary to the Galveston Bay system that runs through Chambers, Liberty, and Harris Counties. The main stem of the Cedar Bayou is approximately 40 stream miles in length and directly impacts the City of Baytown. Within the bayou, the Whispering Pines and Pinehurst neighborhoods of

SECTION 9: FLOOD

Baytown have been identified as vulnerable to flooding and have suffered repetitive losses.[1]

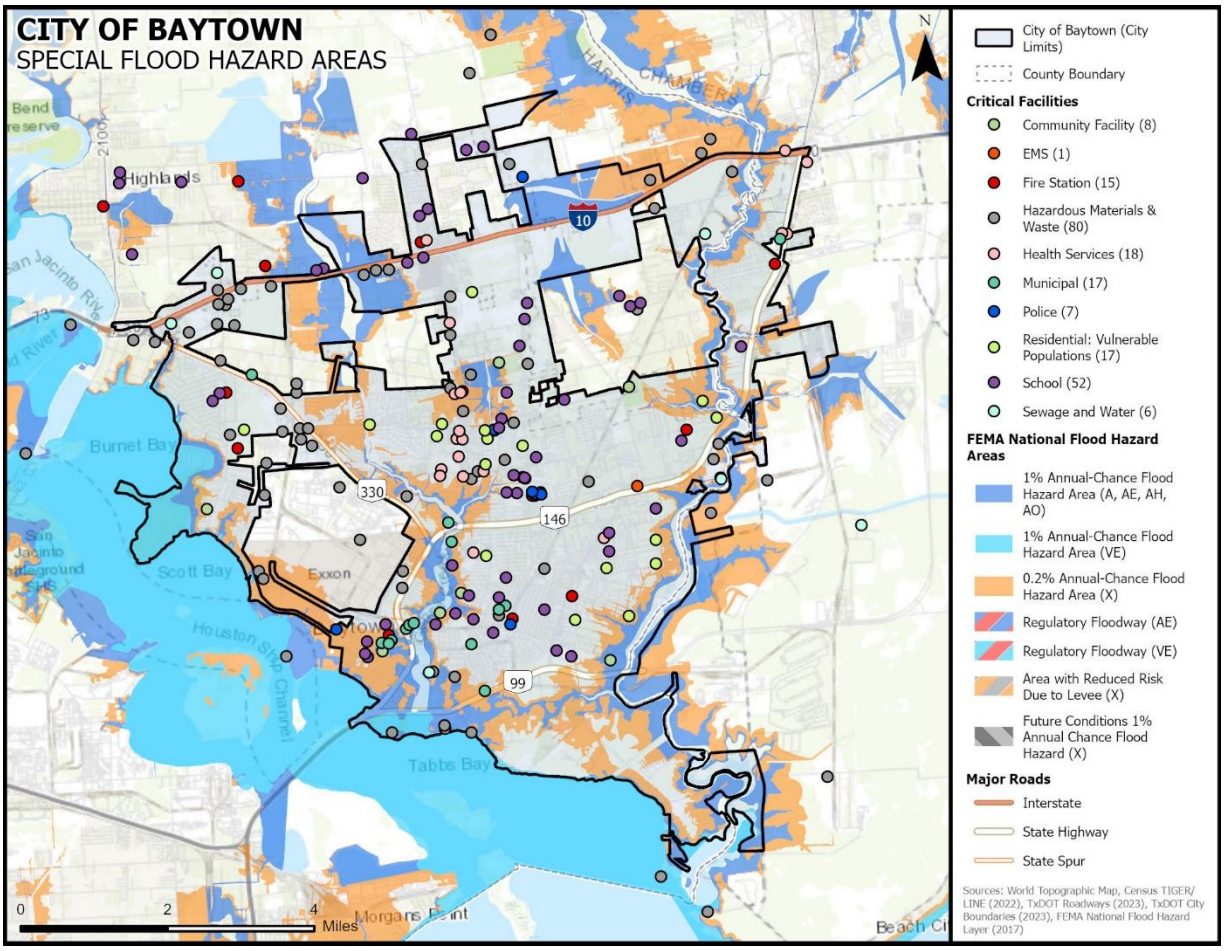
Additionally, there is a concern for flood risk associated with the Lake Houston Dam (located approximately 25 miles northwest of the City of Baytown) and the Lake Conroe Dam (located approximately 70 miles northwest of the City of Baytown). While both dams are located upstream of the planning area and outside of the estimated inundation zones, their large capacity means there is a possibility that the City of Baytown could experience flooding in the event of a breach. Potentially affected areas are primarily along the San Jacinto River and its tributaries; however, impacts are estimated to be limited.

Figure 9-1a. Estimated Flood Zones in City of Baytown



[1] Cedar Bayou Initiative Report. January 2019. https://www.h-gac.com/getmedia/48016ec0-747c-4f7a-9927-fb6f178d4895/cedar-bayou-initiative.pdf.

Figure 9-1b. Estimated Flood Zones in City of Baytown



EXTENT

The severity of a flood event is determined by a combination of several major factors, including stream and river basin topography and physiography, precipitation and weather patterns, recent soil moisture conditions, and the degree of vegetative clearing and impervious surfaces. Typically, floods are long-term events that may last for several days.

Determining the intensity and magnitude of a flood event depends on the flood zone and location of the flood hazard area in addition to the depths of flood waters. The extent of flood damages can be expected to be more damaging in the areas that will convey a base flood. FEMA categorizes areas on the terrain based on how the area will convey flood water. Flood zones are the categories that are mapped on FIRMs. Table 9-1 provides a description of FEMA flood zones and the flood impact in terms of severity or potential harm. Flood Zones A, AE, AO, X, and VE are the hazard areas mapped in the region. Figure

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9-1 should be read in conjunction with the extent for flooding in Tables 9-1 and 9-2 to determine the intensity of a potential flood event.

Table 9-1. Flood Zones

INTENSITY	ZONE	DESCRIPTION
HIGH	ZONE A	Areas with a 1-percent-annual-chance of flooding and a 26 percent chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
	ZONE A1-30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a Base Flood Elevation (BFE) (old format).
	ZONE AE	The base floodplain where BFEs are provided. AE Zones are now used on the new format FIRMs instead of A1-A30 Zones.
	ZONE AO	River or stream flood hazard areas and areas with a 1-percent-annual-chance or greater of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
	ZONE AH	Areas with a 1-percent-annual-chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26 percent chance of flooding over the life of a 30-year mortgage. BFEs derived from detailed analyses are shown at selected intervals within these zones.
	ZONE A99	Areas with a 1-percent-annual-chance of flooding that will be protected by a federal flood control system where construction has reached specified legal requirements. No depths or BFEs are shown within these zones.
	ZONE AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.

INTENSITY	ZONE	DESCRIPTION
MODERATE to LOW	ZONE X 500	An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 100-year flooding.

Zone A is interchangeably referred to as the 100-year flood, the 1-percent-annual-chance flood, the Special Flood Hazard Area (SFHA), or more commonly, the base flood. This is the area that will convey the base flood and constitutes a threat to the planning area. The impact from a flood event can be more damaging in areas that will convey a base flood.

Structures built in the SFHA are subject to damage by rising waters and floating debris. Moving flood water exerts pressure on everything in its path and causes erosion of soil and solid objects. If not elevated above Base Flood Elevation, utility systems, such as heating, ventilation, air conditioning, fuel, electrical systems, sewage maintenance systems and water systems, may also be damaged.

The intensity and magnitude of a flood event is also determined by the depth of flood water. Table 9-2 presents the stream gauge data provided by the United States Geological Survey (USGS). Peak flood data at the locations available in the planning area indicate a peak flood depth range of 0 to 7 feet above average peak flows. In addition, the FIS notes that the City of Baytown has experienced peak coastal storm surges and flood depths of up to 15 feet, indicating a coastal flood depth range of 0-15 feet.

Table 9-2. Extent for City of Baytown[2]

JURISDICTION[3]	PEAK FLOOD EVENT
City of Baytown	Goose Creek in the City of Baytown reached an overflow elevation of 24 feet in August of 2017. The average peak flow for the Rio Grande is 17 feet at this site. This indicates a maximum flood depth of 7 feet above the average peak flow at this site.

[2] Severity estimated by averaging floods at certain stage level over the history of flood events. Severity and peak events are based on USGS data.

[3] Severity is provided where peak data was available for streams, creeks and rivers throughout the planning area.

The range of flood intensity that the planning area can experience is high, or Zone A. Based on historical occurrences, the planning area could expect to experience an average of one to two inches of rain within a 1-hour period, resulting in flash flooding.

The data described in Tables 9-1 and 9-2, together with Figure 9-1, and historical occurrences for the area, provides an estimated potential magnitude and severity for the City of Baytown planning area.

HISTORICAL OCCURRENCES

Historical evidence indicates that areas within the planning area are susceptible to flooding, especially in the form of flash flooding. It is important to note that only flood events that have been reported have been factored into this risk assessment, therefore it is likely that additional flood occurrences have gone unreported before and during the recording period.

Flood event data for both Chambers and Harris Counties has been incorporated to ensure the most comprehensive dataset possible, as the City of Baytown spans both counties. Given that some flood events are reported at the county level rather than by individual jurisdiction, this approach provides a more accurate representation of the area's flood history and overall exposure. Table 9-4 below presents a breakdown by jurisdiction.

Table 9-3 identifies historical flood events that resulted in damages, injuries, or fatalities within the Harris County, Chambers County, and the City of Baytown planning area. Table 9-4 provides the historical flood event summary by jurisdiction. Historical Data is primarily provided by the Storm Prediction Center (NOAA), National Centers for Environmental Information (NCEI) database for the City of Baytown.[4] There have been 320 total recorded flood events across all jurisdictions.

Table 9-3. Historical Flood Events, 1900-2024[5]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	9/8/1900	8,000	0	$36,810,000	$0

[4] Events reported prior to 1996 are based on historical records and local knowledge.

[5] The table only includes historical flood events that resulted in damages, injuries, or fatalities between 1900 and 2024 as reported by the NCEI Database or historical records. Values are in 2024 dollars.

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	8/1/1915	0	0	$68,700,000	$0
Harris County	8/1/1932	40	0	$0	$0
Harris County	7/1/1943	0	0	$20,200,000	$0
Harris County	9/1/1961	34	0	$368,100,000	$0
Harris County	2/1/1969	0	0	$4,000,000	$0
Harris County	6/1/1973	10	0	$61,300,000	$0
Harris County	7/1/1979	0	0	$858,900,000	$0
Harris County	5/1/1983	0	0	$17,177,900	$0
Harris County	8/1/1983	0	0	$1,226,991,000	$0
Harris County	9/1/1983	0	0	$46,625,700	$0
Harris County	10/16/1994	17	0	$1,104,292,500	$0
Harris County	9/18/1996	0	0	$2,992,400	$0
Harris County	9/27/1996	0	0	$20,000	$0
Chambers County	9/27/1996	0	0	$99,800	$0
Chambers County	11/16/1996	0	0	$198,500	$0
Harris County	1/27/1997	0	0	$9,900	$0
Chambers County	1/27/1997	0	0	$9,900	$0
Harris County	3/12/1997	0	0	$255,800	$0
Harris County	3/12/1997	0	0	$6,000	$0
Harris County	4/4/1997	0	0	$9,900	$0
Harris County	4/25/1997	0	0	$19,700	$0
Harris County	4/25/1997	0	0	$491,300	$0
Chambers County	4/25/1997	0	0	$9,900	$0
Chambers County	4/25/1997	0	0	$49,200	$0
Harris County	5/21/1997	1	0	$98,400	$0
Harris County	5/24/1997	0	2	$491,600	$0
Harris County	5/30/1997	0	0	$29,500	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	11/28/1997	0	0	$5,900	$0
Harris County	12/20/1997	0	0	$39,100	$0
Harris County	1/4/1998	0	0	$5,900	$0
Harris County	1/6/1998	0	0	$5,900	$0
Harris County	1/6/1998	0	0	$3,900	$0
Chambers County	1/6/1998	0	0	$9,800	$0
Chambers County	1/6/1998	0	0	$9,800	$0
Chambers County	1/13/1998	0	0	$2,000	$0
Harris County	1/21/1998	0	0	$9,800	$0
Chambers County	1/21/1998	0	0	$9,800	$0
Chambers County	9/14/1998	0	0	$9,700	$0
City of Baytown	9/14/1998	0	0	$9,700	$0
Harris County	10/4/1998	0	0	$9,600	$0
Harris County	10/17/1998	8	0	$0	$0
Harris County	10/18/1998	0	0	$19,200	$0
Harris County	10/18/1998	0	0	$192,000	$0
Chambers County	10/18/1998	0	0	$9,600	$0
Harris County	11/12/1998	0	0	$9,600	$0
Harris County	11/12/1998	0	0	$293,300	$0
Harris County	11/12/1998	0	0	$5,800	$0
Harris County	11/13/1998	0	0	$9,600	$0
Harris County	11/13/1998	0	0	$19,200	$0
Harris County	3/19/1999	0	0	$572,400	$0
Harris County	4/2/2000	0	0	$91,900	$0
Harris County	5/19/2000	0	0	$367,200	$0
Harris County	5/19/2000	0	0	$12,760,700	$0
Chambers County	5/20/2000	0	0	$91,800	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	9/13/2000	0	0	$429,400	$0
Harris County	3/28/2001	0	0	$35,800	$0
Harris County	3/28/2001	0	0	$26,800	$0
Harris County	6/1/2001	22	0	$6,135,000	$0
Harris County	8/28/2001	0	0	$1,795,100	$0
Harris County	8/30/2001	0	0	$88,700	$0
Harris County	9/1/2001	0	0	$44,200	$0
Harris County	4/8/2002	0	0	$35,100	$0
Harris County	4/8/2002	0	0	$17,600	$0
Harris County	8/15/2002	0	0	$398,800	$0
Harris County	8/22/2002	0	0	$17,500	$0
Harris County	9/8/2002	0	0	$26,100	$0
Harris County	9/19/2002	0	0	$95,700	$0
Harris County	10/24/2002	0	0	$173,700	$0
Harris County	10/28/2002	0	0	$998,400	$0
Chambers County	11/5/2002	0	0	$43,500	$0
Harris County	12/4/2002	0	0	$17,500	$0
Chambers County	12/4/2002	0	0	$15,700	$0
Chambers County	3/13/2003	0	0	$8,600	$0
Harris County	8/31/2003	0	0	$5,200	$0
Chambers County	8/31/2003	0	0	$5,200	$0
Chambers County	8/31/2003	0	0	$5,200	$0
Chambers County	9/1/2003	0	0	$5,100	$0
Harris County	11/16/2003	0	0	$5,200	$0
Harris County	11/17/2003	1	1	$5,118,700	$0
Harris County	5/1/2004	0	0	$5,000	$0
Harris County	5/13/2004	0	0	$11,700	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/13/2004	0	0	$83,000	$0
Chambers County	6/23/2004	0	0	$41,500	$0
Chambers County	6/25/2004	0	0	$16,600	$0
Harris County	11/22/2004	0	0	$24,800	$0
Harris County	5/29/2005	0	0	$16,200	$0
Harris County	7/14/2005	0	0	$185,300	$0
Harris County	12/14/2005	0	0	$64,000	$0
Harris County	5/29/2006	0	0	$10,900	$0
Chambers County	5/29/2006	0	0	$77,800	$0
Harris County	6/19/2006	0	0	$5,119,900	$0
Harris County	6/22/2006	0	0	$310,300	$0
Harris County	10/16/2006	2	0	$18,800	$0
Harris County	10/16/2006	0	0	$1,170,000	$0
Harris County	10/16/2006	0	0	$78,000	$0
Harris County	10/26/2006	0	0	$156,000	$0
City of Baytown	10/26/2006	0	0	$78,000	$0
Harris County	5/10/2007	0	0	$22,800	$0
Harris County	5/10/2007	0	0	$22,800	$0
Harris County	5/10/2007	0	0	$113,600	$0
Harris County	5/10/2007	0	0	$22,800	$0
Harris County	5/10/2007	0	0	$15,200	$0
Harris County	5/10/2007	0	0	$68,200	$0
Harris County	5/10/2007	0	0	$45,500	$0
Harris County	5/10/2007	0	0	$984,000	$0
Harris County	5/10/2007	0	0	$22,800	$0
Harris County	7/6/2007	0	0	$75,600	$0
Chambers County	7/6/2007	0	0	$60,500	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	8/16/2007	3	0	$1,135,600	$0
Harris County	10/15/2007	0	0	$7,600	$0
Chambers County	8/5/2008	0	0	$7,200	$0
Harris County	9/12/2008	25	0	$3,680,975,000	$0
Harris County	9/14/2008	0	0	$72,000	$0
Harris County	9/14/2008	0	0	$43,200	$0
Harris County	10/15/2008	0	0	$29,100	$0
Harris County	4/18/2009	0	0	$5,166,900	$0
Harris County	4/24/2009	0	0	$1,476,300	$0
Chambers County	4/24/2009	0	0	$1,500	$0
Harris County	4/27/2009	0	0	$7,400	$0
Harris County	4/28/2009	1	0	$22,143,800	$0
Harris County	4/28/2009	0	0	$14,800	$0
Harris County	10/22/2009	0	0	$5,900	$0
Harris County	10/29/2009	0	0	$8,800	$0
Harris County	10/29/2009	0	0	$7,300	$0
Harris County	10/29/2009	0	0	$7,300	$0
Harris County	5/14/2010	1	0	$7,300	$0
Harris County	7/2/2010	0	0	$2,527,000	$0
Harris County	1/9/2012	0	0	$27,800	$0
Harris County	1/25/2012	0	0	$34,800	$0
Harris County	5/12/2012	0	0	$54,800	$0
Harris County	7/12/2012	0	0	$1,400	$0
Harris County	7/12/2012	0	0	$4,200	$0
Harris County	7/12/2012	0	0	$4,200	$0
Harris County	7/12/2012	0	0	$6,870,200	$13,800
Harris County	7/13/2012	0	0	$2,800	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	7/13/2012	0	0	$4,200	$0
Harris County	4/27/2013	0	0	$4,061,400	$0
Harris County	5/10/2013	0	0	$1,013,600	$0
Harris County	9/20/2013	0	0	$100,900	$0
Harris County	7/3/2014	0	0	$6,700	$0
Harris County	8/1/2014	0	0	$132,400	$0
Harris County	9/18/2014	0	0	$33,100	$0
Harris County	9/19/2014	0	0	$1,400	$0
Harris County	3/21/2015	0	0	$20,000	$0
Harris County	4/16/2015	0	0	$8,000	$1,400
Harris County	4/17/2015	0	0	$399,200	$0
Harris County	5/12/2015	1	0	$1,059,100	$0
Harris County	5/25/2015	6	0	$33,094,000	$0
Harris County	5/30/2015	0	0	$132,400	$0
Harris County	6/30/2015	0	0	$66,000	$0
Harris County	10/31/2015	2	0	$1,323,600	$0
Harris County	4/17/2016	6	0	$46,049,600	$0
Harris County	5/14/2016	0	0	$65,600	$0
Harris County	6/1/2016	0	0	$6,600	$0
Harris County	6/2/2016	0	0	$13,100	$0
Harris County	6/2/2016	0	0	$6,600	$0
Harris County	6/4/2016	0	0	$13,100	$0
Chambers County	6/4/2016	0	0	$13,100	$0
Chambers County	12/3/2016	0	0	$6,600	$0
Harris County	1/18/2017	0	0	$648,200	$0
Harris County	6/4/2017	0	0	$3,900	$0
Chambers County	6/4/2017	0	0	$3,900	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/24/2017	0	0	$1,300	$0
Harris County	6/25/2017	0	0	$2,600	$0
Harris County	8/26/2017	36	0	$12,269,916,300	$128,300
Harris County	9/21/2017	0	0	$6,400	$0
Harris County	5/7/2019	0	0	$61,500	$0
Harris County	5/9/2019	0	0	$24,600	$0
Harris County	9/18/2019	0	0	$6,200	$0
Chambers County	9/18/2019	0	0	$61,400	$0
Harris County	9/19/2019	0	0	$245,207,400	$0
Chambers County	9/19/2019	0	0	$98,083,000	$0
Harris County	9/19/2019	1	0	$0	$0
Harris County	9/19/2019	1	0	$0	$0
Harris County	5/15/2020	0	0	$122,800	$0
Harris County	6/25/2020	0	0	$12,400	$0
Harris County	9/21/2020	0	0	$60,500	$0
Harris County	9/21/2020	0	0	$121,000	$0
Harris County	9/21/2020	0	0	$121,000	$0
Harris County	9/21/2020	0	0	$121,000	$0
Harris County	9/21/2020	0	0	$121,000	$0
Harris County	9/21/2020	0	0	$604,800	$0
Harris County	5/18/2021	0	0	$3,600	$0
Harris County	6/21/2021	0	0	$5,800	$0
Harris County	7/21/2021	0	0	$28,900	$0
Harris County	1/9/2022	0	0	$22,400	$0
Harris County	1/9/2022	0	0	$22,400	$0
Harris County	1/9/2022	0	0	$112,000	$0
Harris County	1/9/2022	0	0	$112,000	$0

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	9/15/2023	0	0	$2,100	$0
Harris County	7/8/2024	0	0	$20,000	$0
Harris County	7/8/2024	0	0	$100,000	$0
City of Baytown	7/8/2024	0	0	$350,000	$0
Harris County	7/26/2024	0	0	$3,000	$0
Total Losses		8,218	3	$20,281,299,400	$143,500

Table 9-4. Summary of Historical Flood Events, 1900-2024

JURISDICTION	NUMBER OF EVENTS	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
City of Baytown	3	0	0	$437,700	$0
Chambers County	47	0	0	$98,966,200	$0
Harris County	270	8,212	3	$20,181,895,500	$143,500
Total Losses	320	8,212	3	$20,281,442,900	

Based on the list of historical flood events for the City of Baytown and both counties, 49 events have occurred since the 2020 Plan.

SIGNIFICANT EVENTS

Flood on September 8, 1900

The Galveston Storm of 1900 is known as one of the greatest natural disasters to impact the United States. The storm brought a devastating storm surge, between 8 and 15 feet, that inundated most of Galveston Island, and other portions of the nearby Galveston Bay. High tides were largely responsible for the 8,000 deaths (historical estimates range from 6,000 to 12,000) attributed to the storm. The damage to property was estimated to be more than $30 million.

Flash Flood on September 11-14, 1998 (DR-1257-TX)

According to the City of Baytown Flood Mitigation Plan, in September of 1998 Tropical Storm Francis and a thunderstorm event that followed later in the same month, resulted in widespread flooding. There was a Presidential Disaster Declaration (DR-1257-TX) for Harris County and the City of Baytown as a result of this flooding. FEMA established a Disaster Field Office in Baytown to assist with flood recovery efforts. It is reported that

there was significant damage to docks, piers, and waterfront structures along Galveston Bay. It was reported to the NCEI that there was high water on Deese Road, Sterling Road, and Main Street in the City of Baytown. An estimated $9,700 (2024 dollars) in damages were reported for the City alone.

Flash Flood on June 1-9, 2001

Referred to as "The Great Flood of 2001," Tropical Storm Allison impacted Harris County and the City of Baytown. The storm notably moved north of the planning area and then shifted back towards the Gulf of Mexico again, hitting Harris County twice. After flooding an estimated 1,000 homes during its initial pass through the area June 5th through 7th, the tropical storm returned June 8th through 9th to deliver its critical blow. Up to 28 inches of rainfall were reported across areas of Harris County and two million people were impacted by the storm. This system resulted in 22 deaths, 95,000 damaged vehices, and more than 70,000 damaged homes. An estimated $6,135,000 (2024 dollars) in damages were reported for Harris County, which includes the City of Baytown.

Flood on September 12, 2008

Hurricane Ike produced a damaging, destructive and deadly storm surge across the upper Texas and southwest Louisiana coasts. Reports in the NCEI for Harris County indicate that the storm surge ranged from 10 to 15 feet above the mean sea level along Galveston Bay and local tributaries which caused major flooding for coastal areas, like the City of Baytown. The number of injuries for this event are unknown but there were at least 25 deaths in Harris County. This event caused $3,680,975,000 (2024 dollars) in damages for Harris County.

Flash Flood on August 26-29, 2017

Hurricane Harvey made landfall as a category 4 hurricane, then weakened to a tropical storm and slowed, looping back and tracking over southeastern Texas, then back over the Gulf of Mexico making a second landfall along the Louisiana coast. The five day period over Southeast Texas produced catastrophic flooding with a large area of 30 to 60 inches of rain, 23 tornadoes, tropical storm force winds and a moderate storm surge. In some of the heavier bands rain fell at a rate of over five inches per hour. This copious record amount of rain led to catastrophic flooding. Thousands of homes, businesses, and roads were flooded due to flash flooding and sheet flow from long duration intense rain. Main stem rivers and adjoining tributaries, creeks and bayous reached full capacity and came out of their banks and this also contributed to the massive flooding across southeastern Texas.

This historical event resulted in at least 36 deaths. An estimated $12,269,916,300 (2024 dollars) in property damages and at least $128,300 (2024 dollars) in crop damages were reported for Harris County. In an NCEI report for Chambers County it was noted that extensive flooding occurred in the Milam Bend subdivision in the City of Baytown along the Cedar Bayou.

Flash Flood on September 18-19, 2019 (DR-4466-TX)

Tropical Storm Imelda produced heavy rain bands that caused devastating flooding across portions of Southeast Texas with maximum rainfall amounts over 40 inches 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. There were several reports of collapsed roofs due to weight of flood waters at public facilities. At least two flood related deaths were reported during this event. Although fresh water flooding was the main impact, an EF1 tornado also occurred in a cell within one of the leading bands from the storm. This damaged an area on the north side of the City of Baytown near the Highlands. In Harris County an estimated $245,207,400 (2024 dollars) of property damages were reported, with an additional $98,083,000 (2024 dollars) of property damages reported for Chambers County.

Flash Flood on July 8, 2024

Hurricane Beryl produced 4-8 inches of rainfall on average, with the highest amounts ranging from 10-15 inches. The storm also produced surge flooding generally between 4 to 6 feet, with a maximum of 8 feet measured by survey crews. There have been 22 total fatalities and $120,000 in damages reported in Harris County for this event. In addition, the City of Baytown planning team reported a minimum of $350,000 in property damages which was related to property damage at the Nature Center and Bayland Marina.

PROBABILITY OF FUTURE EVENTS

There are 3 recorded historical occurrences within the City of Baytown planning area. However, flood events are typically reported at the county level as they impact multiple jurisdictions at one time. Between Harris County, Chambers County, and the City of Baytown, there is a total of 320 reported flood events within the 125-year reporting period. Based on this analysis flooding is considered “Highly Likely,” meaning an event is probable within the next year.

CLIMATE CHANGE CONSIDERATIONS

River flooding in Texas is projected to have no substantial change through 2036. This is in large part due to the construction of dams and reservoirs for flood management in the 20th century. There is a mixture of historical trends categorized by season, with no single clear trend to project. In addition, meteorological drivers of river flooding (increased rainfall intensity, decreased soil moisture) are projected to have competing influences. On balance, if an increasing trend is present in river flooding, it will be at the most extreme flood events or in the wettest parts of the state where there is so much rainfall that a decrease in soil moisture would have little mitigating impact.[6]

According to the Climate Risk and Resilience Portal (ClimRR), the historical annual total precipitation for City of Baytown is 52.01 inches and the current ClimRR climate change projections estimate the annual minimum precipitation at mid-century to be 50.69 inches, which represents a slight decrease from current averages. End of century projections are higher with a new annual minimum precipitation at 53.58 inches. An increase in precipitation and precipitation events could increase flood risk, however, projections are subject to change over time.

According to the United States Environmental Protection Agency, the sea level rise may contribute to increased coastal flooding and flood related impacts. The sea level is rising more rapidly along the Texas coast due to ground water pumping, than climate change itself, however, both are contributing factors. Key findings from Climate Central's Surging Seas Risk Finder and the National Climate Assessments intermediate high sea level rise scenario indicate that the City of Baytown is projected to have 5.3 feet of rise locally by 2100. Rising sea level submerges wetlands and dry land, erodes beaches, and exacerbates coastal flooding.

In addition, tropical storms and hurricanes have become more intense during the past 20 years. Although warming oceans provide these storms with more potential energy, scientists are not sure whether the recent intensification reflects a long-term trend. Nevertheless, hurricane wind speeds and rainfall rates are likely to increase as the climate continues to warm. Whether or not storms become more intense, coastal homes

[6] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 update.

and infrastructure will flood more often as the sea level rises, because storm surges will become higher as well.[7]

VULNERABILITY AND IMPACT

A property's vulnerability to a flood depends on its location and proximity to the floodplain. Structures that lie along banks of a waterway are the most vulnerable and are often repetitive loss structures. According to the City of Baytown Flood Hazard Annex (2024), 469 buildings are located within the Special Flood Hazard Area and may be especially vulnerable to flooding. However, the City of Baytown is committed to mitigating flood risk for these properties and further promotes development outside of the floodplain.

In terms of structure and infrastructure damages and service disruptions, the potential severity of impacts for flood events is considered Minor, with the complete shutdown of critical facilities for up to one week and more than 10 percent of property destroyed or with major damage. However, due to reported injuries and fatalities, the impact of flooding in City of Baytown is considered "Substantial" with multiple deaths possible, depending on the size and extent of the event.[8]

Table 9-5 includes the comprehensive critical facilities identified in Appendix F that were considered the most important to the planning area that are subject to a range of impacts due to flood and are located in the regulatory floodplain. For a comprehensive list of identified critical facilities, please see Appendix F.

Table 9-5. Critical Facilities in the Floodplain

CRITICAL FACILITY TYPES	CRITICAL FACILITIES AT RISK	POTENTIAL IMPACTS
Emergency Response Departments (EOC, Fire, Police, EMS), Hospitals	4 Fire Stations, 4 Health Service Facilities, 1 Police Station	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by rising flood waters.

[7] What Climate Change Means for Texas. United States Environmental Protection Agency. August 2016.

[8] The vulnerability and impact assessment accounts for damages reported for the City of Baytown, Harris County, and Chambers County as events are often reported on a county wide level only.

CRITICAL FACILITY TYPES	CRITICAL FACILITIES AT RISK	POTENTIAL IMPACTS
		• Flood-related rescues may be necessary at swift and low water crossings or in flooded neighborhoods where roads have become impassable, placing first responders in harm's way. • Evacuations may be required for entire neighborhoods because of rising floodwaters, further taxing limited response capabilities and increasing sheltering needs for displaced residents. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Washed out roads and bridges can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • First responders are exposed to downed power lines, contaminated and unusual debris, hazardous materials, and generally unsafe conditions. • Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Community Residential Facilities, Day Care Facilities, Evacuation Centers & Shelters, Governmental Facilities	7 Community Facilities, 8 Municipal Facilities, 3 Residential Facilities (Vulnerable Populations), 14 School Facilities	• Structures can be damaged by rising flood waters. • Power outages could disrupt critical care. • Backup power sources could be damaged, inundated or otherwise inoperable. • Critical staff may be impacted and unable to report for duty, limiting response capabilities. • Evacuations may be necessary due to extended power outages, gas line ruptures, or inundation of facilities. • Additional emergency responders and critical aid workers may not be able to reach the area for days. • Power outages and infrastructure damage may prevent larger airports from acting as temporary command centers for logistics, communications, and emergency operations. • Temporary break in operations may significantly inhibit post event evacuations.

CRITICAL FACILITY TYPES	CRITICAL FACILITIES AT RISK	POTENTIAL IMPACTS
		• Damaged or destroyed highway infrastructure may substantially increase the need for airport operations.
Commercial Suppliers (food, gas, etc.)	N/A	• Facilities or infrastructure may be damaged, destroyed or otherwise inaccessible. • Essential supplies like medicines, water, food, and equipment deliveries may be significantly delayed.
Utility Services and Infrastructure (electric, water, wastewater, communications)	29 Hazardous Materials Facilities, 2 Sewage and Water Facilities	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency service vehicles can be damaged by rising flood waters. • Flood-related rescues may be necessary at swift and low water crossings or in flooded neighborhoods where roads have become impassable, placing emergency service workers in harm's way. • An increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • Service responders are exposed to downed power lines, contaminated and unusual debris, hazardous materials, and generally unsafe conditions. • Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.

Historic loss estimates due to flooding is presented in Table 9-6 below. Since the City of Baytown spans both Chambers and Harris Counties, an assessment of all relevant data was included in the frequency calculation. The average annualized loss (Table 9-6) is provided separately for each jurisdiction; however, it is important to note that a portion of the damages reported at the county level are very likely associated with the City of Baytown. Considering 320 flood events over a 125-year period, the frequency is approximately two to three events every year.

Table 9-6. Average Annualized Losses by Jurisdiction, 1900-2024

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
City of Baytown	$437,700	$3,500

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
Chambers County	$98,966,200	$791,700
Harris County	$20,182,039,000	$161,456,300
TOTALS	$20,281,442,900	$162,251,500

While all citizens are at risk of the impacts of a flood, forced relocation and disaster recovery disproportionately impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. In addition, due to factors like limited mobility, communication difficulties, medical needs, reliance on support services, transportation challenges, housing accessibility issues, and possible shortages in emergency shelter accommodations, the elderly, children, and people with disabilities are also disproportionately affected by flooding events. People who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures.

The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level and 16 percent of the population speaks English 'less than very well'.

Table 9-7. Populations at Greater Risk[9]

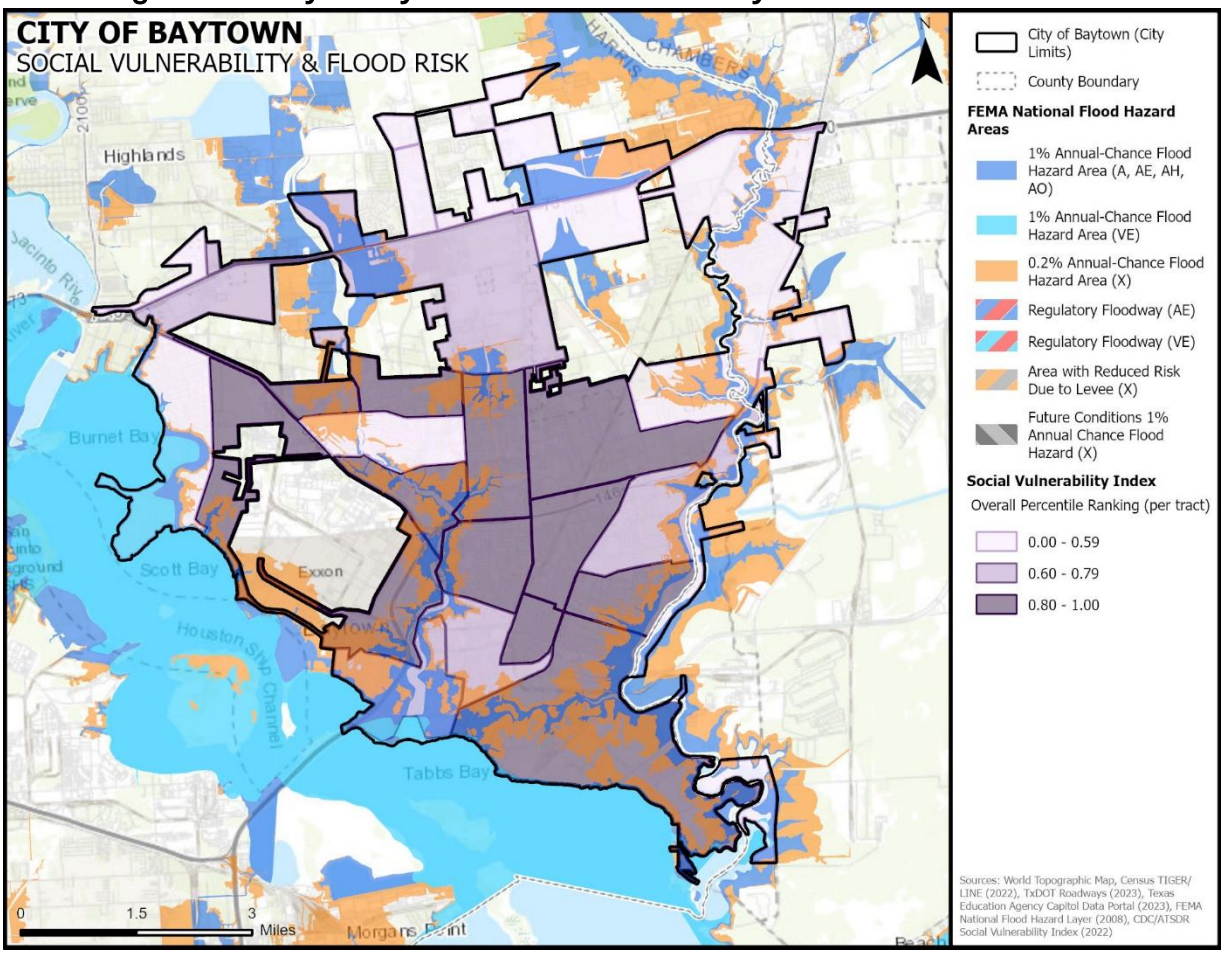
JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

The Center for Disease Control (CDC) created a Social Vulnerability Index (SVI) which includes a database and mapping application that identifies and quantifies communities experiencing social vulnerability. The current CDC SVI uses 16 U.S. census variables from the 5-year American Community Survey (ACS) to identify communities that may need support before, during, or after disasters. All 16 variables fall under four broad

[9] U.S. Census Bureau Five-Year estimates

categories including socioeconomic status (population in poverty, unemployment, etc.), household characteristics (age, disability status, etc.), racial and ethnic minority status, and housing type and transportation (mobile homes, no vehicles, etc.). Populations experiencing social vulnerability may be adversely impacted by natural hazards, disasters, and other community-level stressors. Figure 9-2 identifies areas of social vulnerability using the CDC's SVI and where these areas overlap with the City of Baytown flood hazard areas.

Figure 9-2. City of Baytown Social Vulnerability and Flood Hazard Areas



HAZUS

Hazus is a nationally standardized risk modeling methodology that can be used to estimate potential damage, economic loss, and social impacts from earthquake, flood, tsunami and hurricane hazards. The flood model was utilized as an enhancement to the risk assessment for this hazard profile. This model generates flood (riverine and coastal) hazard data using nationwide hydrological datasets, estimating the expected levels of

damage to infrastructure and buildings. The model assumes a 100-year combined riverine and coastal flood scenario. A summary of the results are included in Table 9-8. Additional summary data can be found in Appendix J.

Table 9-8. Hazus Estimated Losses, 100-year Flood Scenario

JURISDICTION	DISPLACED POPULATION	DAMAGED STRUCTURES	SUBSTANTIALLY DAMAGED STRUCTURES	ECONOMIC LOSSES[10]
City of Baytown	4,674	671	225	$1,291,635,000

ASSESSMENT OF IMPACTS

Flooding is the deadliest natural disaster that occurs in the U.S. each year, and it poses a constant and significant threat to the health and safety of the people in the City of Baytown planning area. Impacts to the planning area can include:

- Flood-related rescues may be necessary at swift water and low water crossings or in flooded neighborhoods where roads have become impassable, placing first responders in harm's way.
- Evacuations may be required for entire neighborhoods because of rising floodwaters, further taxing limited response capabilities and increasing sheltering needs for displaced residents.
- Health risks and threats to residents are elevated after the flood waters have receded due to contaminated flood waters (untreated sewage and hazardous chemicals) and mold growth typical in flooded buildings and homes.
- Significant flood events often result in widespread power outages, increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages can result in an increase in structural fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- Floods can destroy residential structures and make them uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders are exposed to downed power lines, contaminated and potentially unstable debris, hazardous materials, and generally unsafe conditions,

[10] Economic losses include structural damages, building contents, inventory, income and wage losses.

elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.

- Emergency operations and services may be significantly impacted due to damaged facilities.
- Significant flooding can result in the inability of emergency response vehicles to access areas of the community.
- Critical staff may suffer personal losses or otherwise be impacted by a flood event and be unable to report for duty, limiting response capabilities.
- City departments may be flooded, delaying response and recovery efforts for the entire community.
- Private sector entities that the planning area and its residents rely on, such as utility providers, financial institutions, and medical care providers, may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- Some businesses not directly damaged by the flood may be negatively impacted while utilities are being restored or water recedes, further slowing economic recovery.
- When the community is affected by significant property damage, it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Residential structures substantially damaged by a flood may not be rebuilt for years and uninsured or underinsured residential structures may never be rebuilt, reducing the tax base for the community.
- Large floods may result in dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.
- Recreation activities may be unavailable, and tourism can be unappealing for years following a large flood event, devastating directly related local businesses and negatively impacting economic recovery.
- Flooding may cause significant disruptions of clean water and sewer services, elevating health risks and delaying recovery efforts.

- The psychosocial effects on flood victims and their families can traumatize them for long periods of time, creating long term increases in medical treatment and services.
- Extensive or repetitive flooding can lead to decreases in property value for the affected community.
- Flood poses a potential catastrophic risk to annual and perennial crop production and overall crop quality, leading to higher food costs.
- Flood related declines in production may lead to an increase in unemployment.
- Large floods may result in loss of livestock, potentially increased livestock mortality due to stress and waterborne disease, and increased cost for feed.

The overall extent of damage caused by floods is dependent on the extent, depth, and duration of flooding, in addition to the velocities of flows in the flooded areas. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a flood event.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP) PARTICIPATION

Flood insurance offered through the National Flood Insurance Program (NFIP) is the best way for home and business owners to protect themselves financially against the flood hazard. The City of Baytown participates in the NFIP and is in good standing.

As an additional indicator of floodplain management responsibility, communities may choose to participate in FEMA's Community Rating System (CRS). This is an incentive-based program that allows communities to undertake flood mitigation activities that go beyond NFIP requirements. The City of Baytown has been a participant in the CRS since October 1, 1991, and currently holds a Class 5 rating. The City remains committed to enhancing its participation in the program and is actively working to improve its CRS classification.

The City of Baytown currently enforces minimum NFIP standards for new construction and substantial structural improvements. Additionally, as part of its participation in the CRS Program, the City has implemented higher regulatory standards to enhance flood protection such as 24 inch freeboard for new or substantially improved construction. The City is evaluating the adoption of additional higher regulatory NFIP standards to further restrict floodplain development and reduce flood risk.

SECTION 9: FLOOD

The flood hazard areas throughout the City of Baytown are subject to periodic inundation, which may adversely affect public safety, resulting in loss of life and property, health and safety hazards, disruption of commerce and governmental services, and extraordinary public expenditures for flood protection and relief. Flood losses are created by the cumulative effect of obstructions in floodplains which cause an increase in flood heights and velocities. In addition, occupancy in flood hazard areas creates an increase in vulnerabilities to flood hazards as they typically are inadequately elevated, flood-proofed, or otherwise protected from flood damage. Mitigation actions are included to address flood maintenance issues as well and expand drainage culverts and storm water structures to convey flood water more adequately.

It is the purpose of the City of Baytown to continue to promote public health, safety, and general welfare by minimizing public and private losses due to flood conditions in specific areas. The City is guided by its local Flood Damage Prevention Ordinance and will continue to comply with NFIP requirements through their local permitting, inspection, and record-keeping requirements for new and substantially developed construction. Further, the NFIP program promotes sound development in floodplain areas and includes provisions designed to:

- Protect human life and health;
- Minimize expenditure of public money for costly flood control projects;
- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
- Minimize prolonged business interruptions;
- Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets, and bridges located in floodplains;
- Help maintain a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to minimize future flood blight areas; and
- Ensure that potential buyers are notified that property is in a flood area.

In order to accomplish these tasks, the City of Baytown seeks to observe the following guidelines in order to achieve flood mitigation:

- Restrict or prohibit uses that are dangerous to health, safety, or property in times of flood, such as filling or dumping, that may cause excessive increases in flood heights or velocities;
- Require that uses vulnerable to floods, including facilities, which serve such uses, be protected against flood damage at the time of initial construction, as a method of reducing flood losses;

- Control the alteration of natural floodplains, stream channels, and natural protective barriers, which are involved in the accommodation of floodwaters;
- Control filling, grading, dredging, and other development, which may increase flood damage; and
- Prevent or regulate the construction of flood barriers which will unnaturally divert floodwaters or which may increase flood hazards to other lands.

COMMUNITY RATING SYSTEM

The City of Baytown is an active participant in the Community Rating System (CRS). CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. Approximately 1,500 communities participate in the CRS, which is less than 10 percent of current NFIP participating communities nationwide. Lower class ratings mean lower flood insurance premiums for residents.

Out of a 10 point rating system (where 1 is the best), the City of Baytown currently has a class rating of 5. This equates to a 25 percent insurance discount for the residents of Baytown. Approximately 200 participating CRS communities currently have a rating of 5 or lower. The City of Baytown continues to exceed minimum national standards to provide financial relief to homeowners in terms of insurance discounts, as well as significant improvements to construction standards. Please see Appendix C for additional information on the CRS.

NFIP COMPLIANCE AND MAINTENANCE

The City of Baytown has developed mitigation actions that relate to either NFIP maintenance or compliance. Compliance and maintenance actions can be found in Section 20.

Flooding was identified as a high risk hazard during hazard ranking activities at the Risk Assessment Workshop by the majority of the planning team. As such, many of the mitigation actions were developed with flood mitigation in mind. A majority of these flood actions address compliance with the NFIP and implementing flood awareness programs. The City of Baytown recognizes the need and is working towards adopting higher NFIP regulatory standards to further minimize flood risk in their community. In addition, the City focuses on public flood awareness activities. This includes promoting the availability

of flood insurance by placing NFIP brochures and flyers in public libraries or public meeting places.

The City of Baytown has a designated floodplain administrator. The floodplain administrator will continue to maintain the City's participation in CRS, as well as compliance with the NFIP, including continued floodplain administration, zoning ordinances, and development regulation. The floodplain ordinance adopted by the City outlines the minimum requirements for development in Special Flood Hazard Areas.

The City of Baytown has a permitting process in place and the local floodplain administrator is responsible for coordinating inspections of damaged homes located in the floodplain. Following a flood event, local officials inspect damaged homes to make a substantial damage determination. Substantially damaged homes must be brought into compliance. Similarly, proposed improvements to homes located in the floodplain are reviewed by local building officials to determine if a substantial improvement is proposed. The floodplain administrator oversees permitted repairs and improvements to ensure compliance during the rebuilding or improvement process.

REPETITIVE LOSS

The Flood Mitigation Assistance (FMA) Grant Program under FEMA provides federal funding to assist states and communities in implementing mitigation measures to reduce or eliminate the long-term risk of flood damage to buildings that are insured under the National Flood Insurance Program. The Texas Water Development Board (TWDB) administers the FMA grant program for the State of Texas. One of the goals of the FMA program is to reduce the burden of repetitive loss and severe repetitive loss properties on the NFIP through mitigation activities that significantly reduce or eliminate the threat of future flood damages.

Repetitive Loss properties are defined as structures that are:

- Any insurable building for which 2 or more claims of more than $1,000 each, paid by the National Flood Insurance Program (NFIP) within any 9-year period, since 1978;
- May or may not be currently insured under the NFIP.

Severe Repetitive Loss properties are defined as structures that are:

- Covered under the NFIP and have at least 4 flood related damage claim payments (building and contents) over $5,000.00 each, and the cumulative amount of such claims payments exceed $20,000; or

- At least 2 separate claim payments (building payments only) have been made, with the cumulative amount of the building portion of such claims exceeding the market value of the building.

In either scenario, at least 2 of the referenced claims must have occurred within any 9-year period and must be greater than 10 days apart.[11] Table 9-9 shows repetitive loss and severe repetitive loss properties for the City of Baytown. A review of historical damage to buildings, including all repetitive loss properties, is included in Appendix C, CRS Requirements.

Table 9-9. Repetitive Loss and Severe Repetitive Loss Properties

JURISDICTION	STRUCTURE TYPE	NUMBER OF STRUCTURES	NUMBER OF LOSSES
City of Baytown	Single Family	123	307
	Non Residence	15	31
	Business	13	26

[11] Source: Texas Water Development Board.



SECTION 10
HAIL

SECTION 10: HAIL

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Vulnerability and Impact 18
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HAZARD DESCRIPTION



Hailstorm events are a potentially damaging outgrowth of severe thunderstorms. During the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere, and the subsequent cooling of the air mass. Frozen droplets gradually accumulate into ice crystals until they fall as precipitation that is round or irregularly shaped masses of ice typically greater than 0.75 inches in diameter. The size of hailstones is a direct result of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a by-product of heating on the Earth's surface. Higher temperature gradients above Earth's surface result in increased suspension time and hailstone size.

According to the National Insurance Crime Bureau (NICB), between 2018 and 2020 the State of Texas had the greatest number of hail loss claims in the U.S. with 605,866 loss claims (23 percent of total hail claims in the U.S.) due to hail events. In this two-year period Texas experienced a total of 584 severe hail days. Five of the top ten cities for hail loss claims between 2017 and 2019 were in Texas, three of which were in the Dallas-Fort Worth metropolitan area.[1]

[1] Manasek, Thomas, "2018-2020 United States Hail Loss Claims and Questionable Claims" (National Insurance Crime Bureau, March 15, 2021). http://www.rmiia.org/downloads/PUBLIC%202018%20-%202020%20Hail%20foreCAST-%20TJM.pdf

SECTION 10: HAIL

In 2021, 6.8 million properties in the U.S. experienced one or more damaging hail events, resulting in a total of $16.5 billion in insured losses. Texas had the highest number of properties affected by hail with over 1.5 million properties or 17 percent of total properties in the state affected; an increase of 80,000 properties affected between 2020 and 2021. Texas hailstorms accounted for almost a quarter of total U.S. properties affected by hail in 2021.

LOCATION

Hailstorms are an extension of severe thunderstorms that could potentially cause severe damage. As a result, they are not confined to any specific geographic location and can vary greatly in size, location, intensity, and duration. Therefore, the entire City of Baytown planning area is equally at risk to the hazard of hail. Refer to Figure 10-1 for the location of past hail events in the planning area.

EXTENT

The National Weather Service (NWS) classifies a storm as "severe" if there is hail three-quarters of an inch in diameter (approximately the size of a penny) or greater, based on radar intensity or as seen by observers. The intensity category of a hailstorm depends on hail size and the potential damage it could cause, as depicted in the National Centers for Environmental Information (NCEI) Intensity Scale in Table 10-1.

Table 10-1. Hail Intensity and Magnitude[2]

SIZE CODE	INTENSITY CATEGORY	SIZE (diameter inches)	DESCRIPTIVE TERM	TYPICAL DAMAGE
H0	Hard Hail	Up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33 – 0.60	Marble	Slight damage to plants and crops
H2	Potentially Damaging	0.60 – 0.80	Dime	Significant damage to plants and crops
H3	Severe	0.80 – 1.20	Nickel	Severe damage to plants and crops
H4	Severe	1.2 – 1.6	Quarter	Widespread glass and auto damage

[2] NCEI Intensity Scale, based on the TORRO Hailstorm Intensity Scale.

SIZE CODE	INTENSITY CATEGORY	SIZE (diameter inches)	DESCRIPTIVE TERM	TYPICAL DAMAGE
H5	Destructive	1.6 – 2.0	Half Dollar	Widespread destruction of glass, roofs, and risk of injuries
H6	Destructive	2.0 – 2.4	Ping Pong Ball	Aircraft bodywork dented and brick walls pitted
H7	Very Destructive	2.4 – 3.0	Golf Ball	Severe roof damage and risk of serious injuries
H8	Very Destructive	3.0 – 3.5	Hen Egg	Severe damage to all structures
H9	Super Hailstorms	3.5 – 4.0	Tennis Ball	Extensive structural damage, could cause fatal injuries
H10	Super Hailstorms	4.0 +	Baseball	Extensive structural damage, could cause fatal injuries

The intensity scale in Table 10-1 ranges from H0 to H10, with increments of intensity or damage potential in relation to hail size (distribution and maximum), texture, fall speed, speed of storm translation, and strength of the accompanying wind. Based on the best available data regarding the previous occurrences for the area, the City of Baytown planning area may experience hailstorms ranging from an H0 (pea size) to an H8 (hen egg size). The largest hail to be reported was 3.0 inches in diameter, or an H8, which is considered a very destructive hailstorm that can cause severe damage to all structures and severe injuries. An event of this magnitude occurred on May 4, 2006, in Harris County near the City of Baytown planning area. This is likely the greatest extent the planning area can anticipate in the future, based on historical events.

HISTORICAL OCCURRENCES

Historical evidence shown in Figure 10-1 demonstrates that the planning area is vulnerable to hail events overall. Historical events with reported damages, injuries, or fatalities are shown in Table 10-2. Within all of Chambers and Harris Counties, a total of 643 reported historical hail events occurred between 1956 and 2024. Of those, 7 events were reported within the City of Baytown planning area. These events were reported to NCEI and NOAA databases and may not represent all hail events to have occurred during

the past 68 years. Only those events with latitude and longitude available were plotted (Figure 10-1).

Hail event data for both Chambers and Harris Counties have been incorporated to ensure the most comprehensive dataset possible, as the City of Baytown spans both counties. Given that some hail events are reported at the county level rather than by individual jurisdiction, this approach provides a more accurate representation of historical hail risk in the area. Table 10-2 lists all reported hail events which resulted in reported damages, injuries, or fatalities. Table 10-3 summarizes these impacts by jurisdiction.

Figure 10-1. Spatial Historical Hail Events, 1956 – 2024

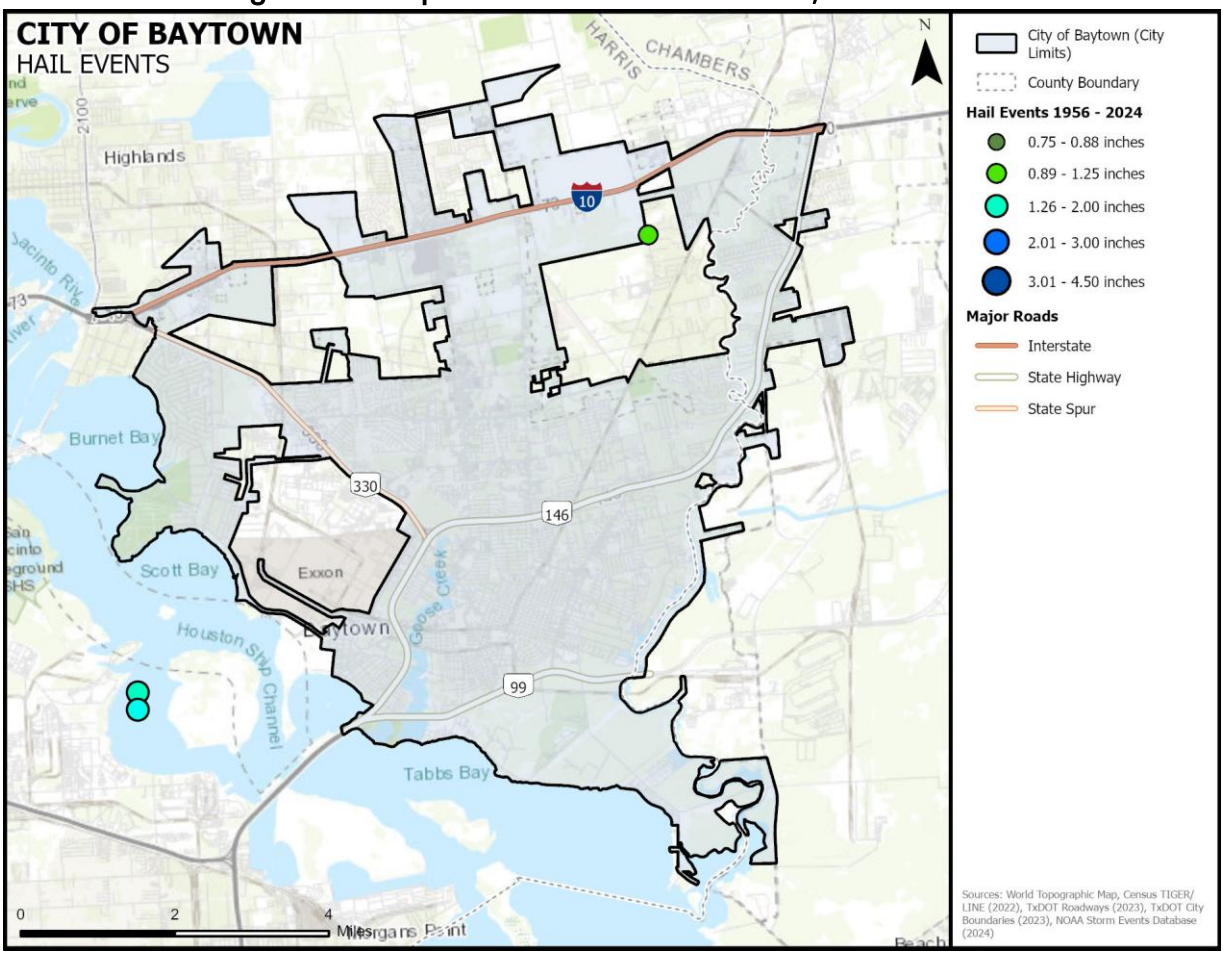

Table 10-2. Damaging Historical Hail Events, 1956 – 2024[3]

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	2/15/1993	1	0	0	$11,000	$0
Harris County	4/3/1993	1.75	0	0	$109,400	$0
Harris County	4/3/1993	0.75	0	0	$11,000	$0
Harris County	4/3/1993	1.75	0	0	$11,000	$0
Chambers County	4/5/1993	0.75	0	0	$1,100	$0
Harris County	5/1/1993	0.75	0	0	$11,000	$0
Harris County	5/1/1993	1.75	0	0	$11,000	$0
Harris County	5/9/1993	1.75	0	0	$11,000	$0
Harris County	10/12/1993	0.75	0	0	$108,100	$0
Harris County	4/5/1994	1.5	0	0	$10,700	$0
Harris County	4/5/1994	1.5	0	0	$10,700	$0
Harris County	4/4/1995	1	0	0	$4,200	$0
Harris County	4/4/1995	1.75	0	0	$2,100	$0
Harris County	4/4/1995	1.75	0	0	$2,100	$0
Harris County	4/20/1995	2.75	0	0	$14,600	$0
Harris County	4/20/1995	1	0	0	$10,400	$0
Harris County	4/20/1995	2.75	0	0	$10,400	$0
Chambers County	4/20/1995	0.88	0	0	$8,300	$0
Harris County	5/11/1995	0.75	0	0	$2,100	$0
Harris County	5/11/1995	0.75	0	0	$2,100	$0
Chambers County	5/11/1995	0.75	0	0	$2,100	$0
Chambers County	5/11/1995	0.75	0	0	$2,100	$0
Harris County	5/18/1995	0.75	0	0	$10,400	$0

[3] Only recorded events with damages are listed. Monetary damages have been inflated to their 2024 value. The database was searched for events between 1950 and 2024. 102 events were reported prior to 1993, however none of these events resulted in reported damages and therefore have not been listed in this table.

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/18/1995	0.75	0	0	$10,400	$0
Harris County	11/2/1995	1.75	0	0	$41,000	$0
Harris County	11/2/1995	1	0	0	$20,500	$0
Harris County	11/2/1995	1	0	0	$20,500	$0
Harris County	11/2/1995	0.75	0	0	$10,300	$0
Harris County	4/22/1996	0.75	0	0	$10,100	$0
Harris County	5/11/1996	0.75	0	0	$10,100	$0
Harris County	5/11/1996	0.75	0	0	$10,100	$0
Chambers County	5/11/1996	0.88	0	0	$10,100	$0
Harris County	6/2/1996	0.75	0	0	$10,100	$0
Harris County	6/2/1996	0.88	0	0	$10,100	$0
Harris County	6/3/1996	0.88	0	0	$10,100	$0
Harris County	6/4/1996	0.75	0	0	$50,300	$0
Harris County	6/4/1996	0.75	0	0	$10,100	$0
Harris County	6/4/1996	0.75	0	0	$10,100	$0
Harris County	6/4/1996	0.75	0	0	$10,100	$0
Harris County	6/4/1996	0.75	0	0	$10,100	$0
Harris County	6/13/1996	0.75	0	0	$10,100	$0
Harris County	6/13/1996	0.75	0	0	$10,100	$0
Harris County	6/13/1996	1	0	0	$10,100	$0
Harris County	6/18/1996	0.75	0	0	$10,100	$0
Harris County	6/18/1996	0.75	0	0	$10,100	$0
City of Baytown	6/20/1996	0.75	0	0	$10,100	$0
Harris County	8/12/1996	0.75	0	0	$10,100	$0
Harris County	8/12/1996	0.75	0	0	$10,100	$0
Harris County	8/19/1996	0.75	0	0	$10,100	$0
Harris County	8/26/1996	0.75	0	0	$10,100	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	1/27/1997	0.75	0	0	$9,900	$0
Harris County	1/27/1997	0.75	0	0	$9,900	$0
Harris County	1/27/1997	0.75	0	0	$9,900	$0
Harris County	1/27/1997	0.75	0	0	$9,900	$0
City of Baytown	4/11/1997	1.5	0	0	$98,300	$0
Harris County	4/11/1997	1.75	0	0	$29,500	$0
Chambers County	4/11/1997	1.75	0	0	$19,700	$0
Harris County	4/11/1997	0.75	0	0	$9,900	$0
Harris County	4/11/1997	1	0	0	$9,900	$0
Harris County	4/11/1997	0.75	0	0	$9,900	$0
Harris County	4/11/1997	0.75	0	0	$9,900	$0
Harris County	4/11/1997	0.75	0	0	$9,900	$0
Harris County	4/11/1997	0.75	0	0	$9,900	$0
Harris County	4/25/1997	1	0	0	$9,900	$0
Harris County	4/27/1997	0.88	0	0	$9,900	$0
Harris County	4/27/1997	0.75	0	0	$9,900	$0
Harris County	4/27/1997	0.75	0	0	$9,900	$0
City of Baytown	4/27/1997	1	0	0	$9,900	$0
Harris County	5/30/1997	0.88	0	0	$9,900	$0
Harris County	5/30/1997	0.75	0	0	$9,900	$0
Harris County	5/30/1997	0.75	0	0	$9,900	$0
Harris County	5/31/1997	0.75	0	0	$9,900	$0
Harris County	6/17/1997	0.75	0	0	$9,900	$0
Harris County	6/21/1997	0.75	0	0	$9,900	$0
Chambers County	8/22/1997	0.75	0	0	$9,800	$0
Chambers County	9/9/1997	1.75	0	0	$29,300	$0
Chambers County	9/9/1997	1.75	0	0	$29,300	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Chambers County	11/18/1997	0.75	0	0	$5,900	$0
Chambers County	1/6/1998	0.88	0	0	$9,800	$0
Chambers County	1/21/1998	1.75	0	0	$19,500	$0
Chambers County	1/21/1998	1.75	0	0	$19,500	$0
Harris County	1/21/1998	1	0	0	$9,800	$0
Harris County	1/21/1998	1	0	0	$9,800	$0
Chambers County	1/21/1998	1	0	0	$9,800	$0
Harris County	1/21/1998	0.75	0	0	$5,900	$0
Harris County	1/21/1998	0.88	0	0	$5,900	$0
Harris County	1/21/1998	0.75	0	0	$5,900	$0
Harris County	1/21/1998	0.75	0	0	$5,900	$0
Harris County	1/21/1998	0.88	0	0	$5,900	$0
Chambers County	1/21/1998	0.75	0	0	$5,900	$0
Chambers County	1/21/1998	1	0	0	$5,900	$0
Chambers County	2/1/1998	0.75	0	0	$5,900	$0
Harris County	2/16/1998	0.75	0	0	$5,900	$0
Harris County	6/5/1998	1.75	0	0	$19,400	$0
Harris County	6/15/1998	0.75	0	0	$9,700	$0
Harris County	7/15/1998	0.75	0	0	$5,800	$0
Harris County	7/17/1998	0.75	0	0	$5,800	$0
Chambers County	8/13/1998	0.75	0	0	$5,800	$0
Harris County	1/1/1999	0.75	0	0	$9,600	$0
Harris County	1/1/1999	0.75	0	0	$5,800	$0
Harris County	1/13/1999	0.75	0	0	$9,600	$0
Harris County	2/27/1999	1.75	0	0	$38,300	$0
Harris County	2/27/1999	0.75	0	0	$5,800	$0
Harris County	3/19/1999	1	0	0	$28,700	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/10/1999	0.88	0	0	$28,500	$0
Harris County	5/10/1999	0.88	0	0	$19,000	$0
Harris County	5/27/1999	1.75	0	0	$142,100	$0
Harris County	5/27/1999	1	0	0	$56,900	$0
Harris County	5/27/1999	0.75	0	0	$19,000	$0
Harris County	5/27/1999	0.75	0	0	$19,000	$0
Harris County	5/27/1999	0.75	0	0	$19,000	$0
Harris County	5/27/1999	0.75	0	0	$19,000	$0
Harris County	5/30/1999	1	0	0	$56,900	$0
Harris County	5/30/1999	1	0	0	$56,900	$0
Harris County	5/30/1999	0.75	0	0	$19,000	$0
Harris County	5/30/1999	0.75	0	0	$19,000	$0
Harris County	5/30/1999	0.75	0	0	$19,000	$0
Harris County	9/8/1999	0.75	0	0	$28,200	$0
Harris County	3/10/2000	1	0	0	$46,000	$0
Harris County	3/10/2000	0.75	0	0	$27,600	$0
Harris County	3/10/2000	0.75	0	0	$18,400	$0
Harris County	4/2/2000	2	0	0	$367,600	$0
Harris County	4/2/2000	1.75	0	0	$183,800	$0
Harris County	4/2/2000	1	0	0	$91,900	$0
Harris County	4/2/2000	1	0	0	$46,000	$0
Chambers County	4/2/2000	0.75	0	0	$18,400	$0
Chambers County	4/2/2000	1	0	0	$18,400	$0
Chambers County	4/3/2000	1.75	0	0	$27,600	$0
Harris County	4/7/2000	1.75	0	0	$91,900	$0
Harris County	4/7/2000	0.88	0	0	$27,600	$0
Harris County	5/2/2000	1	0	0	$27,600	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/3/2000	1	0	0	$91,800	$0
Harris County	5/3/2000	0.75	0	0	$18,400	$0
Harris County	5/4/2000	1.75	0	0	$91,800	$0
Harris County	5/4/2000	0.75	0	0	$27,600	$0
Harris County	5/4/2000	0.75	0	0	$27,600	$0
Harris County	5/4/2000	0.75	0	0	$27,600	$0
City of Baytown	5/4/2000	0.88	0	0	$27,600	$0
Harris County	5/4/2000	0.75	0	0	$18,400	$0
Harris County	7/23/2000	0.75	0	0	$18,300	$0
Harris County	7/23/2000	0.75	0	0	$18,300	$0
Harris County	8/2/2000	1	0	0	$91,100	$0
Harris County	8/2/2000	0.75	0	0	$27,400	$0
Harris County	8/2/2000	0.75	0	0	$27,400	$0
Harris County	3/14/2001	1	0	0	$17,900	$0
Harris County	3/14/2001	0.75	0	0	$17,900	$0
Harris County	3/27/2001	0.75	0	0	$17,900	$0
Harris County	4/16/2001	1.5	0	0	$35,590,300	$0
Harris County	4/16/2001	0.88	0	0	$44,500	$0
Harris County	4/16/2001	0.88	0	0	$35,600	$0
Chambers County	4/16/2001	1.75	0	0	$35,600	$0
Harris County	4/16/2001	0.75	0	0	$26,700	$0
Chambers County	4/16/2001	1	0	0	$26,700	$0
Chambers County	4/16/2001	0.75	0	0	$17,800	$0
Harris County	5/11/2001	1	0	0	$8,900	$0
Harris County	5/11/2001	1.75	0	0	$8,900	$0
Harris County	5/11/2001	0.75	0	0	$5,400	$0
Harris County	5/26/2001	1.75	0	0	$8,900	$0

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JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/26/2001	0.75	0	0	$3,600	$0
Harris County	6/21/2001	0.75	0	0	$8,900	$0
Harris County	6/26/2001	0.88	0	0	$26,600	$0
Harris County	6/26/2001	0.75	0	0	$17,700	$0
Harris County	6/28/2001	0.88	0	0	$53,100	$0
Harris County	6/28/2001	0.75	0	0	$8,900	$0
Harris County	6/29/2001	1	0	0	$35,400	$0
Harris County	6/29/2001	0.75	0	0	$8,900	$0
Harris County	6/29/2001	0.75	0	0	$8,900	$0
Harris County	9/20/2001	0.75	0	0	$3,600	$0
Harris County	9/21/2001	0.75	0	0	$3,600	$0
Harris County	2/21/2002	1	0	0	$26,600	$0
Harris County	2/21/2002	0.75	0	0	$8,900	$0
Harris County	2/21/2002	0.75	0	0	$8,900	$0
Harris County	3/30/2002	1	0	0	$17,700	$0
Harris County	3/30/2002	1	0	0	$17,700	$0
Harris County	3/30/2002	1	0	0	$17,700	$0
Harris County	3/30/2002	0.75	0	0	$8,900	$0
Harris County	5/30/2002	1	0	0	$26,300	$0
Harris County	8/3/2002	1	0	0	$8,800	$0
Harris County	8/23/2002	1	0	0	$8,800	$0
Harris County	10/28/2002	1.75	0	0	$8,700	$0
Harris County	12/23/2002	1	0	0	$8,800	$0
Harris County	12/23/2002	1	0	0	$8,800	$0
Harris County	2/14/2003	1.75	0	0	$8,600	$0
Harris County	2/14/2003	1	0	0	$5,200	$0
Harris County	2/14/2003	0.75	0	0	$1,800	$0

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JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	2/21/2003	0.75	0	0	$12,100	$0
Harris County	2/21/2003	0.75	0	0	$8,600	$0
Harris County	2/21/2003	0.75	0	0	$8,600	$0
Chambers County	4/7/2003	1.75	0	0	$12,000	$0
Harris County	4/7/2003	1.75	0	0	$8,600	$0
Harris County	4/7/2003	1.75	0	0	$8,600	$0
City of Baytown	4/7/2003	1.75	0	0	$8,600	$0
Harris County	4/7/2003	1	0	0	$6,900	$0
Harris County	4/7/2003	1	0	0	$6,900	$0
Harris County	4/7/2003	0.75	0	0	$5,200	$0
Harris County	4/7/2003	0.75	0	0	$5,200	$0
Harris County	4/7/2003	0.75	0	0	$5,200	$0
Harris County	4/7/2003	0.75	0	0	$3,500	$0
Harris County	4/7/2003	0.75	0	0	$3,500	$0
Harris County	4/24/2003	1	0	0	$10,300	$0
Harris County	4/24/2003	0.75	0	0	$8,600	$0
Harris County	4/24/2003	1.75	0	0	$8,600	$0
Harris County	4/24/2003	1.5	0	0	$6,900	$0
Harris County	4/24/2003	0.75	0	0	$5,200	$0
Harris County	4/24/2003	1	0	0	$5,200	$0
Harris County	7/11/2003	1.75	0	0	$13,700	$0
Harris County	8/8/2003	1	0	0	$10,300	$0
Harris County	8/8/2003	0.75	0	0	$3,500	$0
Harris County	8/8/2003	0.75	0	0	$3,500	$0
Harris County	8/8/2003	0.75	0	0	$3,500	$0
Harris County	8/8/2003	0.75	0	0	$3,500	$0
Harris County	8/8/2003	0.75	0	0	$3,500	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	4/6/2004	1	0	0	$16,800	$0
Harris County	4/10/2004	1.75	0	0	$83,800	$0
Harris County	4/10/2004	1.75	0	0	$67,000	$0
Harris County	4/10/2004	1.75	0	0	$50,300	$0
Harris County	4/10/2004	0.75	0	0	$25,200	$0
Harris County	4/10/2004	0.75	0	0	$25,200	$0
Chambers County	4/10/2004	1	0	0	$25,200	$0
Harris County	4/10/2004	0.75	0	0	$16,800	$0
Harris County	4/10/2004	0.88	0	0	$16,800	$0
Chambers County	4/10/2004	0.75	0	0	$16,800	$0
Harris County	4/10/2004	0.75	0	0	$8,400	$0
Harris County	5/17/2004	0.75	0	0	$3,400	$0
Harris County	6/4/2004	1.75	0	0	$166,000	$0
Harris County	6/4/2004	0.88	0	0	$33,200	$0
Harris County	6/5/2004	1	0	0	$16,600	$0
Harris County	6/5/2004	1	0	0	$16,600	$0
Harris County	7/23/2004	0.75	0	0	$10,000	$0
Harris County	10/4/2004	0.88	0	0	$82,500	$0
Harris County	10/4/2004	1	0	0	$33,000	$0
Harris County	2/23/2005	1	0	0	$8,300	$0
Harris County	2/23/2005	1	0	0	$8,300	$0
Harris County	2/23/2005	1	0	0	$8,300	$0
Harris County	2/23/2005	0.75	0	0	$5,000	$0
Harris County	2/24/2005	1	0	0	$16,500	$0
Harris County	3/7/2005	1	0	0	$40,800	$0
Harris County	3/7/2005	0.75	0	0	$8,200	$0
Harris County	3/7/2005	0.75	0	0	$8,200	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	3/7/2005	0.75	0	0	$8,200	$0
Harris County	3/13/2005	1.75	0	0	$31,300	$0
Harris County	3/19/2005	1	0	0	$40,800	$0
Harris County	3/19/2005	1	0	0	$40,800	$0
Harris County	3/19/2005	0.75	0	0	$8,200	$0
Harris County	3/21/2005	0.75	0	0	$9,800	$0
Harris County	4/11/2005	0.88	0	0	$8,100	$0
Harris County	5/8/2005	0.75	0	0	$8,100	$0
Harris County	6/14/2005	0.75	0	0	$6,500	$0
City of Baytown	7/6/2005	0.75	0	0	$24,200	$0
Harris County	7/11/2005	1	0	0	$14,500	$0
Harris County	3/20/2006	0.75	0	0	$7,900	$0
Harris County	3/29/2006	0.75	0	0	$7,900	$0
Chambers County	4/24/2006	1.75	0	0	$23,500	$0
Chambers County	4/25/2006	1.75	0	0	$23,500	$0
Harris County	5/4/2006	3	0	0	$155,500	$0
Harris County	5/4/2006	1.5	0	0	$116,600	$0
Harris County	5/4/2006	1.75	0	0	$77,800	$0
Harris County	5/4/2006	1.25	0	0	$46,700	$0
Harris County	5/4/2006	1	0	0	$31,100	$0
Harris County	5/4/2006	0.88	0	0	$15,600	$0
Harris County	5/4/2006	1	0	0	$10,900	$0
Harris County	5/4/2006	1	0	0	$10,900	$0
Harris County	5/4/2006	0.88	0	0	$6,300	$0
Harris County	5/4/2006	0.75	0	0	$4,700	$0
Harris County	5/4/2006	0.75	0	0	$4,700	$0
Harris County	5/4/2006	0.75	0	0	$4,700	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/14/2006	0.88	0	0	$15,600	$0
Harris County	5/14/2006	0.88	0	0	$9,400	$0
Harris County	5/14/2006	0.75	0	0	$6,300	$0
Harris County	5/14/2006	0.75	0	0	$6,300	$0
Harris County	5/14/2006	0.75	0	0	$6,300	$0
Harris County	12/21/2006	0.88	0	0	$6,300	$0
Harris County	3/12/2007	1	0	0	$15,400	$0
Harris County	3/13/2007	0.88	0	0	$4,600	$0
Harris County	3/14/2007	0.75	0	0	$23,000	$0
Harris County	3/14/2007	0.75	0	0	$23,000	$0
Harris County	11/21/2007	0.75	0	0	$4,500	$0
Harris County	6/18/2008	1.25	0	0	$24,500	$0
Harris County	6/18/2008	1	0	0	$21,600	$0
Harris County	6/18/2008	0.88	0	0	$11,600	$0
Harris County	6/18/2008	0.88	0	0	$11,600	$0
Harris County	6/19/2008	1	0	0	$10,100	$0
Harris County	6/19/2008	1.25	0	0	$10,100	$0
Harris County	6/19/2008	0.88	0	0	$7,200	$0
Harris County	10/22/2008	1.75	0	0	$7,300	$0
Harris County	10/22/2008	0.75	0	0	$1,500	$0
Harris County	11/12/2008	0.75	0	0	$1,500	$0
Harris County	3/27/2009	2	0	0	$31,100	$0
Harris County	3/27/2009	1.75	0	0	$11,900	$0
Harris County	3/27/2009	1.75	0	0	$10,400	$0
Harris County	3/27/2009	1	0	0	$7,400	$0
Harris County	3/27/2009	1	0	0	$7,400	$0
Harris County	3/27/2009	1	0	0	$4,500	$0

SECTION 10: HAIL

JURISDICTION	DATE	MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	3/27/2009	1.75	0	0	$3,000	$0
Harris County	3/27/2009	1	0	0	$3,000	$0
Harris County	3/27/2009	1	0	0	$1,500	$0
Harris County	4/12/2009	1	0	0	$1,500	$0
Harris County	4/17/2009	1	0	0	$8,900	$0
Harris County	2/8/2010	0.88	0	0	$1,500	$0
Harris County	5/26/2011	1.5	0	0	$188,000	$0
Chambers County	5/26/2011	1.75	0	0	$1,400	$0
Harris County	4/2/2012	1	0	0	$4,200	$0
Harris County	4/20/2012	1	0	0	$2,800	$0
Harris County	6/12/2012	1	0	0	$6,900	$0
City of Baytown	2/20/2014	1	0	0	$1,400	$0
Harris County	4/19/2015	2	0	0	$20,000	$0
Harris County	4/19/2015	2.75	0	0	$12,000	$0
Harris County	4/19/2015	1.75	0	0	$4,000	$0
Harris County	4/19/2015	1.75	0	0	$4,000	$0
Harris County	4/19/2015	1.75	0	0	$4,000	$0
Harris County	1/8/2016	2.5	0	0	$20,000	$0
Harris County	1/8/2016	1.75	0	0	$8,000	$0
Harris County	1/8/2016	1.75	0	0	$6,700	$0
Harris County	1/8/2016	1	0	0	$6,700	$0
Harris County	5/12/2016	1.75	0	0	$6,600	$0
Harris County	5/12/2016	1	0	0	$4,000	$0
Harris County	5/12/2016	1	0	0	$4,000	$0
Harris County	8/1/2016	Unknown	0	0	$18,800	$0
TOTALS		**(Max Extent)**	0	**0**	**$42,108,400**	**$0**

SECTION 10: HAIL

Table 10-3. Historical Hail Events Summary, 1956 – 2024

JURISDICTION	NUMBER of EVENTS	MAX MAGNITUDE (inches)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
City of Baytown	7	1.75	0	0	$180,100	$0
Chambers County	53	2	0	0	$446,700	$0
Harris County	583	3	0	0	$41,481,600	$0
TOTAL LOSSES	643	(Max Extent)	0	0	$42,108,400	

Based on the list of historical hail events for the City of Baytown planning area, there have been no reported events since the 2020 Plan. However, there have been 89 reported events in Harris and Chambers Counties since 2020.

SIGNIFICANT EVENTS

April 11, 1997 – City of Baytown

During the evening hours, hail between 0.75 and 1.75 inches in diameter was reported across several areas of Harris County, with the most significant damages reported in the City of Baytown. In all of Harris County, property damage from this hailstorm was estimated at $206,900 (2024 dollars), with the City of Baytown accounting for $98,300 (2024 dollars) of the total damages. This is the most damaging hail event in terms of monetary losses that's been reported in the City of Baytown.

April 16, 2001 – Harris and Chambers Counties

Widespread hail ranging from 0.75 to 1.75 inches in diameter was reported across Harris and Chambers Counties. Up to several inches of hail remained accumulated on the ground in some areas 24 hours after the storm had subsided. Major impacts from this hailstorm included numerous reports of broken windows and trees and shrubs stripped of their leaves. Across seven different hail event reports in the NCEI database, total property damages across both counties were estimated at $35,777,200 (2024 dollars).

May 4, 2006 – Harris County

A large storm affecting much of Harris County led to very large, damaging hail up to 3.0 inches in diameter. This is the largest hail reported in the NCEI database for Harris or Chambers Counties. Across 12 event reports for hail made throughout Harris County, the total property damage was estimated at $485,500 (2024 dollars).

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PROBABILITY OF FUTURE EVENTS

There are 7 recorded historical occurrences of hail within the City of Baytown planning area. However, hail events are often reported at the county level as they impact several jurisdictions at one time. Between Harris and Chambers Counties, there has been a total of 643 reported hail events within a 68-year reporting period. Based on this analysis, hail is considered "Highly Likely" for the City of Baytown planning area, meaning an event is probable within the next year.

CLIMATE CHANGE CONSIDERATIONS

Although the impact of climate change on the frequency and severity of hail events is uncertain, some climate studies attempt to give insight on the future conditions of hailstorms. As ocean temperatures rise due to climate change, more moisture is evaporating into the atmosphere. The warm and moist air masses that fuel severe weather may become more unstable on average, which could favor the increased development of thunderstorms and hail. However, it is also suggested that in a warming climate, the average melting level will rise in thunderstorms, meaning small hailstones will have more of a chance to melt as they fall to the ground. Therefore, hail may become less frequent, but large hail can be expected when it does occur, leading to the possibility of increased damages.[4]

VULNERABILITY AND IMPACT

Much of the damage inflicted by hail is to crops. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are most damaged by hail.

Utility systems on roofs of buildings and critical facilities would be vulnerable and could be damaged. Hail could cause a significant threat to people, as they could be struck by hail and falling trees and branches. Outdoor activities and events may elevate the risk to residents and visitors when a hailstorm strikes with little warning. Portable buildings typically utilized by schools and commercial sites such as construction areas would be more vulnerable to hail events than the typical site-built structures.

[4] Yale Climate Connections, Hailstorms and Climate Change, March 17, 2022.

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The City of Baytown planning area features mobile or manufactured home parks throughout the planning area. These parks are typically more vulnerable to hail events than typical site-built structures. In addition, manufactured homes are located sporadically throughout the planning area. The U.S. Census data indicates a total of 2,038 (6 percent of total housing stock) manufactured homes located in the City of Baytown planning area. In addition, 49 percent (16,575 structures) of the housing structures in the City of Baytown planning area were built before 1980. These structures would typically be built to lower or less stringent construction standards than newer construction and may be more susceptible to damage during significant wind events.

Table 10-4. Structures at Greater Risk

JURISDICTION	BUILT PRIOR TO 1980	MANUFACTURED HOME
City of Baytown	16,575	2,038

While all citizens are at risk of the impacts of hail, forced relocation and disaster recovery disproportionately impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. An estimated 18 percent of the planning area population live below the poverty level (Table 10-5). While warning times for this type of hazard events should be substantial enough for these individuals to seek shelter, the elderly, children, and people with a disability may have trouble taking shelter due to mobility issues or a lack of awareness, making them more susceptible to injury or harm. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures.

Table 10-5. Populations at Greatest Risk[5]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

[5] US Census Bureau 2023 data for the City of Baytown

SECTION 10: HAIL

The City of Baytown Planning Team identified the following critical facilities (Table 10-6) as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by hail events. For a comprehensive list of critical facilities, please see Appendix F.

Table 10-6. Critical Facilities Vulnerable to Hail

CRITICAL FACILITY TYPE	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by hailstones. • Power outages could disrupt communications, delaying emergency response times. • Accumulated hail on the streets may impede emergency response vehicle access to areas. • Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/ Assisted Living Facilities	• Structures can be damaged by hailstones. • Power outages could disrupt critical care. • Backup power sources could be damaged. • Evacuations may be necessary due to extended power outages, gas line ruptures, or structural damage to facilities. • Power outages and infrastructure damage may prevent larger airports from acting as temporary command centers for logistics, communications, and emergency operations. • Temporary break in operations may significantly inhibit post event evacuations. • Damaged or destroyed highway infrastructure may substantially increase the need for airport operations.
Commercial Supplier (Food, fuel, etc.)	• Facilities or infrastructure may be damaged, destroyed or otherwise inaccessible. • Essential supplies like medicines, water, food, and equipment deliveries may be significantly delayed.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Power outages could disrupt communications, delaying emergency response times. • Accumulated hail on the streets may impede service response vehicle access to areas.

CRITICAL FACILITY TYPE	POTENTIAL IMPACTS
	• Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.

Hail has been known to cause injury to humans and occasionally has been fatal. There are no recorded fatalities or injuries due to hail in the City of Baytown planning area or reported elsewhere in Chambers and Harris Counties. Overall, the total loss estimate of property in the planning area is $180,100 (2024 dollars) with an average annualized loss of $2,700. For all of Chambers and Harris Counties, the total loss estimate is $42,108,400 (2024 dollars) with an average annualized loss of $619,300.

Based on historic loss and damages, the impact of hail damages on the City of Baytown planning area can be considered "Limited" severity of impact, meaning minor quality of life lost, critical facilities and services shut down for 24 hours or less, and less than 10 percent of property destroyed or with major damage.

Table 10-7. Estimated Annualized Losses by Jurisdiction

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
City of Baytown	$180,100	$2,700
Chambers County	$446,700	$6,600
Harris County	$41,481,600	$610,000
TOTALS	$42,108,400	$619,300

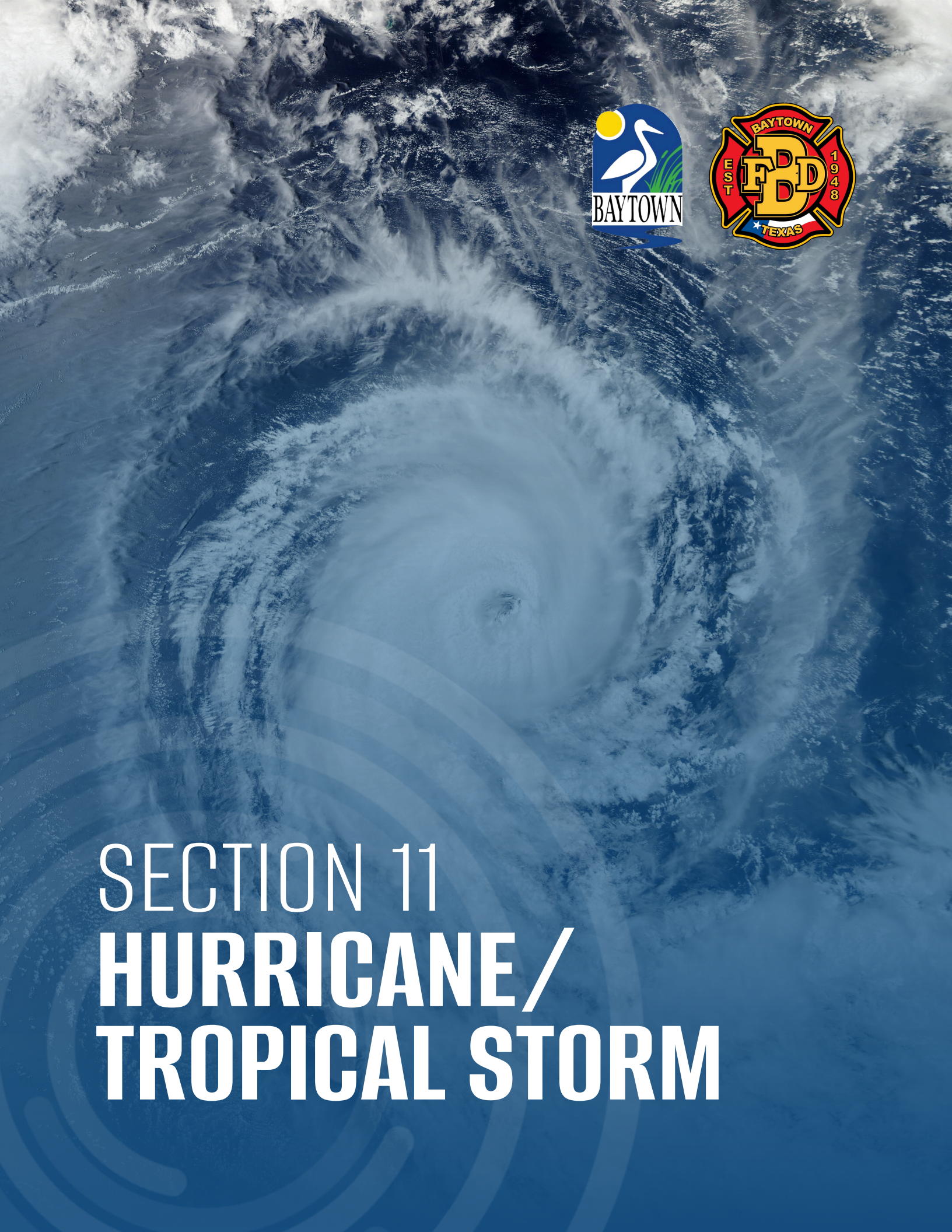
ASSESSMENT OF IMPACTS

Hail events have the potential to pose a significant risk to people and can create dangerous situations. Hail conditions can be frequently associated with a variety of impacts, including:

- Hail may create hazardous road conditions during and immediately following an event, potentially delaying critical staff from reporting for duty as well as delaying first responders from providing for or preserving public health and safety.
- Individuals and first responders who are exposed to the storm may be struck by hail, falling branches, or downed trees resulting in injuries or possible fatalities.

- Large hail events will likely cause extensive roof damage to residential structures along with siding damage and broken windows, creating a spike in insurance claims and a rise in premiums, and potentially result in physical harm to occupants.
- Automobile damage may be extensive depending on the size of the hail and length of the storm.
- Hail events can result in power outages over widespread areas increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage can result in an increase in structure fires and/or carbon monoxide poisoning, as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- First responders are exposed to downed power lines, damaged structures, hazardous spills, and debris that often accompany hail events, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Some businesses not directly damaged by the hail event may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damage without a backup power source.
- Depending on the severity and scale of damage caused by large hail events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- A significant hail event could significantly damage agricultural crops, resulting in extensive economic losses for the community and surrounding area.
- Hail events may injure or kill livestock and wildlife or destroy wildlife habitat.
- A large hail event could impact the accessibility of recreational areas and parks due to extended power outages or debris clogged access roads.
- Historical sites and properties are placed at a higher risk of impact due to materials used and the inability to change properties due to their historic status. There are two historic sites listed on the National Register of Historic Places in the City of Baytown.

The economic and financial impacts of hail will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning conducted by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of any hail event.



SECTION 11
HURRICANE/ TROPICAL STORM

SECTION 11: HURRICANE / TROPICAL STORM

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HAZARD DESCRIPTION

According to the National Oceanic and Atmospheric Administration (NOAA), a hurricane is an intense tropical weather system of strong thunderstorms with well-defined surface circulation and maximum sustained winds of 74 mph or higher. In the Northern Hemisphere, circulation of winds near the Earth's surface is counterclockwise.



Hurricanes often begin as tropical depressions that intensify into tropical storms when maximum sustained winds increase to between 35–64 knots (39–73 mph). At these wind speeds, the storm becomes more organized and circular in shape and begins to resemble a hurricane. Tropical storms can be equally problematic without ever becoming a hurricane. Tropical storms resulting in high winds and heavy rainfall can be dangerous to people and property, as Tropical Storm Frances was for southeast Texas in September 1998. Once sustained winds reach or exceed 74 mph, the storm becomes a hurricane. The intensity of a landfalling hurricane is expressed in categories relating wind speeds to potential damage. Tropical storm-force winds are strong enough to be dangerous to those caught in them. For this reason, emergency managers plan to have evacuations completed and personnel sheltered before winds of tropical storm-force arrive, which precedes the arrival of hurricane-force winds.

SECTION 11: HURRICANE / TROPICAL STORM

LOCATION

The City of Baytown lies along the Texas Coast in an area with a thirty-seven percent (37%) chance of a hurricane, extreme hurricane or tropical storm occurring in any given year.[1] The planning areas location means that it is vulnerable, exposed and susceptible to threats directly and indirectly related to a hurricane event, such as high-force winds and flooding. Hurricanes and tropical storms typically impact the City of Baytown from June to November, the official Atlantic U.S. hurricane season. The City of Baytown planning area is in a high-risk area for hurricane wind speeds up to 200 miles per hour (mph).

EXTENT

As a hurricane develops, the barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour, the storm is deemed a hurricane.

Hurricanes are categorized according to the strength and intensity of their winds using the Saffir-Simpson Hurricane Scale (Table 11-1). A Category 1 storm has the lowest wind speeds, while a Category 5 hurricane has the highest. However, a lower category storm can inflict greater damage than higher category storms depending on where they strike, the amount of storm surge, other weather they interact with, and how slow they move.

Table 11-1. Extent Scale for Hurricanes[2]

CATEGORY	MAXIMUM SUSTAINED WIND SPEED (mph)	MINIMUM SURFACE PRESSURE (millibars)	STORM SURGE (feet)
1	74 – 95	Greater than 980	3 – 5
2	96 – 110	979 – 965	6 – 8
3	111 – 130	964 – 945	9 – 12

[1] City of Baytown Flood Mitigation Plan, prepared by the City of Baytown Floodplain Mitigation Planning Committee, 11/29/2005.

[2] Source: National Hurricane Center, https://www.nhc.noaa.gov/HAW2/english/basics/saffir_simpson.shtml

SECTION 11: HURRICANE / TROPICAL STORM

CATEGORY	MAXIMUM SUSTAINED WIND SPEED (mph)	MINIMUM SURFACE PRESSURE (millibars)	STORM SURGE (feet)
4	131 – 155	944 – 920	13 – 18
5	155+	Less than 920	19+

Based on the historical storm tracks for hurricanes and tropical storms, as well as the location of the City of Baytown, the maximum estimated extent to be mitigated for is a Category 5 storm. This is the worst the planning area can anticipate based on historical records.

HISTORICAL OCCURRENCES

Historical systems that have tracked across the City of Baytown or in close proximity to the planning area between 1900 and 2024, bringing storm systems, excessive precipitation and potentially damaging wind to are listed in Table 11-2 below.

According to the historical hurricane tracks from NOAA's National Hurricane Center, there have been 76 storms that are known to have come within 100 miles of the City of Baytown planning area from 1900 through 2024. For the purposes of this analysis, 11 additional tropical cyclones whose paths fell outside of the 100-mile radius have also been incorporated due to their reported impacts on Harris and Chambers Counties.

Table 11-2 lists hurricanes and tropical storms that impacted Harris and Chambers Counties, as reported in the NCEI database. Hurricane data is provided on a countywide basis in this database. Data from both counties has been incorporated into this analysis, as the City of Baytown spans both counties. Some damages were reported under flooding in the NCEI database; an analysis was performed to cross reference applicable hurricane and tropical storm events to create the most comprehensive dataset possible.

Not all events or impacts are recorded in the NCEI, so damages and events are often unreported or underreported. The NCEI database only contains hurricane data beginning in 1996. Damages for older hurricane and tropical storm events have been provided by the Planning Team and local input where possible.

SECTION 11: HURRICANE / TROPICAL STORM

Table 11-2. Historical Hurricane / Tropical Storm Events, 1900 – 2024[3][4]

DATE	STORM NAME	CATEGORY (max)	DEATHS	INJURIES	PROPERTY AND CROP DAMAGE
8/27/1900 – 9/15/1900	Unnamed	Category 4	8,000	0	$36,810,000
7/1/1901 – 7/10/1901	Unnamed	Tropical Storm	0	0	$0
7/19/1908 – 8/3/1908	Unnamed	Tropical Storm	0	0	$0
9/16/1908 – 9/18/1908	Unnamed	Tropical Storm	0	0	$0
7/13/1909 – 7/22/1909	Unnamed	Category 3	0	0	$0
9/15/1914 – 9/19/1914	Unnamed	Tropical Storm	0	0	$0
8/5/1915 – 8/23/1915	Unnamed	Category 4	0	0	$68,711,500
8/1/1918 – 8/7/1918	Unnamed	Category 3	0	0	$0
6/16/1921 – 6/26/1921	Unnamed	Category 1	0	0	$0
8/20/1926 – 8/27/1926	Unnamed	Category 3	0	0	$0
8/12/1932 – 8/15/1932	Unnamed	Category 4	40	0	$0
7/14/1933 – 7/27/1933	Unnamed	Tropical Storm	0	0	$0
8/26/1934 – 9/1/1934	Unnamed	Category 1	0	0	$0
8/10/1938 – 8/15/1938	Unnamed	Category 2	0	0	$0
10/10/1938– 10/17/1938	Unnamed	Tropical Storm	0	0	$0
8/3/1940 – 8/10/1940	Unnamed	Category 2	0	0	$0
9/18/1940 – 9/25/1940	Unnamed	Tropical Storm	0	0	$0
9/11/1941 – 9/16/1941	Unnamed	Tropical Storm	0	0	$0
9/17/1941 – 9/27/1941	Unnamed	Category 3	0	0	$0
8/17/1942 – 8/23/1942	Unnamed	Category 1	0	0	$0
7/25/1943 – 7/30/1943	Unnamed	Category 2	0	0	$20,245,400
10/1/1943	Unnamed	Unknown	0	0	$0
8/24/1945 – 8/29/1945	Unnamed	Category 3	0	0	$0

[3] Source: NOAA Historical Hurricane Tracks, https://coast.noaa.gov/hurricanes/#map=4/32/-80

[4] Impacts from events reported prior to 1996 are based on historical records and local knowledge. Damage values are in 2024 dollars.

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DATE	STORM NAME	CATEGORY (max)	DEATHS	INJURIES	PROPERTY AND CROP DAMAGE
6/13/1946 – 6/16/1946	Unnamed	Tropical Storm	0	0	$0
8/18/1947 – 8/27/1947	Unnamed	Category 1	0	0	$0
9/27/1949 – 10/7/1949	Unnamed	Category 2	0	0	$0
7/27/1954 – 7/30/1954	Barbara	Tropical Storm	0	0	$0
8/25/1955 – 8/28/1955	Unnamed	Tropical Storm	0	0	$0
6/24/1957 – 6/29/1957	Audrey	Category 3	0	0	$0
8/8/1957 – 8/11/1957	Bertha	Tropical Storm	0	0	$0
9/14/1958 – 9/22/1958	Gerda	Tropical Storm	0	0	$0
7/22/1959 – 7/27/1959	Debra	Category 1	0	0	$0
9/3/1961 – 9/18/1961	Carla	Category 4	34	0	$0
9/16/1963 – 9/20/1963	Cindy	Tropical Storm	0	0	$0
8/5/1964 – 8/8/1964	Abby	Tropical Storm	0	0	$0
9/5/1967 – 9/24/1967	Beulah	Category 5	15	0	$122,699,200
9/12/1970 – 9/19/1970	Felice	Tropical Storm	0	0	$0
7/7/1971 – 7/8/1971	Unnamed	Tropical Depression	0	0	$0
9/3/1971 – 9/13/1971	Fern	Category 1	2	0	$36,810,000
9/5/1971 – 9/18/1971	Edith	Category 5	0	0	$0
9/1/1973 – 9/7/1973	Delia	Tropical Storm	0	0	$0
9/6/1973 – 9/12/1973	Unnamed	Tropical Depression	0	0	$0
7/13/1974 – 7/17/1974	Unnamed	Tropical Depression	0	0	$0
8/24/1974 – 8/26/1974	Unnamed	Tropical Depression	0	0	$0
8/29/1974 – 9/10/1974	Carmen	Category 4	0	0	$0
6/13/1977 – 6/14/1977	Unnamed	Tropical Depression	0	0	$0
8/26/1978 – 8/29/1978	Debra	Tropical Storm	0	0	$0
7/15/1979 – 7/29/1979	Claudette	Tropical Storm	0	0	$858,894,100

SECTION 11: HURRICANE / TROPICAL STORM

DATE	STORM NAME	CATEGORY (max)	DEATHS	INJURIES	PROPERTY AND CROP DAMAGE
8/30/1979 – 9/2/1979	Elena	Tropical Storm	0	0	$0
7/17/1980 – 7/21/1980	Unnamed	Tropical Depression	0	0	$0
9/4/1980 – 9/7/1980	Danielle	Tropical Storm	0	0	$0
6/3/1981 – 6/5/1981	Unnamed	Tropical Depression	0	0	$0
9/9/1982 – 9/12/1982	Chris	Tropical Storm	0	0	$0
8/15/1983 – 8/21/1983	Alicia	Category 3	21	3,094	$3,680,991,000
6/23/1986 – 6/28/1986	Bonnie	Category 1	0	0	$0
8/9/1987 – 8/17/1987	Unnamed	Tropical Storm	0	0	$0
6/24/1989 – 7/1/1989	Allison	Tropical Storm	11	0	$613,495,800
7/30/1989 – 8/3/1989	Chantal	Category 1	13	0	$122,699,200
10/12/1989 – 10/16/1989	Jerry	Category 1	3	0	$85,889,400
7/28/1995 – 8/2/1995	Dean	Tropical Storm	0	0	$0
8/21/1998 – 8/24/1998	Charley	Tropical Storm	0	0	$9,700
9/8/1998 – 9/13/1998	Frances	Tropical Storm	3	0	$406,191,800
9/8/2000 – 9/9/2000	Unnamed	Tropical Depression	0	0	$0
6/5/2001 – 6/19/2001	Allison	Tropical Storm	22	0	$6,136,014,100
8/4/2002 – 8/9/2002	Bertha	Tropical Storm	0	0	$0
9/5/2002 – 9/11/2002	Fay	Tropical Storm	0	3	$4,320,570
7/7/2003 – 7/17/2003	Claudette	Category 1	0	0	$13,374,200
8/30/2003 – 9/2/2003	Grace	Tropical Storm	0	0	$56,600
9/2/2004 – 9/24/2004	Ivan	Category 5	0	0	$0
8/23/2005-8/31/2005	Katrina	Category 5	0	0	$0
9/18/2005 – 9/26/2005	Rita	Category 5	7	0	$155,181,200
8/13/2007-8/23/2007	Dean	Category 5	0	0	$0
8/15/2007 – 8/19/2007	Erin	Tropical Storm	3	0	$1,135,600

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DATE	STORM NAME	CATEGORY (max)	DEATHS	INJURIES	PROPERTY AND CROP DAMAGE
9/12/2007 – 9/14/2007	Humberto	Category 1	1	0	$62,453,900
8/25/2008-9/5/2008	Gustav	Category 4	0	0	$0
8/3/2008 – 8/6/2008	Edouard	Tropical Storm	0	0	$7,200
9/1/2008 – 9/15/2008	Ike	Category 4	37	0	$27,362,024,700
6/16/2015 – 6/21/2015	Bill	Tropical Storm	0	0	$0
6/19/2017 – 6/24/2017	Cindy	Tropical Storm	0	0	$0
8/16/2017 – 9/2/2017	Harvey	Category 4	104	0	$165,645,281,000
9/17/2019 – 9/19/2019	Imelda	Tropical Storm	2	0	$343,358,000
7/23/2020-7/26/2020	Hanna	Category 1	0	0	$0
8/20/2020 – 8/29/2020	Laura	Category 4	0	0	$0
9/17/2020 – 9/25/2020	Beta	Tropical Storm	0	0	$1,149,300
10/4/2020 – 10/11/2020	Delta	Category 4	0	0	$0
9/12/2021 – 9/17/2021	Nicholas	Category 1	0	0	$0
6/28/2021 – 7/11/2024	Beryl	Category 5	4	0	$175,685,000
Total Losses			8,322	3,097	$205,953,488,470

Based on the list of historical hurricane events for the City of Baytown planning area, six events have occurred since the 2020 Plan.

SIGNIFICANT EVENTS

There have been 18 declared disasters and emergency declarations between 1953 and 2024 which included Harris or Chambers Counties (Table 11-3) related to hurricane or tropical storm events.

Table 11-3. Disaster Declarations for Hurricane / Tropical Storm, 1953 – 2024

YEAR	DECLARATION TITLE	DECLARATION TYPE	DISASTER NO.
1983	Hurricane Alicia	DR	689
1989	Tropical Storm Allison	DR	836
1998	Tropical Storm Charley	DR	1239
1998	Tropical Storm Frances	DR	1245

SECTION 11: HURRICANE / TROPICAL STORM

YEAR	DECLARATION TITLE	DECLARATION TYPE	DISASTER NO.
2001	Tropical Storm Allison 06-06-2001	DR	1379
2005	Hurricane Katrina Evacuation	EM	3216
2005	Hurricane Rita	EM	3261
2005	Hurricane Rita	DR	1606
2007	Hurricane Dean	EM	3277
2007	Tropical Storm Erin	DR	1730
2008	Hurricane Gustav	EM	3290
2008	Hurricane Ike	EM	3294
2008	Hurricane Ike	DR	1791
2017	Hurricane Harvey	DR	4332
2019	Tropical Storm Imelda	DR	4466
2020	Hurricane Hanna	EM	3530
2020	Tropical Storms Marco and Laura	EM	3540
2024	Hurricane Beryl	DR	4798

Unnamed Galveston Hurricane: August 27 – September 15, 1900

The Galveston hurricane of 1900 was the deadliest weather disaster in United States history. First detected over the Atlantic Ocean on August 27, this weather system became a Category 4 hurricane by the time it made landfall south of Galveston on September 8. Storm tides, estimated between 8 and 15 feet, inundated Galveston Island and other communities nearby on the Texas coast. These high tides were responsible for a large percentage of the 6,000 to 12,000 estimated deaths caused by this storm. Property damage was estimated at the time at $30,000,000, with thousands of homes being destroyed or significantly damaged. Exact data on what percentage of these fatalities or monetary damages occurred in Harris or Chambers counties, or the City of Baytown planning area, is unavailable.

Hurricane Alicia: August 15 – August 21, 1983

Hurricane Alica formed over the north-central Gulf of Mexico on August 15 and drifted slowly northwest, strengthening on this path until it made landfall on August 18 as a

Category 3 hurricane. The storm first moved over the western end of Galveston Island, before continuing northwest through Texas and Oklahoma before ultimately dissipating in Nebraska on August 21. During the storm's apex, Hobby Airport in the City of Houston reported sustained winds of 94 mph and wind gusts up to 107 mph. These winds littered downtown Houston with broken glass as high-rise buildings had windows blown out. Additionally, this storm also brought 23 reported tornadoes. Huge storm surge values and water level rises were reported across the coast. In the City of Baytown, water level rose 10.7 feet, with water levels reaching the tops of building in the Brownwood subdivision. Following this storm, that subdivision was completely bought out due to the frequent flooding issues. In total, Hurricane Alicia caused 21 fatalities, 3,094 injuries, and an estimated $3,680,991,000 (2024 dollars) in damages.

Tropical Storm Allison: June 5 – June 19, 2001

Tropical Storm Allison began as an area of disturbed weather over the northwestern Gulf of Mexico on June 5, rapidly developing into a tropical storm by the time it made landfall near the City of Freeport later that day. Once over land, the tropical storm stalled over Harris County for four hours, resulting in rainfall totals as high as 12 inches across the county. By the end of the storm, as much as 28 inches of rainfall was reported in part of Harris County, and 37 inches of rainfall was reported at the Port of Houston. Tropical-storm force winds and high tides also resulted from Tropical Storm Allison along the Texas coast, but the greatest damages were caused by the widespread heavy rain and resulting flooding. Many of the worst affected areas were in Harris County, where over 73,000 residences and hundreds of businesses were flooded. Tropical Storm Allison also resulted in 22 fatalities within Harris County. In total, damages in Harris and Chambers Counties were estimated at $6,136,014,100 (2024 dollars).

Hurricane Rita: September 18 – September 26, 2005

Hurricane Rita formed east of the Bahamas and moved into the eastern Gulf of Mexico on September 20, rapidly intensifying from a Category 2 to a Category 5 hurricane by September 21. By the time Rita made landfall near the Louisiana-Texas state line, the storm was a Category 3 hurricane with 120 mph winds. Although Harris and Chambers Counties were to the west on the weaker side of the hurricane, impacts were still felt in that region including the City of Baytown. These included power outages caused by sustained and damaging winds, and beach erosion and storm surge flooding occurring along some areas of the Texas coast. This event provoked one of the largest evacuations in U.S. history, with over 2 million coastal Texans heading inland which resulted in long traffic delays. In Harris County, 7 fatalities were reported as being directly caused by

Hurricane Rita. Both Harris and Chambers Counties reported additional fatalities that were indirectly related, most of those occurring during the evacuation prior to the storm during extreme heat. Between Chambers and Harris Counties, total damages were estimated at $155,181,200 (2024 dollars).

Hurricane Ike: September 1 – September 15, 2008

Hurricane Ike, which moved into the Gulf of Mexico on September 9 as a Category 1, made landfall as a Category 2 hurricane along the north end of Galveston Island in the early morning of September 13. By the end of that day, Ike had weakened to a tropical storm just east of Palestine, Texas. Maximum windspeeds during the storm were estimated up to 110 mph. The storm surge along the upper Texas coast was among the highest ever recorded, causing extensive surge and wave-related damages from Matagorda County up to the Louisiana state line. Excessive rainfall of 8 to 12 inches caused inland flooding across Harris County, including over 150 homes. Wind damage also struck the county, leading to widespread damage to structures, vegetation, and power systems. Across Harris, Chambers, Montgomery, and Liberty Counties, over 2 million people were affected by power outages lasting as long as 21 to 25 days. In Harris County, Hurricane Ike and the resulting flooding caused 37 reported fatalities as well as an estimated $27,362,024,700 (2024 dollars) in property damage.

Hurricane Harvey: August 16 – September 2, 2017

Hurricane Harvey made landfall as a Category 4 hurricane near the City of Rockport on the evening of August 25. After this initial path onto land, the storm looped back and tracked over southeast Texas and the Gulf of Mexico before making a second landfall along the Louisiana coast. Over the five days Harvey hovered above southeast Texas, the storm produced catastrophic flooding over a large area with 30 to 60 inches of rainfall. Additional hazards brought by the storm included 23 tornadoes, tropical storm-force winds, and moderate storm surge. With some bands of rain falling at a rate above 5 inches per hour, thousands of homes, businesses, and roads were inundated with major flooding. Nearly all bayous in rivers in Harris and Chambers Counties experienced catastrophic flooding. At Lake Houston, water entered the lake at a rate of 430,000 cubic feet per second, causing the lake to reach an elevation of 53.01 feet. The Lake Houston Dam was not able to release water fast enough, leading to backups which contributed to the flooding of thousands of homes and businesses in the Lake Houston area. In Harris and Chambers Counties, Hurricane Harvey and the resulting floods caused over 100 fatalities and an estimated $165,645,281,000 (2024 dollars) in damages to property and crops.

Figure 11-1. Flood waters in the City of Baytown following Hurricane Harvey[5]



Hurricane Beryl: June 28 – July 11, 2024

Hurricane Beryle made landfall in the early morning of July 8 near the City of Matagorda, bringing sustained winds of 74 mph and wind gusts of up to 97 mph. On average, Beryl produced 4 to 8 inches of rainfall, with some areas receiving as much as 10 to 15 inches of rain. The storm also produced surge flooding up to 8 feet. Across Chambers and Harris Counties, the damaging winds caused widespread damage to trees, power lines, and buildings. Extensive flooding resulting from Beryl also impacted both counties, inundating many structures and roadways. The Planning Team reported $350,000 in flooding damages in the City of Baytown planning area alone. In Harris County, 4 fatalities were attributed directly to the hurricane and 8 additional fatalities were deemed indirectly related. These included 6 fatalities caused by heat-related illness and 2 due to trauma suffered while clearing debris. The total property damage estimate for Harris and Chambers Counties was $175,685,000 (2024 dollars).

[5] The Baytown Sun. *Harvey: A flood of memories*, 2017. https://baytownsun.com/local/harvey-a-flood-of-memories/collection_ce7a654e-8b34-11e7-a2e1-6bc181d57aec.html

Figure 11-2. Fallen tree in the City of Baytown following Hurricane Beryl[6]



PROBABILITY OF FUTURE EVENTS

Based on historical occurrences of significant hurricane events, the probability of future events is “Highly Likely”, with an event probable in the next year for the City of Baytown planning area.

CLIMATE CHANGE CONSIDERATIONS

Hurricane and tropical storm events have the potential to pose a significant risk to people and property. Such events can create dangerous situations for public health and safety officials and cause catastrophic damages. The impact of climate change could produce larger, more severe hurricane events, exacerbating the current hurricane impacts. The economic and financial impacts of hurricanes and tropical storms will depend entirely on

[6] Hollis, Matt. *Hurricane Beryl left many fallen trees in its wake, including this one on Pelly Street.* The Baytown Sun, https://baytownsun.com/local/many-in-baytown-without-power-after-beryl/article_98b33986-3d75-11ef-9fdb-ef6ab08528c9.html 2024.

the scale of the events, what is damaged, and how quickly repairs to critical components of the economy can be implemented.

The current climate assessment report for Texas indicates an expected increase in the intensity of very strong hurricanes, despite an expected lack of increase, or even a decrease, in hurricane frequency overall. Different research studies have produced some conflicting results. While some recent research has pointed to an apparent trend for U.S. tropical cyclones to move more slowly at landfall, much like Hurricane Harvey, other research suggests that Texas may be spared from such a slowdown. At this point, the enhanced risk is difficult to quantify, but substantial scientific progress on this topic is likely as climate models become better able to simulate the observed spatial distribution, frequency, and intensity of hurricanes.[7]

According to the Fifth National Climate Assessment, coastal cities have an increased risk of severe damage from hurricane events due to sea level rise. By 2100, under a projected 3.3 feet of sea level rise along the Texas Gulf Coast, a Category 2 hurricane is estimated to cause 3 to 10 times more damage to buildings and be $10.4 billion more costly (from averages of $3.7 to $14.1 billion) than a similar storm today.[8]

VULNERABILITY AND IMPACT

Hurricane and tropical storm events can cause major damage to large areas; hence, all existing buildings, facilities, and populations are equally exposed and vulnerable to this hazard and could potentially be impacted. The City of Baytown planning area features multiple mobile or manufactured home parks throughout the planning area. These mobile home parks are typically more vulnerable to hurricane events than typical site-built structures. The U.S. Census data indicates a total of 2,038 (6 percent of total housing stock) manufactured homes located in the City of Baytown planning area (Table 11-4). In addition, 49 percent (16,575 structures) of the single family residential (SFR) structures in the City of Baytown were built before 1980. These structures would typically be built to lower or less stringent construction standards than newer construction and may be more susceptible to damage during significant events.

[7] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 update.

[8] U.S. Global Change Research Program. (2023). Chapter 26: Southern Great Plains. In Fifth National Climate Assessment. https://nca2023.globalchange.gov/chapter/26/

Table 11-4. Structures at Greater Risk[9]

JURISDICTION	BUILT PRIOR TO 1980	MANUFACTURED HOME
City of Baytown	16,575	2,038

The City of Baytown Planning Team identified the following critical facilities as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by hurricane and tropical storm events. For a comprehensive list of critical facilities, please see Appendix F.

Table 11-5. Critical Facilities Vulnerable to Hurricane and Tropical Storm Events

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by falling trees or flying debris. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Debris/downed trees can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions. • Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental	• Structures can be damaged by falling trees or flying debris. • Power outages could disrupt critical care. • Backup power sources could be damaged. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities.

[9] US Census Bureau American Community Survey Five-Year Estimates 2019-2023 data for the City of Baytown.

SECTION 11: HURRICANE / TROPICAL STORM

CRITICAL FACILITIES	POTENTIAL IMPACTS
Facilities, Residential/ Assisted Living Facilities	• Evacuations may be necessary due to extended power outages, gas line ruptures, or structural damages to facilities.
Commercial Supplier (Food, fuel, etc.)	• Facilities or infrastructure may be damaged, destroyed or otherwise inaccessible. • Essential supplies like medicines, water, food, and equipment deliveries may be significantly delayed. • Additional emergency responders and critical aid workers may not be able to reach the area for days.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by falling trees or flying debris. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Debris/downed trees can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.

Over the past 124 years, hurricane and tropical storm events have resulted in $205,953,488,470 (2024 dollars) in damages to property and crops in Harris and Chambers Counties, including the City of Baytown, with an average annualized loss of $1,660,915,230. During that same period, thousands of fatalities and injuries have been reported as a result of hurricane and tropical storm events. Based on these historical impacts, the potential severity is considered “Substantial” with multiple deaths possible, complete shutdown of facilities for 30 days or more, and more than 50 percent of property destroyed or with major damage.

Table 11-6. Estimated Annualized Losses by Jurisdiction

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
Harris and Chambers Counties	$205,953,488,470	$1,660,915,230

ASSESSMENT OF IMPACTS

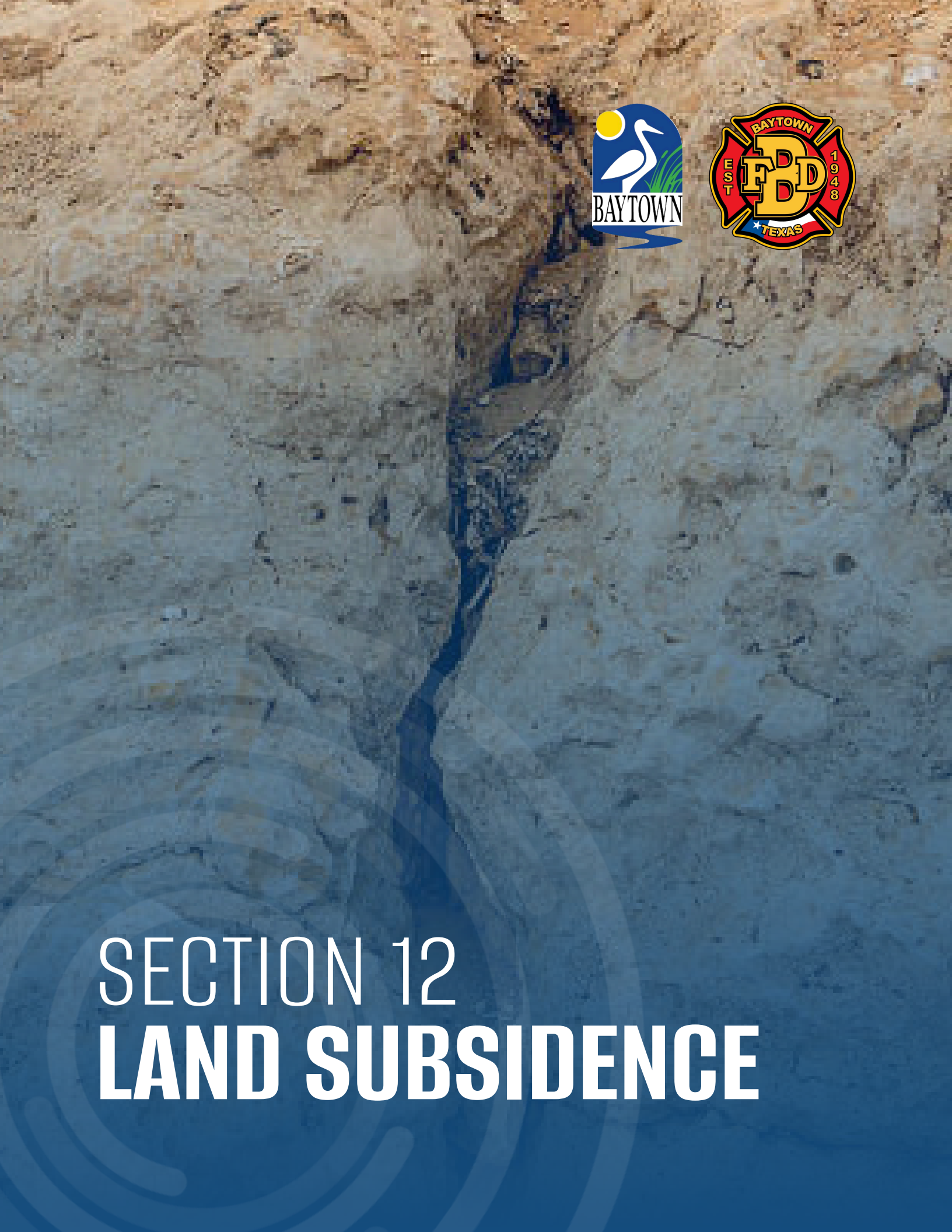
Hurricane and tropical storm events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. The impact of climate change could produce larger, more severe hurricane events, exacerbating the current hurricane impacts. Impacts to the planning area can include:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Driving conditions in the planning area may be dangerous during a hurricane event, especially over elevated bridges, elevating the risk of injury and accidents during evacuations if not timed properly.
- Emergency evacuations may be necessary prior to a hurricane landfall, requiring emergency responders, evacuation routing, and temporary shelters.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- During hurricane landfall, first responders may be prevented from responding to calls as the winds may reach a speed in which their vehicles and equipment are unsafe to operate.
- Hurricane events often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage often results in an increase in structure fires and carbon monoxide poisoning as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- School closures may be required during and after hurricane events which cause dangerous driving conditions, power outages, or damages to facilities.
- Extended power outages can also be deadly for individuals reliant on electricity to live independently in their homes.

- Extreme hurricane events may rupture gas lines and down trees and power lines, increasing the risk of structure fires during and after a storm event.
- Extreme hurricane events may lead to prolonged evacuations during search and rescue, and immediate recovery efforts requiring additional emergency personnel and resources to prevent entry, protect residents, and protect property.
- First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
- Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications.
- Critical staff may be unable to report for duty, limiting response capabilities.
- City departments may be damaged, delaying response and recovery efforts for the entire community.
- Private sector entities that the City and residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by the hurricane may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to hurricane damage. In the City of Baytown, 49 percent of homes were built before 1980, and two sites in the City of Baytown are on the National Register of Historic Places, which may pre-date modern building codes.
- Vegetation in urban parks may become flattened or oversaturated from high winds and heavy rains.
- Large scale hurricanes can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damage without a backup power source.
- As the City of Baytown planning area continues to increase in population, the number of people and housing developments exposed to the hazard increases. Continued public education on the planning area's risks to hurricane and tropical storm events will continue to be key to the Planning Team's overall mitigation strategy.

SECTION 11: HURRICANE / TROPICAL STORM

The economic and financial impacts of hurricane events on the area will depend on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any hurricane event.



SECTION 12
LAND SUBSIDENCE

SECTION 12: LAND SUBSIDENCE

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Probability of Future Events 10
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HAZARD DESCRIPTION



Land subsidence is often described as the gradual or sudden sinking of the Earth's surface. Land subsidence typically happens slowly and goes unnoticed unless it reaches extreme levels, as seen in rare catastrophic sinkhole events. According to the United States Geological Survey (USGS), subsidence is a global problem, and in the United States more than 17,000 square miles in 45 States have been directly affected by subsidence.

Most subsidence is caused by human behavior such as mining, oil and gas extraction, and groundwater pumping from major and minor aquifer systems. The excessive removal of groundwater from aquifers that possess soluble or compressible layers may undergo an increase in erosion, compaction, and subsurface collapse. Even if the groundwater is returned to their average levels, most of land subsidence consequences are irreversible.

Land surfaces above shallow aquifer systems or areas adjacent to particularly porous earth have an increased risk of experiencing subsidence. Buildings and other infrastructure, such as roads, building foundations, and highways, are extremely susceptible to damage in the event of a land surface collapse.

More than 80 percent of land subsidence in the United States is a caused by groundwater use. Subsidence is an often-overlooked environmental consequence of land and water-

use practices.[1] In the Houston-Galveston region in which the City of Baytown resides, land subsidence is often caused by aquifer compaction due to substantial, long-term groundwater withdrawals. Land subsidence was first observed in the region in 1918 when the Goose Creek Oil Field near Galveston Bay began to display surficial fissures due to the extraction of oil and water beneath the surface. In 1975, the Texas Legislature created the Harris-Galveston Subsidence District (HGSD), the first political subdivision of its kind in the United States. HGSD was authorized as a groundwater regulatory agency to cease ongoing and prevent future subsidence.[2] Heavily populated cities in Texas can drain aquifer systems in excess which greatly raises the likelihood of land subsidence events. Increased development and population growth in the City of Baytown increases the demand for groundwater, and therefore, can increase land subsidence risk.

LOCATION

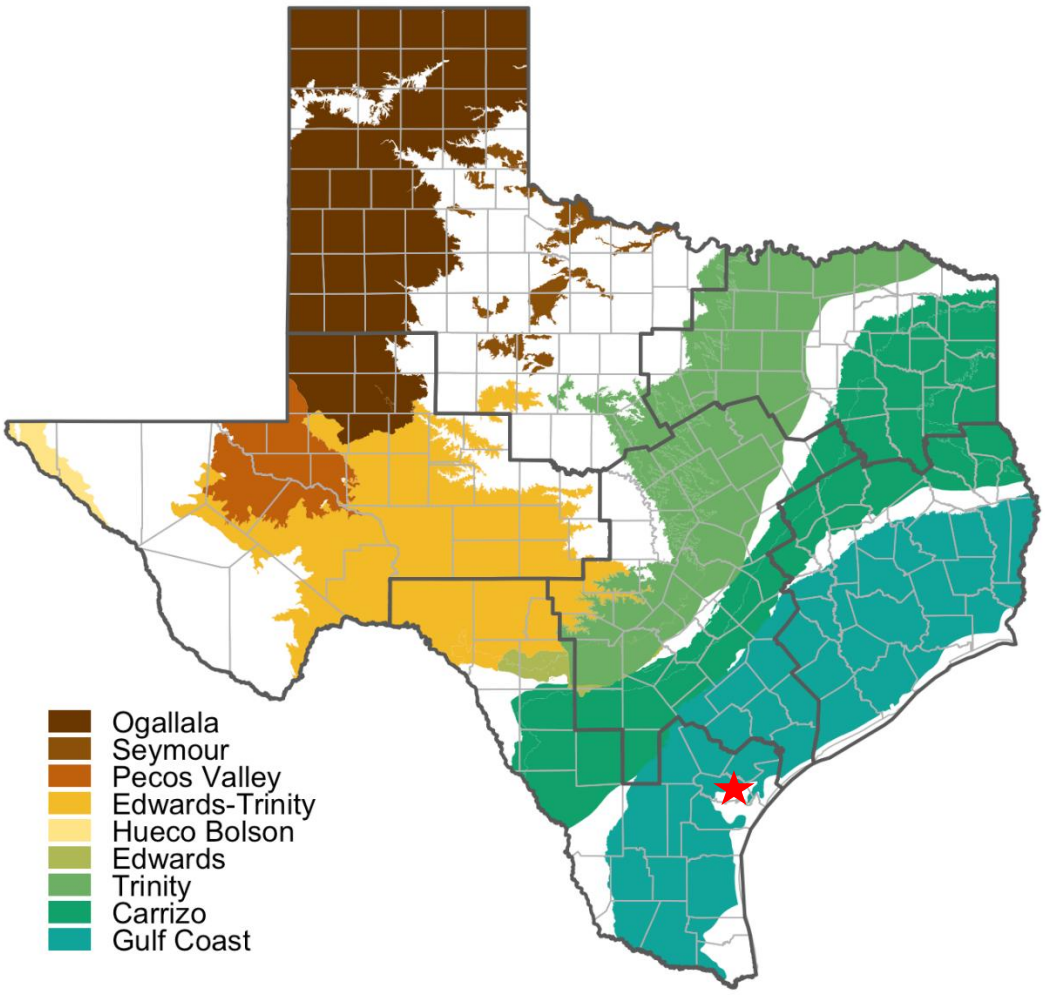
Land subsidence can be widespread and impact entire states, or it can be small and localized. The City of Baytown is located on the Gulf Coast aquifer and is in a potential subsidence area, meaning the entire planning area is at some level of risk (Figure 12-1). While land subsidence is commonly caused by groundwater pumping, collapse features, like sinkholes, tend to be associated with different rock types such as evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomite). Evaporite rocks make up an estimated 40 percent of the United States and are more susceptible to dissolution. The map below shows prominent areas of the United States made up of these rock types. Land subsidence can occur anywhere, but these areas, including the City of Baytown, are at higher risk of larger underground cavities and sinkholes (Figure 12-2).

[1] United States Geological Survey (USGS). Land Subsidence. https://www.usgs.gov/mission-areas/water-resources/science/land-subsidence

[2] The Harris-Galveston Subsidence District

SECTION 12: LAND SUBSIDENCE

Figure 12-1. Texas Aquifer Potential Subsidence Areas[3]

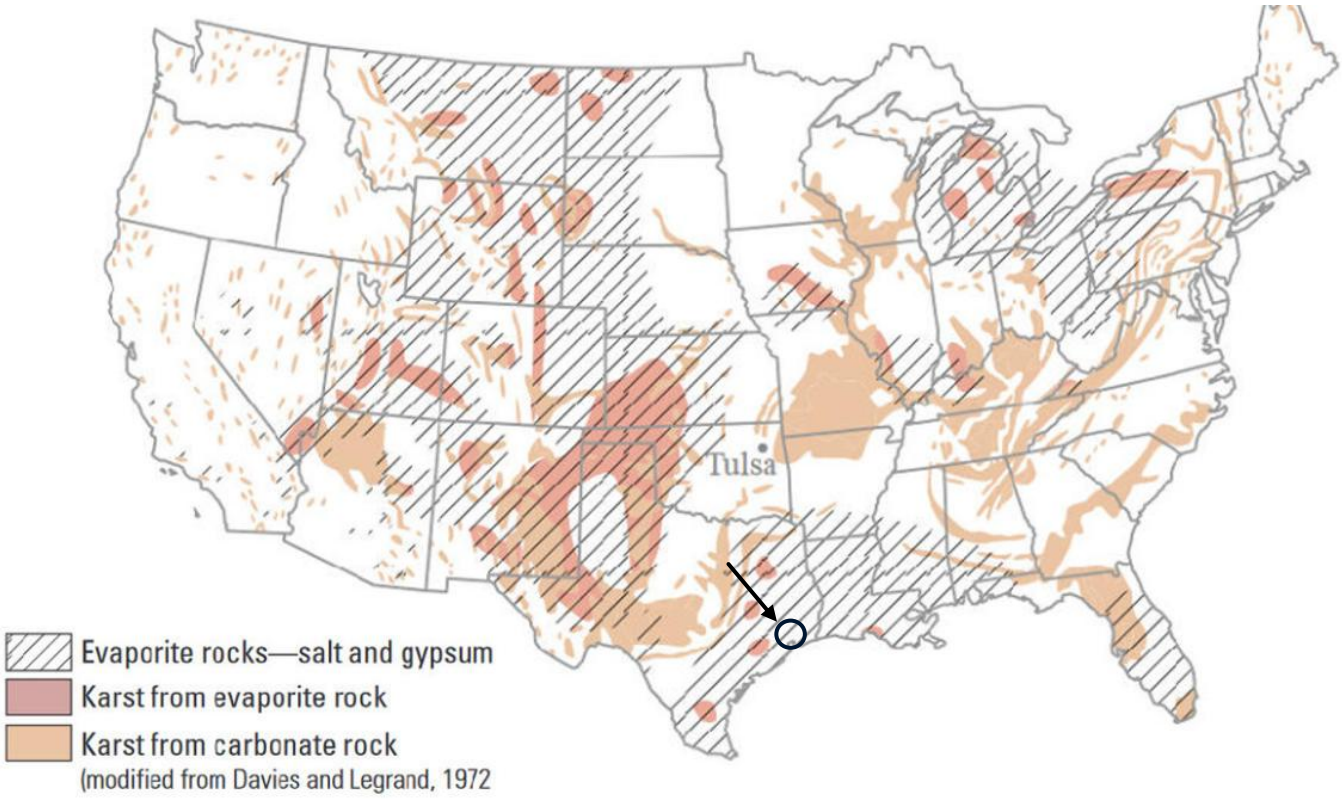


Source: Texas Water Development Board
https://www.twdb.texas.gov/mapping/gisdata.asp

[3] The City of Baytown planning area is marked by the red star.

SECTION 12: LAND SUBSIDENCE

Figure 12-2. Areas Prone to Collapse[4]



EXTENT

The extent of land subsidence in Texas varies by region and factors such as soil composition, groundwater withdrawal, drought, erosion, oil or gas extraction, or mining can impact the extent of subsidence. Areas may historically appear free of subsidence threats or occurrences but can suddenly be vulnerable to dramatic events. In some rare cases, extreme land subsidence can lead to sinkholes when the subsurface land cannot support the surface land any longer. A sinkhole is described as a portion of the ground that possesses no natural external surface drainage, typically draining water into the subsurface[5]. The development of sinkholes can range from a slow to dramatic collapse

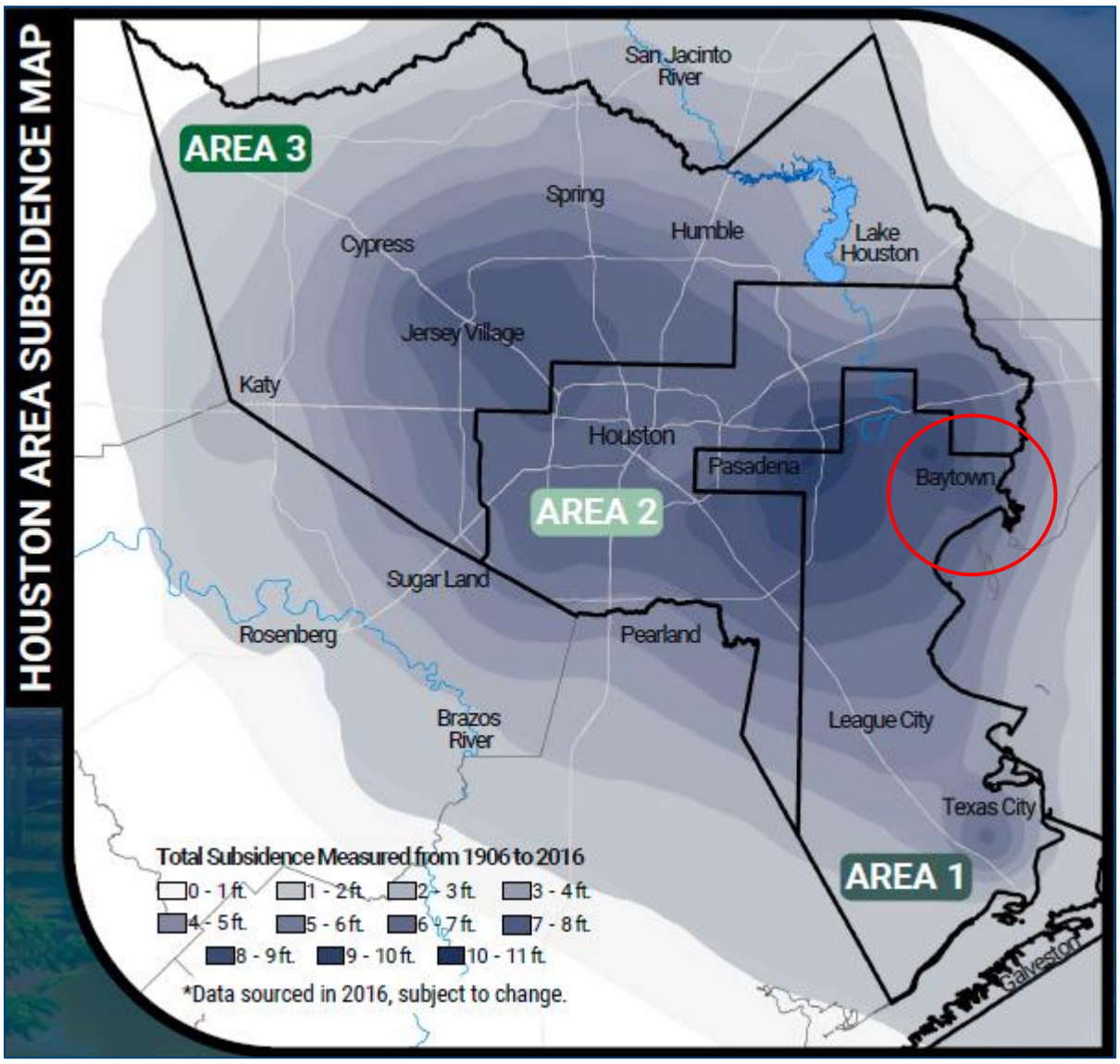
[4] United States Geological Survey (USGS). Land Subsidence in the United States. https://water.usgs.gov/ogw/pubs/fs00165/

[5] United States Geological Survey (USGS). Water Science School (2018). Sinkholes. https://www.usgs.gov/special-topics/water-science-school/science/sinkholes

which may result in property damages or injury and loss of life. These events can differ in size from a few feet to many acres with equal variety in depth.

Extent is typically measured by the number of feet of land loss or sunk. Per the Harris-Galveston Subsidence District, the City of Baytown is in an area which has seen total land subsidence ranging from 6 to 11 feet between 1906 and 2016 (Figure 12-3).

Figure 12-3. Houston Area Subsidence Map, 1906 – 2016[6]

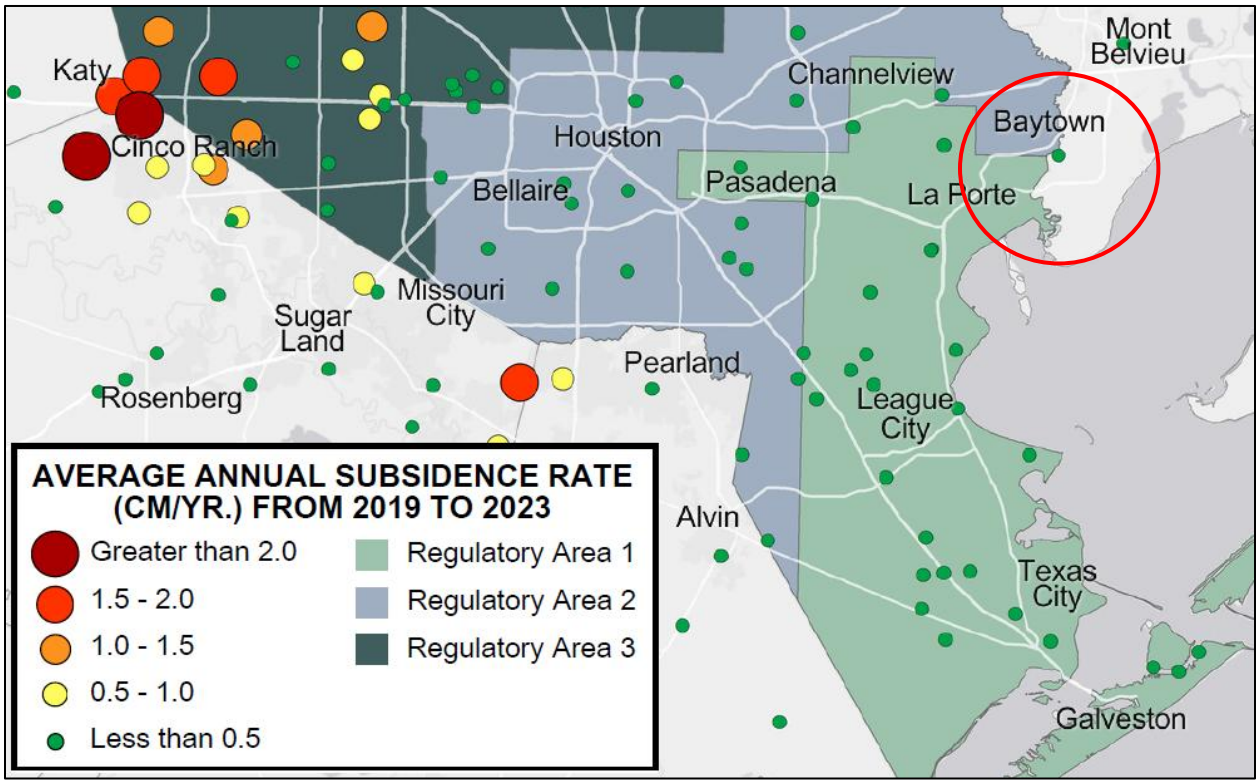


[6] Harris-Galveston Subsidence District. The approximate location of the planning area is indicated by the red circle.

SECTION 12: LAND SUBSIDENCE

Smaller subsidence rates have been observed in recent years for the City of Baytown planning area. The Harris-Galveston Subsidence District 2023 Annual Groundwater Report shows the average annual subsidence rate for the City of Baytown to be less than 0.5 centimeters per year between 2019 and 2023 (Figure 12.4).

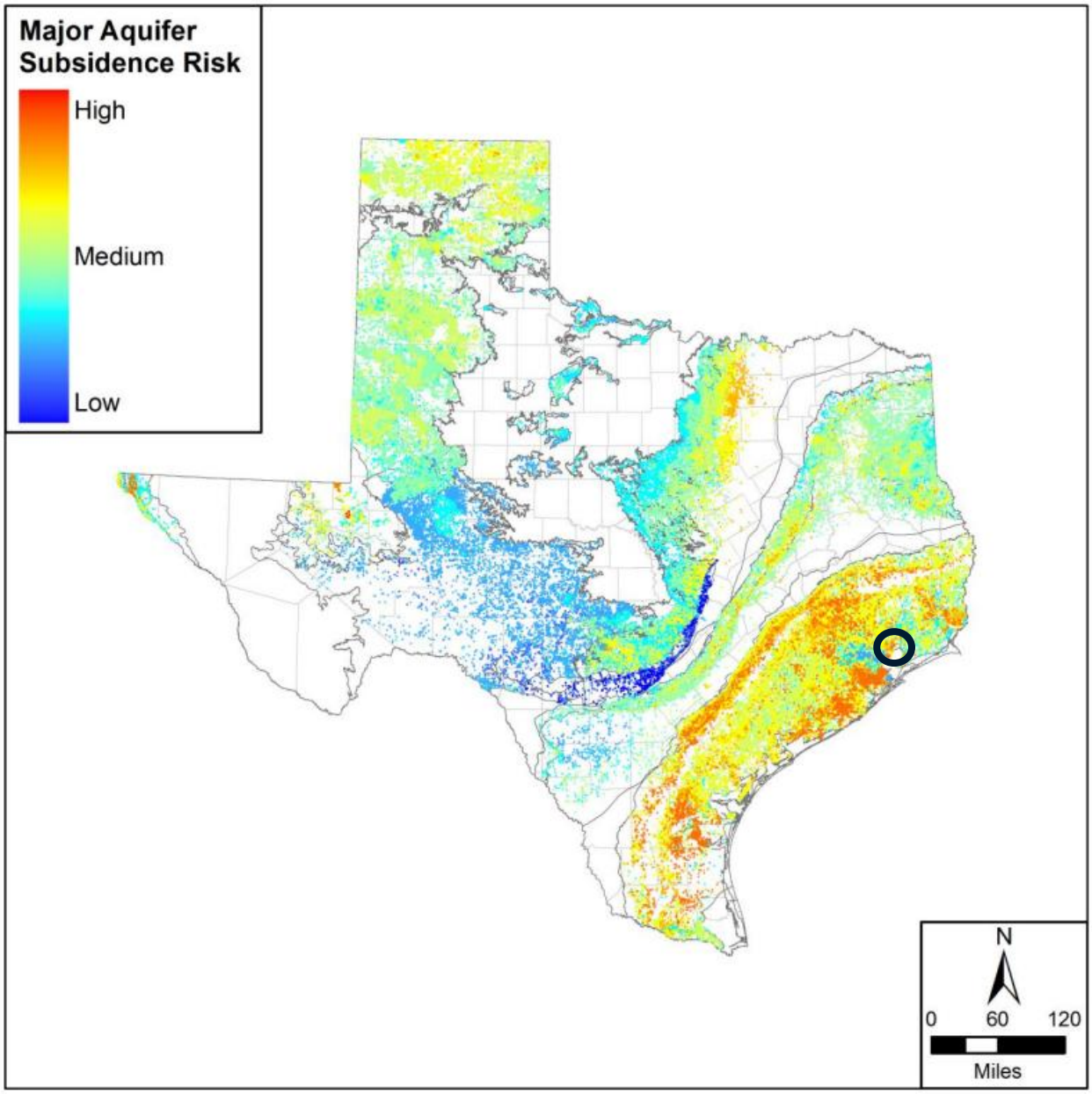
Figure 12-3. Average Annual Subsidence Rates, 2019-2023[7]



The Texas Water Development Board (TWDB) calculated subsidence risk at each of the wells evaluated within major and minor aquifers, as shown in Figure 12-4, with risk levels ranging from low to high. According to this assessment, the City of Baytown is at a high level of subsidence risk. This indicates a significant level of concern for potential land sinking overtime. High risk areas, like the Texas coastal region, have already experienced several feet of land sinking, causing infrastructure damage and increased flood risks.

[7] Harris-Galveston Subsidence District 2023 Annual Groundwater Report. The approximate location of the planning area is indicated by the red circle.

Figure 12-4. TWDB Major Aquifer Subsidence Risk[8]



[8] Texas Water Development Board (TWDB). Final Report: Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping. March 21, 2017. https://www.twdb.texas.gov/groundwater/models/research/subsidence/Final_Subsidence_Vulnerability_Report_final.pdf.

SECTION 12: LAND SUBSIDENCE

HISTORICAL OCCURRENCES

Land subsidence occurring along the Texas Coast is often a result of the combination of groundwater loss and soil types which are vulnerable to subsidence. Declines of 200 to 300 feet in aquifer water levels in some areas of southeastern Harris County have been caused by years of heavy pumping for municipal and manufacturing uses.[9] Areas of evaporate rock (like salt or gypsum) are particularly sensitive to subsurface cavities and sinkhole development (Figure 12-2).

There are instances of subsidence known to have occurred in the City of Baytown, however, the available data primarily measures the overall trends of groundwater loss and land subsidence over long periods of time. There is no comprehensive database available to provide information on the extent and magnitude of specific land subsidence events. Information about known subsidence events primarily depends on local knowledge and local news sources. The following section provides a description of two known significant events, though it's likely that many instances remain unreported.

[9] Southeast Texas Groundwater Conservation District. https://setgcd.org/maps/

SECTION 12: LAND SUBSIDENCE

SIGNIFICANT EVENTS

February 4, 2016

A sinkhole opened on February 4, 2016, around 3:45 a.m. when a vehicle drove over a pothole on Fortinberry Street. When the vehicle drove onto the pothole, the ground descended into a large sinkhole, submerging the vehicle. The driver, who reported water entering the floor of the car soon after falling in, was able to safely exit the vehicle through a back passenger window. City officials stated the sinkhole was caused by an 8-inch water line that had leaked for several days. Other than the damaged vehicle, no long-term damage was caused by this sinkhole before it was filled back in.[10]

Figure 12-5. Fortinberry Street Sinkhole - February 5, 2016[11]



[10] The Baytown Sun. *Sinkhole Swallows Car*. February 5, 2016. https://baytownsun.com/local/sinkhole-swallows-car/article_2db4e9ac-cbc0-11e5-9c11-2ff0639094d0.html

[11] Donath, Lana, *Sinkhole Swallows Car*, 2016. The Baytown Sun.

June 4, 2024

A sinkhole opened up along the eastbound lanes of the East Freeway feeder road near Thompson Road in the City of Baytown. It was unclear if the sinkhole opened up gradually or fell away all at once. TxDOT officials stated the sinkhole was caused by a City of Baytown sewer line in which a manhole leak had occurred. The feeder road was temporarily shut down as the sewer line was repaired, but officials stated the roadway was safe and unaffected.[12]

Figure 12-6. I-10 Sinkhole - June 4, 2024[13]



PROBABILITY OF FUTURE EVENTS

With limited reporting of subsidence, it can be difficult to calculate the probability of future events. However, the City of Baytown is in a region highly susceptible to land subsidence, which may continue to develop from below-ground withdrawals or from natural or man-made forces. Additionally, increasing population trends in the planning

[12] KHOU 11. *Sinkhole appears along I-10 in far east Harris County.* June 4, 2024. https://www.khou.com/article/traffic/massive-sinkhole-east-harris-county/285-b449e166-8416-4ccf-b20f-ec014afd9eba

[13] ABC13 Houston. *Crews resume repairs on manhole along I-10 feeder road, expected to be done by June 24: officials*, 2024. https://abc13.com/post/texas-pride-utilities-handle-repairs-manhole-10-eastbound/14933049/

area will lead to increasing groundwater withdrawals from surface aquifers, and this can lead to more incidences of land subsidence / sinkholes. Major occurrences of future land subsidence events are considered “Likely” with an event probable in the next 3 years.

CLIMATE CHANGE CONSIDERATIONS

While data regarding the direct impact of climate change on land subsidence in non-coastal areas is limited, certain climate change conditions can increase land subsidence risk. As climate change causes higher temperatures, more severe drought, and changes in overall precipitation, the demand for water increases. In communities reliant on groundwater, the increase in groundwater pumping directly increases the risk of land subsidence.

VULNERABILITY AND IMPACT

Vulnerability is difficult to evaluate since land subsidence events can occur at any time, in random locations, and soil conditions can be very difficult and costly to monitor. Due to the randomness of these events, all existing and future structures, and facilities within the City of Baytown planning area, could potentially be impacted and remain vulnerable to possible damage and property loss. The amount of monetary damage associated with previous events is unknown, but costs related to property damage can be expected in the future.

Damage is likely to occur to underground utility systems including water, sewage, and electrical which can lead to water and power outages, disrupting critical services. Land subsidence can also cause significant damage to roads, buildings, houses, and any other standing structure. Historically in the City of Baytown planning area, damage has occurred to water and gas lines, as well as transportation infrastructure. While all structures in the planning may be susceptible, those structures built above major aquifers or otherwise closest to groundwater removal sites may be at highest risk.

Land subsidence typically poses limited risk to people. While all citizens are vulnerable to the impacts of subsidence, forced relocation and disaster recovery disproportionately impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. An estimated 18 percent of the planning area population live below the poverty level (Table 12-1). The elderly, children, and people with a disability may have trouble evacuating if needed, making them more susceptible to injury or harm. In addition, people who speak a language other

than English may face increased vulnerability due to language barriers that limit their access to important information regarding safety measures.

Table 12-1. Populations at Greater Risk[14]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

The City of Baytown Planning Team identified the following critical facilities (Table 12-2) as assets that are considered the most important to the planning area and are potentially susceptible to land subsidence. The critical infrastructure with the greatest vulnerability are utility services, transportation structures, and municipal infrastructure. Failures of these facilities can result in loss of service and cascading impacts. For a comprehensive list of critical facilities see Appendix F.

Table 12-2. Critical Facilities Vulnerable to Land Subsidence

CRITICAL FACILITY TYPE	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to damaged facilities. • Damaged roads or transportation structures can impede emergency response vehicle access to areas. • Fire stations, police stations, and hospitals may suffer structural damage, affecting their ability to function effectively during emergencies. • Subsidence related emergencies may require the deployment of additional resources and personnel to impacted areas, and personnel may be exposed to unsafe conditions.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/	• Structures can be damaged by the shifting of the Earth. • Power outages could disrupt critical care. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Evacuations may be necessary due to structural damage to facilities.

[14] US Census Bureau 2023 data for City of Baytown.

CRITICAL FACILITY TYPE	POTENTIAL IMPACTS
Assisted Living Facilities	• Infrastructure damage may prevent larger airports from acting as temporary command centers for logistics, communications, and emergency operations. • Temporary break in operations may significantly inhibit post event evacuations. • Damaged or destroyed highway infrastructure may substantially increase the need for airport operations.
Commercial Supplier (Food, fuel, etc.)	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed. • Economic disruption due to infrastructure damage negatively impact commercial services and distribution.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Damage to underground utility systems including water, sewage, and electrical can lead to a disruption of essential services. • Emergency operations and services may be significantly impacted due to damaged facilities. • Damaged roads or transportation structures can impede emergency response vehicle access to areas. • Subsidence related emergencies may require the deployment of additional resources and personnel to impacted areas, and personnel may be exposed to unsafe conditions.

There are no reported damage estimates, injuries, or fatalities from land subsidence events in the City of Baytown. The impact on the planning area is considered “Limited”, meaning injuries or illnesses are treatable with first aid, critical facilities and services shut down for 24 hours or less, and less than 10 percent of property destroyed or with major damage.

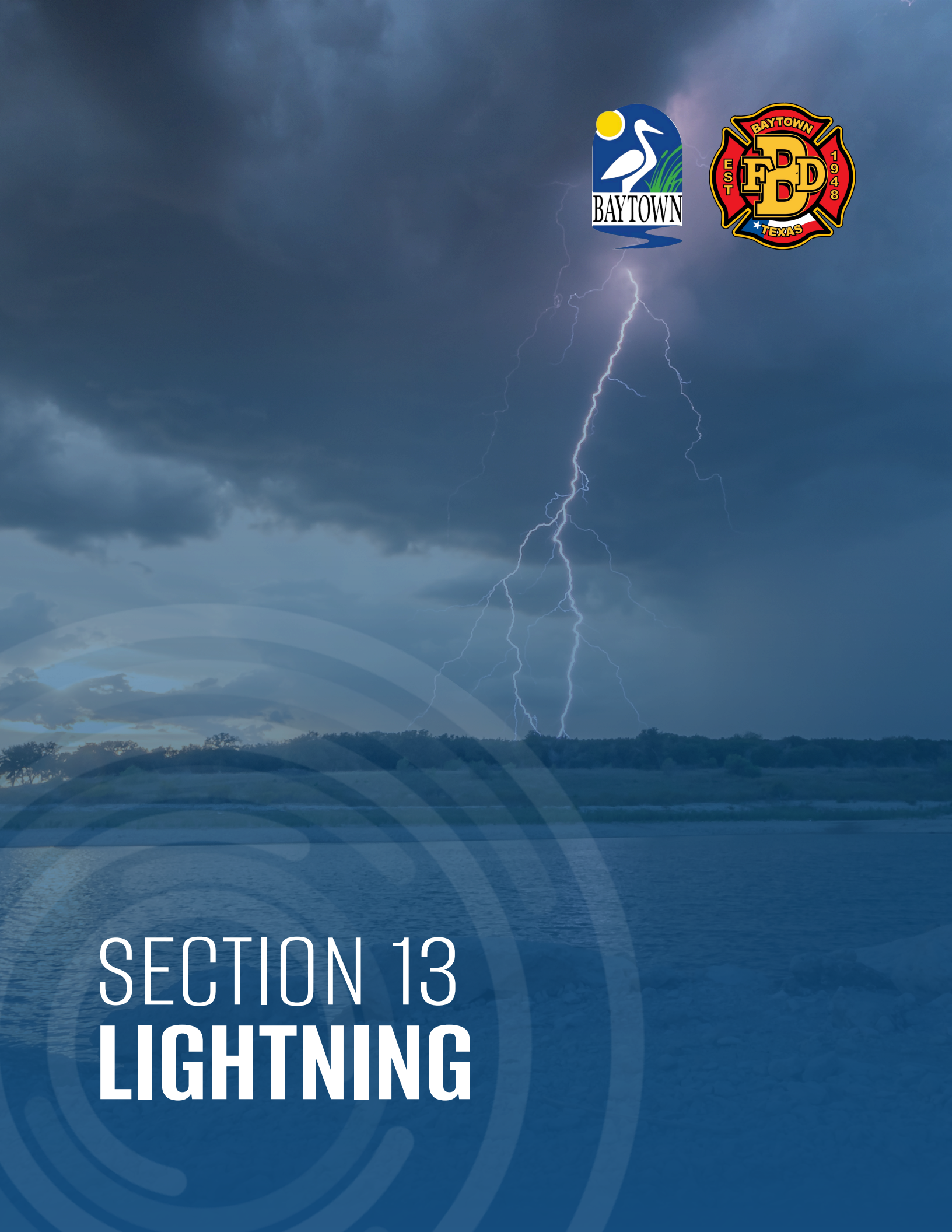
ASSESSMENT OF IMPACTS

Land subsidence has the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. Land subsidence can be associated with a variety of impacts, including:

- Response personnel, including utility workers, public works personnel, debris removal staff, tow truck operators, and other first responders, are subject to injury or illness.

- Response personnel would be required to travel in potentially hazardous conditions, elevating the life safety risk due to accidents and potential contact with downed power lines.
- Power and water outages are possible throughout the planning area due to damaged power lines, underground water pipes, and other damaged utility infrastructure.
- Emergency response and service operations may be impacted by limitations on access and mobility if roadways are closed, or obstructed.
- Depending on the severity and scale of damage caused by ground movement, damage to critical infrastructure can require weeks to repair.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to impacts of subsidence. 49 percent (16,575 structures) of homes in the planning area were built before 1980.
- Buildings, homes, and other structures can collapse or sink, potentially trapping residents.
- Significant subsidence can result in emergency response vehicles being unable to access areas of the community.
- Emergency operations and services may be significantly impacted due to damaged facilities, loss of communications, and damaged emergency vehicles and equipment.
- Private sector entities such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Some businesses not directly damaged by subsidence may be negatively impacted while roads are restored, further slowing economic recovery.
- Historical sites and properties are placed at a higher risk of impact due to materials used and the inability to change properties due to their historic status. There are two historical sites listed on the National Register of Historic Places for the City of Baytown.

The economic and financial impacts of land subsidence on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any land subsidence event.



SECTION 13
LIGHTNING

SECTION 13: LIGHTNING

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HAZARD DESCRIPTION

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder which often accompanies lightning strikes. While most often affiliated with severe thunderstorms, lightning often strikes outside of heavy rain and might occur as far as 10 miles away from any rainfall.

According to the National Weather Service (NWS), the 10-year (2012–2021) average for fatalities is 23 people with an average of 300 injuries in the United States each year by lightning. Lightning can occur as cloud-to-ground flashes or as intra-cloud lightning flashes. Direct lightning strikes can cause significant damage to buildings, critical facilities, infrastructure, and communication equipment affecting emergency response. Lightning is also responsible for igniting wildfires that can result in widespread damages to property before firefighters have the ability to contain and suppress the resultant fire.

LOCATION

Lightning can strike in any geographic location and is considered a common occurrence in Texas. The City of Baytown planning area is in a region of the country that is moderately susceptible to lightning strikes. Therefore, lightning could occur at any location within

the entire planning area. It is assumed that the entire City of Baytown planning area is uniformly exposed to the threat of lightning.

EXTENT

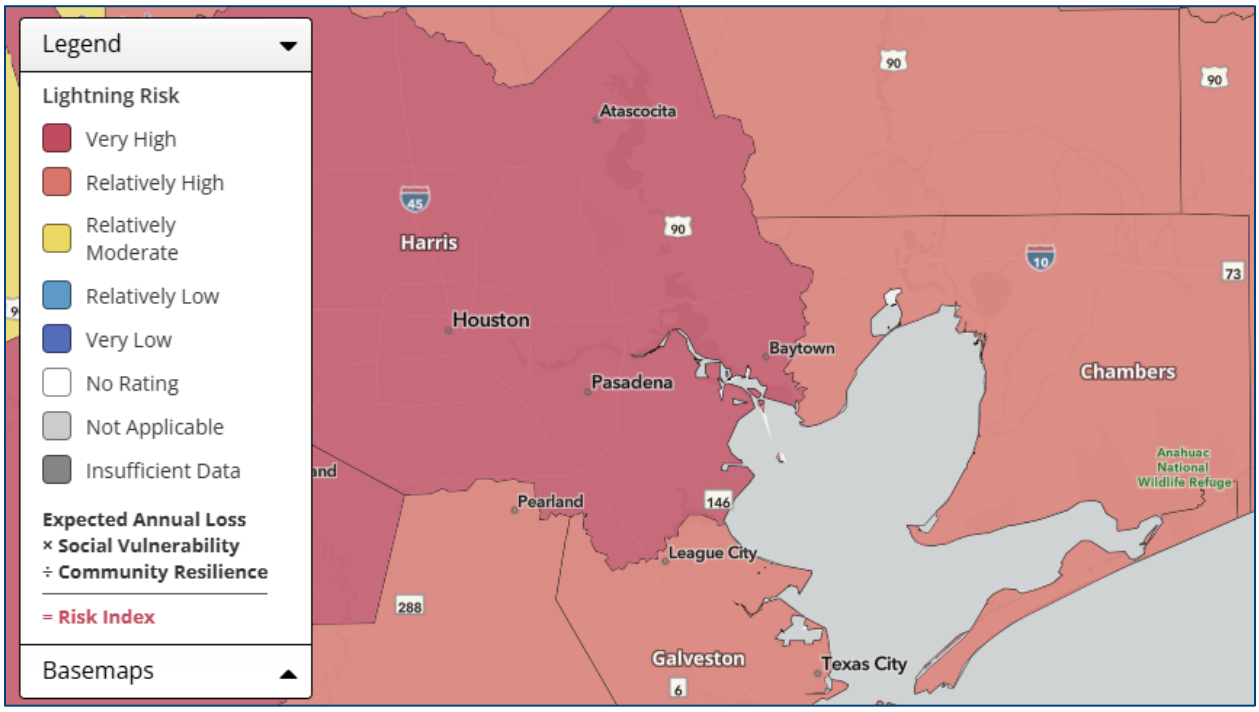
According to the 2024 Annual Lightning Report by Vaisala, the State of Texas ranks fifth in the U.S. for lightning strike density with an average of 150.5 flashes per square mile.[1] Vaisala's U.S. National Lightning Detection Network lightning flash density map shows an average of 233.1 lightning events per square mile per year in Harris County and 189.1 lightning events per square mile in Chambers County. Since the City of Baytown resides in both counties, the planning area can expect a lightning flash density between 189.1 and 233.1 lightning events per square mile. This range of rates equates to approximately 7,200 to 8,800 flashes per year for the entire planning area. In all of Harris County, approximately 397,700 total flashes per year can be expected; Chambers County's approximate total flashes per year is 112,900. Based on these flash densities in Harris and Chambers counties, the City of Baytown planning area could experience from 3 to 11 flashes per 15-minute interval during storm events.

FEMA's National Risk Index includes an analysis of the planning area's expected annual loss and the community's risk factor which incorporates social vulnerability as well as community resilience to determine the lightning risk for the area, compared to the rest of the United States. The City of Baytown planning area is located in a region where the extent is broadly classified as relatively high, with Harris County in particular being classified as very high (Figure 13-1).

[1] Source: https://www.xweather.com/annual-lightning-report

SECTION 13: LIGHTNING

Figure 13-1. City of Baytown Lightning Risk, National Risk Index, February 2025[2]



HISTORICAL OCCURRENCES

The NCEI (National Centers for Environmental Information) database indicates 2 recorded lightning events occurring directly within the City of Baytown planning area. Within all of Chambers and Harris Counties, 77 lightning events have been reported in the NCEI database. It is highly likely multiple lightning occurrences have gone unreported before and during the recording period. The NCEI is a national data source organized under the National Oceanic and Atmospheric Administration and considered a reliable resource for hazards. However, the flash density for the planning area along with input from local team members indicates regular lightning occurrences that simply have not been reported.

Lightning event data for both Chambers and Harris Counties have been incorporated to ensure the most comprehensive dataset possible, as the City of Baytown spans both counties. Given that some lightning events are reported at the county level rather than by individual jurisdiction, this approach provides a more accurate representation of historical lightning risk in the area. Table 13-1 lists all reported lightning events and their

[2] Source: Map | National Risk Index, https://hazards.fema.gov/nri/map

associated impacts including fatalities, injuries, and damages. Table 13-2 summarizes these impacts by jurisdiction.

Table 13-1. Historical Lightning Events, 1996 – 2024[3]

JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/20/1996	0	0	$150,700	$0
Harris County	7/26/1996	0	0	$200,600	$0
Harris County	3/18/1997	0	0	$147,600	$0
Harris County	7/6/1997	0	1	$245,200	$0
Harris County	7/17/1997	0	10	$196,200	$0
City of Baytown	7/28/1997	0	0	$9,806,800	$0
City of Baytown	9/2/1997	0	0	$97,700	$0
Harris County	9/2/1997	0	1	$390,600	$0
Harris County	3/14/2000	1	0	$0	$0
Harris County	8/2/2000	0	17	$0	$0
Chambers County	8/24/2000	1	0	$0	$0
Harris County	6/1/2004	1	0	$0	$0
Harris County	6/17/2004	1	0	$0	$0
Harris County	8/1/2004	1	0	$0	$0
Harris County	8/18/2004	0	1	$0	$0
Harris County	8/28/2004	0	1	$33,300	$0
Harris County	2/1/2005	1	1	$0	$0
Harris County	2/24/2005	0	1	$0	$0
Harris County	3/7/2005	0	0	$16,300	$0
Harris County	5/29/2005	0	0	$323,900	$0
Harris County	5/29/2005	0	1	$0	$0
Harris County	12/14/2005	0	2	$0	$0
Harris County	6/1/2006	0	0	$7,800	$0
Harris County	7/23/2006	0	0	$31,000	$0

[3] Values are in 2024 dollars. Database was searched for events between 1996 and 2024.

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/13/2007	0	4	$0	$0
Harris County	10/7/2007	0	1	$0	$0
Harris County	6/18/2008	0	0	$50,400	$0
Harris County	6/25/2008	0	0	$36,000	$0
Harris County	6/25/2008	0	1	$0	$0
Harris County	8/26/2008	0	0	$57,500	$0
Harris County	9/21/2009	0	0	$109,400	$0
Chambers County	6/24/2010	1	1	$0	$0
Harris County	6/30/2012	1	0	$0	$0
Harris County	7/15/2012	2	1	$0	$0
Harris County	7/19/2012	0	0	$1,400	$0
Harris County	7/19/2012	0	1	$0	$0
Harris County	4/2/2013	0	0	$47,400	$0
Harris County	5/10/2013	0	1	$0	$0
Harris County	7/15/2013	0	0	$40,500	$0
Harris County	8/14/2013	0	0	$8,100	$0
Harris County	9/7/2013	0	0	$12,100	$0
Harris County	7/16/2014	0	4	$0	$0
Harris County	6/27/2015	0	0	$52,800	$0
Harris County	6/27/2015	0	0	$19,800	$0
Harris County	7/4/2015	0	0	$39,600	$0
Harris County	8/19/2015	0	0	$198,200	$0
Harris County	8/20/2015	0	0	$19,900	$0
Chambers County	4/13/2016	0	0	$39,500	$0
Harris County	4/21/2016	1	0	$0	$0
Harris County	8/22/2016	0	2	$0	$0
Harris County	3/29/2017	0	0	$58,200	$0
Chambers County	5/12/2017	0	0	$25,800	$0
Harris County	7/9/2017	0	0	$19,300	$0

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JURISDICTION	DATE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	7/9/2017	0	0	$12,900	$0
Harris County	9/20/2017	1	0	$0	$0
Harris County	10/20/2017	0	0	$1,300	$1,300
Harris County	6/14/2018	0	0	$18,800	$0
Harris County	8/28/2018	0	0	$3,800	$0
Harris County	10/22/2018	1	0	$0	$0
Harris County	6/24/2019	0	2	$0	$0
Harris County	6/27/2019	1	0	$0	$0
Harris County	7/30/2019	0	0	$3,700	$0
Harris County	8/14/2019	0	0	$30,700	$0
Harris County	10/3/2019	0	1	$0	$0
Harris County	5/18/2021	0	0	$52,700	$0
Harris County	5/18/2021	0	0	$23,400	$0
Harris County	8/16/2021	0	0	$57,600	$0
Harris County	8/16/2021	0	0	$1,200	$0
Harris County	11/11/2021	0	0	$17,000	$0
Harris County	5/22/2022	0	0	$53,900	$0
Harris County	8/10/2022	0	0	$53,200	$0
Harris County	8/10/2022	0	1	$0	$0
Harris County	10/13/2022	0	0	$52,900	$0
Harris County	4/6/2023	0	0	$20,800	$0
Harris County	6/6/2023	0	0	$20,700	$0
Harris County	6/8/2023	0	0	$103,200	$0
Harris County	5/16/2024	1	0	$50,200	$0
TOTALS		15	56	$13,062,900	

Table 13-2. Historical Lightning Events Summary, 1996 – 2024

JURISDICTION	NUMBER OF EVENTS	DEATHS	INJURIES	PROPERTY DAMAGES	CROP DAMAGES
City of Baytown	2	0	0	$9,904,500	$0

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JURISDICTION	NUMBER OF EVENTS	DEATHS	INJURIES	PROPERTY DAMAGES	CROP DAMAGES
Chambers County	4	2	1	$65,300	$0
Harris County	71	13	55	$3,091,800	$1,300
TOTALS	77	15	56	$13,061,600	$1,300

Based on the list of historical lightning events for the City of Baytown planning area, there have been no reported events since the 2020 Plan. However, there have been 13 reported events in Harris County since 2020.

SIGNIFICANT EVENTS

July 28, 1997 – City of Baytown

Lightning struck the Exxon plant causing electrical problems at the facility. An estimated $9,806,800 (2024 dollars) in damages was caused, largely due to the plant needing to be temporarily shut down. In terms of monetary damages, this is the most severe reported lightning event in Harris and Chambers Counties.

September 2, 1997 – City of Baytown

A lightning strike in the afternoon induced a fire at a wastewater treatment facility at the Exxon Refinery. Property damage was estimated at $97,700 (2024 dollars).

July 15, 2012 – Harris County

During a thunderstorm in the late morning, several men who were playing soccer at an outdoor field sought shelter under a large tree near the field. Two men were killed by a lightning strike near this tree, and a third man was injured.

June 27, 2019 – Harris County

Severe thunderstorms in The Woodlands area produced lightning which struck at least two homes causing housefires. Per OSHA reports, one man was struck and killed by lightning in a new home construction area.

May 16, 2024 – Harris County

A severe thunderstorm moved over the Greater Houston area, bringing damaging wind gusts, flash flooding, two tornadoes, and severe lightning activity. One lightning strike caused a fire which destroyed a mobile home and resulted in one fatality. Property damage was estimated at $50,200.

SECTION 13: LIGHTNING

PROBABILITY OF FUTURE EVENTS

Based on historical records and input from the planning team the probability of occurrence for future lightning events in the City of Baytown planning area is considered "Highly Likely" or an event probable in the next year. The planning team stated that lightning occurs regularly in the area. According to the 2024 Annual Lightning Report by Vaisala, the City of Baytown planning area experiences between 189.1 and 233.1 lightning flashes per square mile per year (approximately 7,200 to 8,800 total flashes per year). Given this estimated probability of events, it can be expected that future lightning events will continue to threaten life and cause minor property damage throughout the planning area. Impacts of climate change are not expected to increase the average frequency of lightning events but may lead to an increase in the intensity of events when they do occur.

CLIMATE CHANGE CONSIDERATIONS

As CO_2 increases and the land surface warms, stronger updrafts are more likely to produce lightning. In a climate with double the amount of CO_2, we may see fewer lightning storms overall, but 25 percent stronger storms, with a 5 percent increase in lightning. Lightning damage is also likely to increase because of its role in igniting forest fires, where dry vegetation, also caused by rising temperatures, creates more 'fuel' for fires, so even a small climate change may have huge consequences. While the impact climate change will have on our weather still remains uncertain, researchers agree that implementing simple measures like lightning detection systems and installing grounding systems in buildings could go a long way in avoiding deaths and injuries.[4]

Lightning events have the potential to pose a significant risk to people and property throughout the City of Baytown planning area. The economic and financial impacts of lightning on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. While no increase in the number of hazard events is anticipated, the impact of the hazard may see an increase in losses. As populations grow and urban development continues to rise, the overall vulnerability and impact are expected to increase in the next five years.

[4] Environmental Journal, Nathan Neal, January 11, 2021.

SECTION 13: LIGHTNING

VULNERABILITY AND IMPACT

Vulnerability is difficult to evaluate since lightning events can occur at different strength levels, in random locations, and can create a broad range of damage depending on the strike location. Due to the randomness of these events, all existing and future structures and facilities in the City of Baytown planning area could potentially be impacted and remain vulnerable to possible injury and property loss from lightning strikes.

The direct and indirect losses associated with these events include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources. The entire population of the City of Baytown planning area is considered exposed to the lightning hazard. The peak lightning season in the State of Texas is from June to August; however, the most fatalities occur in July. Fatalities occur most often when people are outdoors and/or participating in some form of recreation. The population located outdoors during a lightning event is considered at risk and more vulnerable to a lightning strike compared to those inside a structure. Moving to a lower risk location will decrease a person's vulnerability.

The entire general building stock and all infrastructure of the City of Baytown planning area are considered exposed to the lightning hazard. Lightning can be responsible for damages to buildings, cause electrical, forest and/or wildfires, and damage infrastructure such as power transmission lines and communication towers.

While all citizens are at risk to the impacts of lightning, forced relocation and disaster recovery disproportionately impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. An estimated 18 percent of the planning area population live below the poverty level. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures. Table 13-3 lists these vulnerable populations and several others for the City of Baytown

Table 13-3. Populations at Greater Risk[5]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

The City of Baytown Planning Team identified the following critical facilities (Table 13-4) as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by lightning events. For a comprehensive list of critical facilities, please see Appendix F.

Table 13-4. Critical Facilities Vulnerable to Lightning Events

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to power outages, damaged facilities, fires and/or loss of communications as a result of lightning strikes. • Emergency vehicles, including critical equipment, can be damaged by lightning strikes or by falling trees damaged by lightning. • Power outages could disrupt communications, delaying emergency response times. • Downed trees due to lightning strikes can impede emergency response vehicle access to areas. • Lightning strikes can be associated with structure fires and wildfires, further straining the capacity and resources of emergency personnel. • Extended power outages may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/	• Structures can be damaged by falling trees damaged by lightning. • Power outages could disrupt critical care. • Backup power sources could be damaged. • Evacuations may be necessary due to extended power outages, fires, or other associated damages to facilities.

[5] US Census Bureau, American Community Survey Five-Year Estimates, 2023

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CRITICAL FACILITIES	POTENTIAL IMPACTS
Assisted Living Facilities	
Commercial Supplier (food, fuel, etc.)	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed. • Economic disruption due to power outages and fires negatively impact airport services as well as area businesses reliant on airport operations.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and critical services may be significantly impacted due to power outages, damaged facilities, fires and/or loss of communications as a result of lightning strikes. • Emergency vehicles, including critical equipment, can be damaged by lightning strikes or by falling trees damaged by lightning. • Power outages could disrupt communications, delaying emergency response times. • Downed trees due to lightning strikes can impede emergency response vehicle access to areas. • Lightning strikes can be associated with structure fires and wildfires, further straining the capacity and resources of emergency personnel. • Extended power outages may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.

There are no recorded fatalities or injuries directly within the City of Baytown planning area due to lightning events. However, across Chambers and Harris Counties, there have been 15 fatalities and 56 injuries reported. Overall, the total loss estimate of property and crops in the planning area is $9,904,500 (2024 dollars) with an average annualized loss of $341,500. For all of Chambers and Harris Counties, the total loss estimate is $13,061,600 (2024 dollars) with an average annualized loss of $450,400.

In terms of damages to structures, infrastructure, and crops, the potential severity of impact for lightning events would be considered Limited, meaning critical facilities and services shut down for 24 hours or less and less than 10 percent of property destroyed.

However, due to the reported fatalities and injuries, the impact of lightning in the City of Baytown is considered "Substantial" with multiple deaths possible.[6]

Table 13-5. Estimated Annualized Losses by Jurisdiction

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
City of Baytown	$9,904,500	$341,500
Chambers County	$65,300	$2,300
Harris County	$3,093,100	$106,700
TOTALS	$13,062,900	$450,400

ASSESSMENT OF IMPACTS

Lightning events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. Additional impacts to the planning area can include:

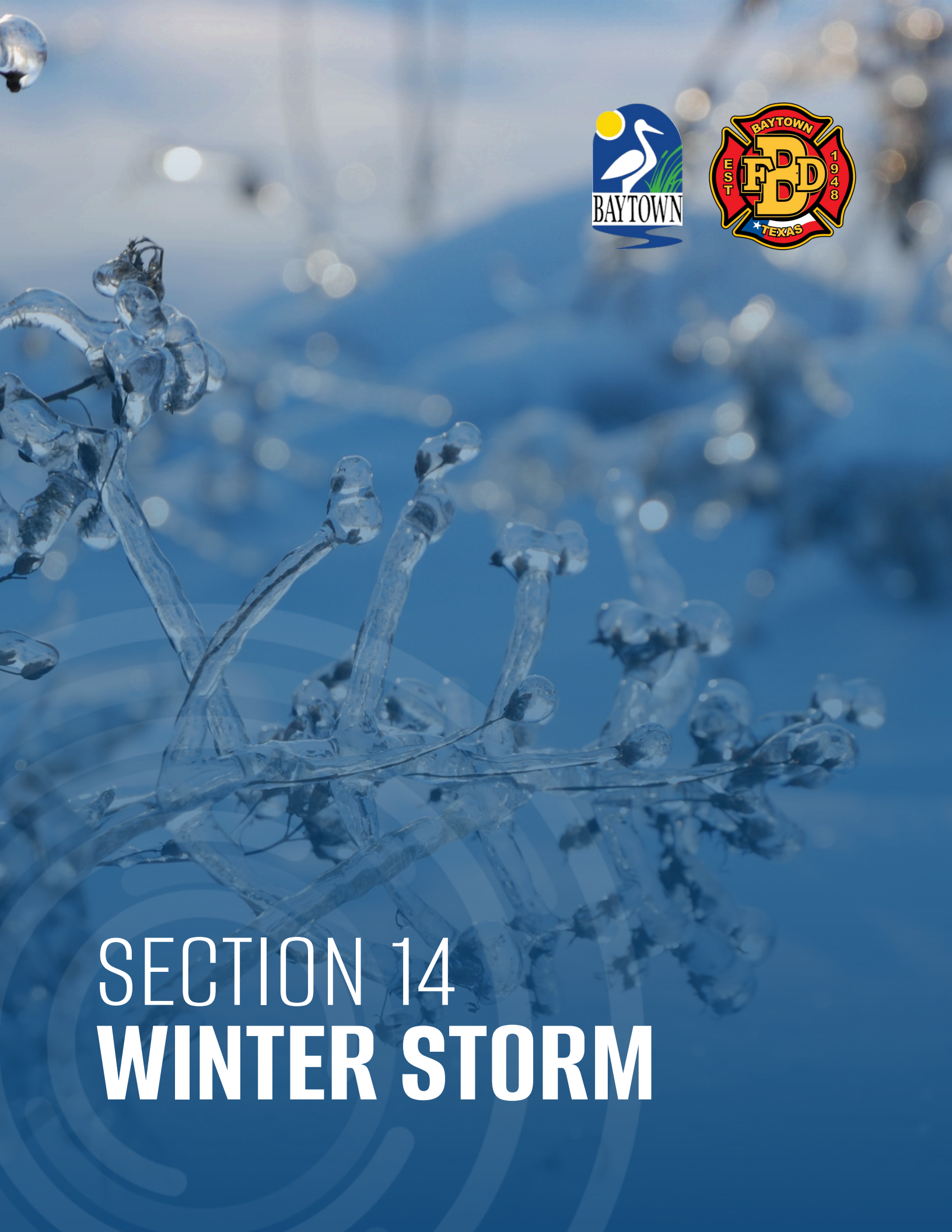
- The City of Baytown planning area features developed parks and green spaces. Lightning events could impact recreational activities, placing residents and visitors in imminent danger, potentially requiring emergency services or park evacuation.
- Older structures built to less stringent building codes may suffer greater damage from a lightning strike as they are typically built with less fire-resistant materials and often lack any fire mitigation measures such as sprinkler systems. 49 percent of homes in the City of Baytown were built before 1980. Similarly, historic buildings may lack fire mitigation materials or measures due to their historic status. Two historic sites in the planning area are listed on the National Register of Historic Places.
- Vegetation in urban parks may be destroyed by lightning-caused brush fires and result in poor air quality impacting public health.
- Individuals exposed to the storm can be directly struck, posing significant health risks and potential death.
- Structures can be damaged or crushed by falling trees damaged by lightning, which can result in physical harm to the occupants.

[6] The vulnerability and impact assessment accounts for damages reported for the City of Baytown, Harris County, and Chambers County as events are often reported on a countywide basis.

SECTION 13: LIGHTNING

- Lightning strikes can result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage often results in an increase in structure fires and carbon monoxide poisoning as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- Lightning strikes can be associated with structure fires and wildfires, creating additional risk to residents and first responders.
- Emergency operations and services may be significantly impacted due to power outages and/or loss of communications.
- City departments may be damaged, delaying response and recovery efforts for the entire community.
- Economic disruption due to power outages and fires negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by lightning events may be negatively impacted while utilities are being restored, further slowing economic recovery.
- Businesses that are more reliant on utility infrastructure than others may suffer greater damage without a backup power source.

The economic and financial impacts of lightning on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any significant lightning event.



SECTION 14
WINTER STORM

SECTION 14: SEVERE WINTER STORM

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HAZARD DESCRIPTION



A severe winter storm event is identified as a storm with snow, ice, or freezing rain. This type of storm can cause significant problems for area residents. Winter storms are associated with freezing or frozen precipitation such as freezing rain, sleet, snow, and the combined effects of winter precipitation and strong winds. Wind chill is a function of temperature and wind. Low wind chill is a product of high winds and freezing temperatures.

Winter storms that threaten the City of Baytown planning area usually begin as powerful cold fronts that push south from central Canada. Although the county is at risk of ice hazards, extremely cold temperatures, and snow, the effects and frequencies of winter storm events are generally mild and short-lived.

As indicated in Figure 14-1, the City of Baytown planning area is located within USDA Hardiness Zones 9b, indicating annual minimum temperatures between 25°F and 30°F. Table 14-1 describes the types of winter weather possible to occur in the City of Baytown planning area.

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Figure 14-1. Annual Minimum Temperature[1]

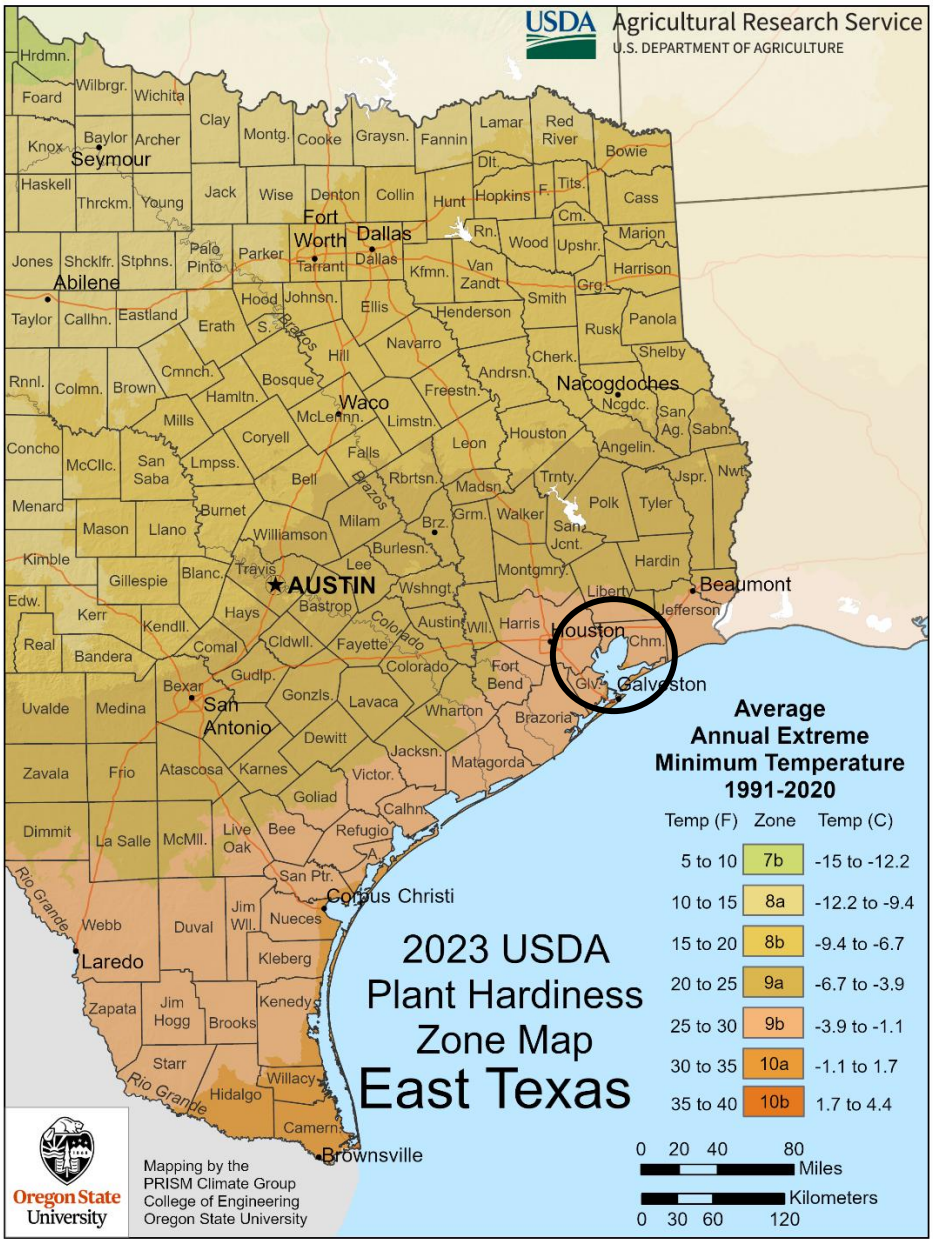


Table 14-1. Types of Winter Weather

TYPE OF WINTER WEATHER	DESCRIPTION
Freezing Rain or Freezing Drizzle	Rain or drizzle is likely to freeze upon impact, resulting in a coating of ice glaze on roads and all other exposed objects.

[1] USDA

SECTION 14: SEVERE WINTER STORM

TYPE OF WINTER WEATHER	DESCRIPTION
Sleet	Small particles of ice usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
Blizzard	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. This alert is the most perilous winter storm with visibility dangerously restricted.
Frost/Freeze	Below freezing temperatures are expected and may cause significant damage to plants, crops, and fruit trees.
Wind Chill	A strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees lower in a calm atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill factor.

LOCATION

Winter storm events are not confined to specific geographic boundaries. Therefore, all existing and future buildings, facilities, and populations in the City of Baytown planning area are vulnerable to a winter storm hazard and could potentially be impacted.

EXTENT

The extent or magnitude of a severe winter storm is measured in intensity based on the temperature and level of snow or ice accumulations as shown in Table 14-2. Table 14-2 should be read in conjunction with the wind-chill factor described in Figure 14-2 to determine the intensity of a winter storm. The chart is not applicable when temperatures are over 50°F or winds are calm. This is an index developed by the National Weather Service.

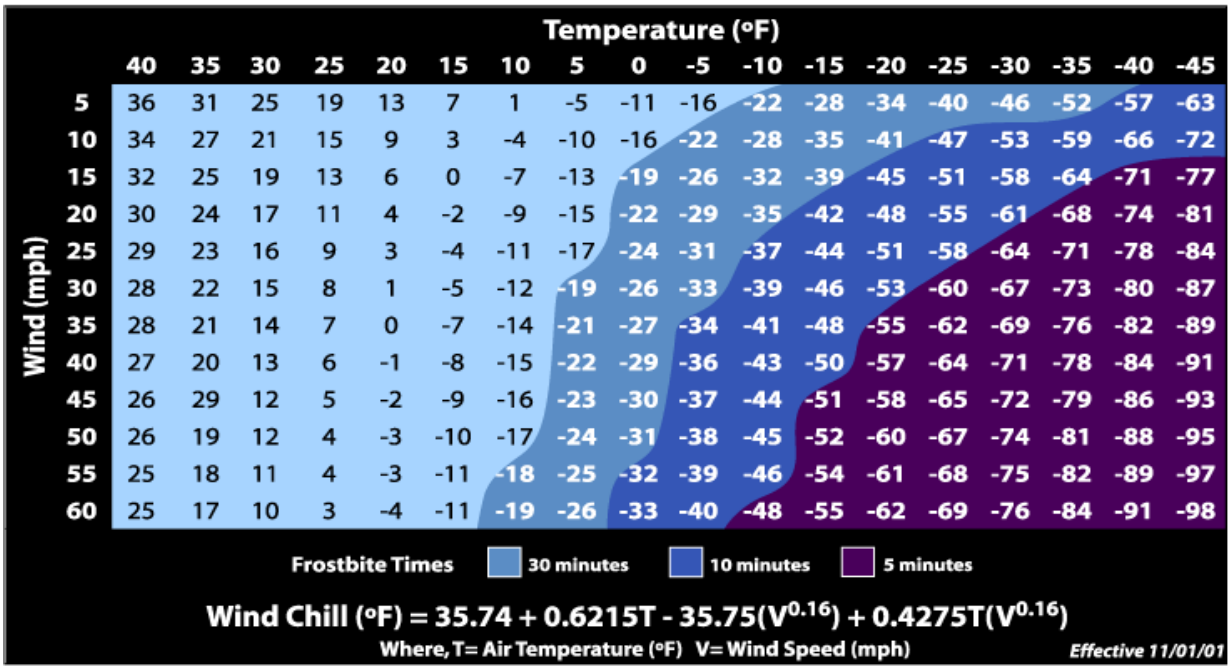
Table 14-2. Magnitude of Severe Winter Storms

INTENSITY	TEMPERATURE RANGE (Fahrenheit)	EXTENT DESCRIPTION
Mild	40° – 50°	Winds less than 10 mph and freezing rain or light snow falling for short durations with little or no accumulations
Moderate	30° – 40°	Winds 10 – 15 mph and sleet and/or snow up to 4 inches

SECTION 14: SEVERE WINTER STORM

INTENSITY	TEMPERATURE RANGE (Fahrenheit)	EXTENT DESCRIPTION
Significant	25° – 30°	Intense snow showers accompanied with strong gusty winds between 15 and 20 mph with significant accumulation
Extreme	20° – 25°	Wind driven snow that reduces visibility, heavy winds (between 20 to 30 mph), and sleet or ice up to 5 millimeters in diameter
Severe	Below 20°	Winds of 35 mph or more and snow and sleet greater than 4 inches

Figure 14-2. Wind Chill Chart



Wind chill temperature is a measure of how cold the wind makes real air temperature feel to the human body. Since wind can dramatically accelerate heat loss from the body, a blustery 30°F day would feel just as cold as a calm day with 0°F temperatures. In the National Centers for Environmental Information (NCEI) Storm Events Database, winter storm events are reported at the county level. Per NCEI data, Harris and Chambers Counties, in which the City of Baytown planning area resides, have 30 previous occurrences recorded from 1996 through 2024. The planning area has never

experienced a blizzard, but it has been subject to extreme cold and wind chill, heavy snow, ice storms, sleet, winter weather, and winter storms.

The average number of cold days is similar for the entire planning area. Therefore, the intensity or extent of a winter storm event to be mitigated for the area ranges from significant to severe according to the definitions in Table 14-2. The City of Baytown planning area can expect anywhere between 0.1 to 4.0 inches of ice and snow during a winter storm event, and temperatures between 25°F and 30°F with winds ranging from 0 to 35 mph. During Winter Storm Uri in February 2021, wind chill values as low as 0°F were reported in Harris County. During the most recent snowstorm on January 21, 2025, the City of Baytown experienced 5.5 inches of snow accumulation, per the National Weather Service.[2] These severe conditions are likely the greatest extent the planning area can anticipate in the future, based on historical events.

The National Weather Service issues a winter storm watch, advisory or warning in advance of an event in order to give people enough time to prepare for an event. The City of Baytown could be under any of these warning types in advance of a winter storm event. Table 14-3 describes when each warning type would be issued.

Table 14-3. Winter Storm Watch, Advisory, Warning Descriptions

TYPE OF WINTER WEATHER	DESCRIPTION
Winter Weather Advisory	This alert may be issued for a variety of severe conditions. Weather advisories may be announced for snow, blowing or drifting snow, freezing drizzle, freezing rain, or a combination of weather events.
Winter Storm Watch	Severe winter weather conditions may affect your area (freezing rain, sleet, or heavy snow may occur separately or in combination).
Winter Storm Warning	Severe winter weather conditions are imminent.
Freezing Rain or Freezing Drizzle	Rain or drizzle is likely to freeze upon impact, resulting in a coating of ice glaze on roads and all other exposed objects.
Sleet	Small particles of ice usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
Blizzard	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. This alert is the most perilous winter storm with visibility dangerously restricted.

[2] Source: https://www.fox26houston.com/weather/houston-weather-snowfall-total-jan-21-2025

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TYPE OF WINTER WEATHER	DESCRIPTION
Frost/Freeze	Below freezing temperatures are expected and may cause significant damage to plants, crops, and fruit trees.
Wind Chill	A strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees lower in a calm atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill factor.

HISTORICAL OCCURRENCES

According to historical records and the best available data there have been 27 recorded winter storm events in the Harris and Chambers Counties. Historical winter storm information, as provided by the NCEI, identifies winter storm activity across a multi-county forecast area for each event. The appropriate percentage of the total property and crop damage reported for the entire forecast area has been allocated to each county impacted by the event, when appropriate.

Historical winter storm data for the planning area is provided on a county-wide basis per the NCEI database. Therefore, winter storm events in Harris and Chambers Counties have been included in this analysis, as the City of Baytown planning area spans both counties. Table 14-4 shows historical incident information for Harris and Chambers Counties.

Table 14-4. Historical Winter Storm Events, 1996 –2024

JURISDICTION	DATE	EVENT TYPE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	1/12/1997	Ice Storm	0	0	$0	$0
Chambers County	1/12/1997	Ice Storm	0	0	$0	$0
Harris County	12/12/1997	Cold /Wind Chill	1	0	$0	$0
Harris County	12/24/2004	Heavy Snow	0	0	$0	$0
Chambers County	12/24/2004	Heavy Snow	0	0	$0	$0
Harris County	1/16/2007	Ice Storm	0	0	$7,800	$0
Harris County	12/10/2008	Heavy Snow	0	0	$0	$0
Chambers County	12/10/2008	Heavy Snow	0	0	$0	$0

SECTION 14: SEVERE WINTER STORM

JURISDICTION	DATE	EVENT TYPE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	1/23/2014	Winter Storm	0	0	$0	$0
Harris County	1/28/2014	Winter Weather	0	0	$0	$0
Harris County	3/3/2014	Winter Weather	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	3/3/2014	Winter Storm	0	0	$0	$0
Harris County	12/7/2017	Heavy Snow	0	0	$0	$0
Harris County	1/2/2018	Extreme Cold / Wind Chill	1	0	$0	$0
Harris County	1/2/2018	Extreme Cold / Wind Chill	1	0	$0	$0
Harris County	1/2/2018	Extreme Cold / Wind Chill	1	0	$0	$0
Harris County	1/16/2018	Sleet	0	0	$0	$0
Harris County	1/16/2018	Extreme Cold / Wind Chill	1	0	$0	$0
Harris County	1/17/2018	Extreme Cold / Wind Chill	1	0	$0	$0
Harris County	2/12/2021	Cold /Wind Chill	33	0	$40,438,500	$0
Harris County	2/14/2021	Winter Storm	0	0	$0	$0
Harris County	2/15/2021	Cold /Wind Chill	0	0	$0	$0
Harris County	2/15/2021	Cold /Wind Chill	0	0	$0	$0
Harris County	2/3/2022	Winter Weather	0	0	$0	$0
TOTALS			39	0	$40,446,300	

Table 14-5. Historical Winter Storm Events Summary, 1996 – 2024

JURISDICTION	NUMBER OF EVENTS	DEATHS	INJURIES	PROPERTY DAMAGES	CROP DAMAGES
Harris and Chambers Counties	27	39	0	$40,446,300	$0

Based on the list of historical winter storm events for the City of Baytown planning area, five of the events were reported to the NCEI since the 2020 Plan.

SIGNIFICANT EVENTS

December 12, 1997 – Harris County

In the evening, one man was reported deceased due to hypothermia and cold exposure during a period of subfreezing temperatures.

January 2018 – Harris County

Over the first three weeks of the month, multiple fatalities resulted from cold exposure and hypothermia. Three fatalities occurred on January 2nd during subfreezing temperatures. Two other fatalities, one on January 16th and the other on the 17th, occurred during continued extreme cold after sleet fell over the county.

February 12-16, 2021 – Winter Storm Uri (Dr-4586) – Harris and Chambers Counties

Winter Storm Uri was one of the most impactful winter events in the state's history. The winter storm event lasted a week and brought snow, sleet, and freezing rain to much of the State of Texas. The presence of the storm began on February 10, 2021, when a cold front brought a surge of cold air to the area. On February 13th, the winter storm hit the region, including the City of Baytown, Harris County, and Chambers County, and many areas were placed under a Winter Storm Warning.

Fatalities across the state were attributed to hypothermia, vehicle accidents, carbon monoxide poisoning, and chronic medical conditions complicated by a lack of electricity over several days. Statewide, more than 69 percent of households lost power at some point during the event, with average disruptions lasting 42 hours. Water service was also disrupted, with 49 percent of households losing running water with an average disruption of 52 hours.[3]

[3] Donald, Jess. "Winter Storm Uri. The Economic Impact of the Storm". October 2021. Fiscal Notes. Texas Comptroller of Public Accounts. https://comptroller.texas.gov/economy/fiscal-notes/2021/oct/winter-storm-impact.php

SECTION 14: SEVERE WINTER STORM

The winter weather in Harris and Chambers Counties resulted in wind chill indices near zero to single digits for multiple days in a row. The increased power demand, wind, and ice led to widespread and sustained power outages over that time. Bursting pipes also caused many to be without water as well. In Harris County, 33 fatalities were attributed directly to the extreme cold, with 7 more being categorized as indirectly caused by Winter Storm Uri. Property damage across the county was estimated at $40,438,500 (2024 dollars).

January 21, 2025 – City of Baytown[4]

During a winter storm which affected much of southeast Texas, the City of Baytown saw a record amount of snowfall with approximately 5.5 inches of snow, per the National Weather Service. This was the greatest snowfall reported anywhere within Harris County during this event. No major impacts were reported from this storm, with City officials citing the City's preparation, the cooperation of citizens, and the use of warming centers as factors which ensured the City of Baytown's safety during the storm.[5]

PROBABILITY OF FUTURE EVENTS

According to historical records, the City of Baytown planning area is expected to experience a winter storm event approximately once a year. The probability of a future winter storm event affecting the City of Baytown planning area is considered "Highly Likely," with a winter storm likely to occur within the next year.

CLIMATE CHANGE CONSIDERATIONS

Climate change is expected to reduce the number of extreme cold events statewide but increase in the variability of events.[6] Extreme cold events will continue to be possible but overall winters are becoming milder, and the frequency of extreme winter weather events are decreasing due to the warming of the Arctic and less extreme cold air coming from

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[4] Due to the recency of this event, a formal event report is not yet available in the NCEI database. However, due to the historical nature of this event, available information on this snowstorm has been incorporated into the risk analysis to create the most comprehensive dataset possible.

[5] Source: https://baytownsun.com/local/all-s-good-after-record-baytown-snowfall/article_d50d5f48-d923-11ef-a8c2-2f082eff9c11.html#:~:text=Marley%20and%20Hendrix%20Myers%20take,sledding%20in%20the%20Lakewood%20addition.&text=To%20say%20it%20was%20a,thanks%20to%20Winter%20Storm%20Enzo.

[6] Fourth National Climate Assessment. Chapter 23 Southern Great Plans. U.S. Global Change Program. 2018.

that region. A trend that is expected to continue with winter extremes estimated to be milder by 2036 compared to extremes in the historic record.[7]

VULNERABILITY AND IMPACT

During periods of extreme cold and freezing temperatures, water pipes can freeze and crack, and ice can build up on power lines, causing them to break under the weight or causing tree limbs to fall on the lines. These events can disrupt electric service for long periods.

An economic impact may occur due to increased consumption of heating fuel, which can lead to energy shortages and higher prices. House fires and resulting deaths tend to occur more frequently from increased and improper use of alternate heating sources. Fires during winter storms also present a greater danger because water supplies may freeze and impede firefighting efforts.

The City of Baytown Planning Team identified the following critical facilities (Table 14-6) as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by winter storm events. For a comprehensive list of critical facilities, please see Appendix F.

Table 14-6. Critical Facilities Vulnerable to Winter Storm Events

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations, services and response times may be significantly impacted due to power outages, and/or loss of communications. • Exposure to extreme cold can cause illnesses in first responders if exposed for a period of time. • Roads may become impassable due to snow and/or ice impacting response times by emergency services. • Extended power outages due to increased usage may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Animal Shelter, Evacuation	• Power outages due to increased usage could disrupt critical care. • Backup power sources could be damaged.

[7] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 update.

CRITICAL FACILITIES	POTENTIAL IMPACTS
Centers & Shelters, Governmental Facilities, Residential/ Assisted Living Facilities	• Increased number of patients due to exposure to cold temperatures could lead to a strain on staff. • Water pipes can freeze and burst leading to flooding within facilities. • Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed. • Economic disruption due to power outages negatively impact airport services as well as area businesses reliant on airport operations. • Exposure risks to outdoor workers.
Commercial Supplier (food, fuel, etc.)	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations, services and response times may be significantly impacted due to power outages, and/or loss of communications. • Roads may become impassable due to snow and/or ice impacting response times by emergency services. • Power outages due to increased usage could disrupt critical care. • Backup power sources could be damaged. • Water pipes can freeze and burst leading to flooding within facilities.

People and animals are subject to health risks from extended exposure to cold air (Table 14-7). Elderly people are at greater risk of death from hypothermia during these events, especially in the neighborhoods with older housing stock. According to the U.S. Center for Disease Control, every year hypothermia kills about 600 Americans, half of whom are 65 years of age or older.

Due to factors like limited mobility, communication difficulties, medical needs, sensitivity to cold temperatures, reliance on support services, transportation challenges, housing accessibility issues, and possible shortages in emergency shelter accommodations, people with disabilities are particularly vulnerable to winter storms. Inclusive measures

are crucial to address these vulnerabilities and ensure their safety during severe weather events.

Populations living below the poverty level may not be able to afford to run heat on a regular basis or an extended period of time. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures.

The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level and 16 percent of the populations speak English 'less than very well' (Table 14-7).

Table 14-7. Populations at Greater Risk[8]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

Older homes tend to be more vulnerable to the impacts of winter storm events. Approximately 49 percent (16,575 structures) of the housing units in the planning area were built before 1980 (Table 14-8).

Table 14-8. Structures at Greater Risk

JURISDICTION	BUILT PRIOR TO 1980
City of Baytown	16,575

Winter Storms have been known to cause injury to humans and occasionally have been fatal. There have been 39 fatalities reported in Harris and Chambers counties due to winter storms historically. Overall, the total loss estimate is $40,446,300 (in 2024 dollars) with an average annualized loss of $1,394,700. In terms of structural damages, the impact of winter storm damages on the City of Baytown planning area would be

[8] U.S. Census Bureau 2023 data for the City of Baytown

considered Minor severity of impact, meaning a shutdown of critical facilities and services for up to one week and more than ten percent of properties damaged or destroyed. However, with the number of fatalities reported regionally, the impact is considered "Substantial", with multiple deaths possible depending on the severity and duration of the event.

Table 14-9. Estimated Annualized Losses by Jurisdiction

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
Chambers and Harris Counties	$40,446,300	$1,394,700

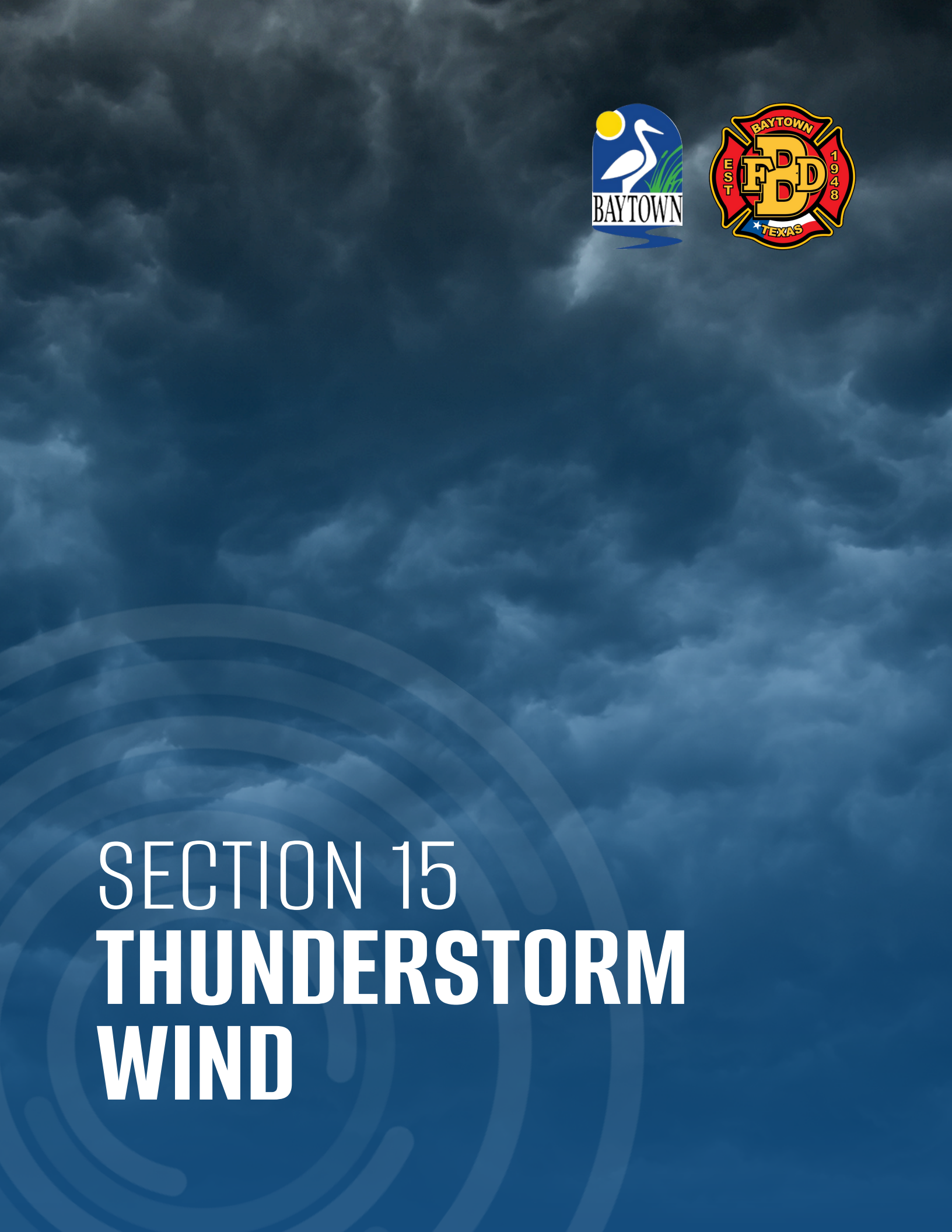
ASSESSMENT OF IMPACTS

The greatest risk from a winter storm hazard is to public health and safety. The impact of climate change could produce longer, more intense winter storm events, exacerbating the current winter storm impacts. Worsening winter storm conditions can be frequently associated with a variety of impacts, including:

- Vulnerable populations, particularly the elderly (12 percent of total population), children under 5 (7 percent of total population), and those with a disability (13 percent of total population), can face serious or life-threatening health problems from exposure to extreme cold including hypothermia and frostbite.
- Loss of electric power or other heat source can result in increased potential for fire injuries or hazardous gas inhalation because residents burn candles for light or use fires or generators to stay warm.
- Response personnel, including utility workers, public works personnel, debris removal staff, tow truck operators, and other first responders, are subject to injury or illness resulting from exposure to extreme cold temperatures.
- Response personnel would be required to travel in potentially hazardous conditions, elevating the life safety risk due to accidents and potential contact with downed power lines.
- During times of ice and snow accumulation, response times will increase until public works road crews are able to make major roads passable.
- Operations or service delivery may experience impacts from electricity blackouts due to winter storms.
- Power outages are possible throughout the planning area due to downed trees and power lines and/or rolling blackouts.

- Critical facilities without emergency backup power may not be operational during power outages.
- Emergency response and service operations may be impacted by limitations on access and mobility if roadways are closed, unsafe, or obstructed.
- Hazardous road conditions will likely lead to increases in automobile accidents, further straining emergency response capabilities.
- Depending on the severity and scale of damage caused by ice and snow events, damage to power transmission and distribution infrastructure can require days or weeks to repair.
- Winter storms can reduce the efficacy of shaded fuel breaks for wildfire mitigation as treated areas were more likely to have downed trees and limbs than untreated areas.
- Winter storms can result in damage to endangered species habitat and increased fuel loads within forested habitats. There are 8 federally endangered, threatened or candidate species in Harris County, and 12 federally endangered, threatened or candidate species in Chambers County.
- Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to impacts of winter storm events. Approximately 49 percent of homes in the City were built before 1980. Similarly, historic buildings and sites are placed at a higher risk of impact due to materials used and the inability to change properties due to their historic status. There are two historical sites listed on the National Register of Historic Places for the City of Baytown.
- Schools may be forced to shut early due to treacherous driving conditions.
- Exposed water pipes may be damaged by severe or late season winter storms at both residential and commercial structures, causing significant damages.

The economic and financial impacts of winter weather on the community will depend on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of a winter storm event.



SECTION 15
THUNDERSTORM WIND

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HAZARD DESCRIPTION

Thunderstorms create extreme wind events which includes straight-line winds. Wind is the horizontal motion of the air past a given point, beginning with differences in air pressures. Pressure that is higher at one place than another sets up a force pushing from high toward low pressure; the greater the difference in pressures, the stronger the force. The distance between the area of high pressure and the area of low pressure also determines how fast the moving air accelerates.



Thunderstorms are created when heat and moisture near the Earth's surface are transported to the upper levels of the atmosphere. By-products of this process are the clouds, precipitation, and wind that become the thunderstorm.

According to the National Weather Service (NWS), a thunderstorm occurs when thunder accompanies rainfall. Radar observers use the intensity of radar echoes to distinguish between rain showers and thunderstorms.

Straight-line winds are responsible for most thunderstorm wind damages. One type of straight-line wind, the downburst, is a small area of rapidly descending air beneath a thunderstorm. A downburst can cause damage equivalent to a strong tornado and make air travel extremely hazardous.

SECTION 15: THUNDERSTORM WIND

LOCATION

Thunderstorm wind events can develop in any geographic location and are considered a common occurrence in Texas. Therefore, a thunderstorm wind event could occur at any location within the City of Baytown planning area. These storms develop randomly and are not confined to any geographic area within the planning area. It is assumed that the entire City of Baytown planning area is uniformly exposed to the threat of thunderstorm winds.

EXTENT

The extent or magnitude of a thunderstorm wind event is measured by the Beaufort Wind Scale. Table 15-1 describes the different intensities of wind in terms of speed and effects, from calm to violent and destructive.

Table 15-1. Beaufort Wind Scale[1]

FORCE	WIND		WMO CLASSIFICATION	APPEARANCE OF WIND EFFECTS
	(mph)	(knots)		
0	Less than 1	Less than 1	Calm	Calm, smoke rises vertically
1	1-3	1-3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4-7	4-6	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	8-12	7-10	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	13-18	11-16	Moderate Breeze	Dust, leaves and loose paper lifted, small tree branches move
5	19-24	17-21	Fresh Breeze	Small trees in leaf begin to sway
6	25-31	22-27	Strong Breeze	Larger tree branches moving, whistling in wires
7	32-38	28-33	Near Gale	Whole trees moving, resistance felt walking against wind

[1] Source: World Meteorological Organization

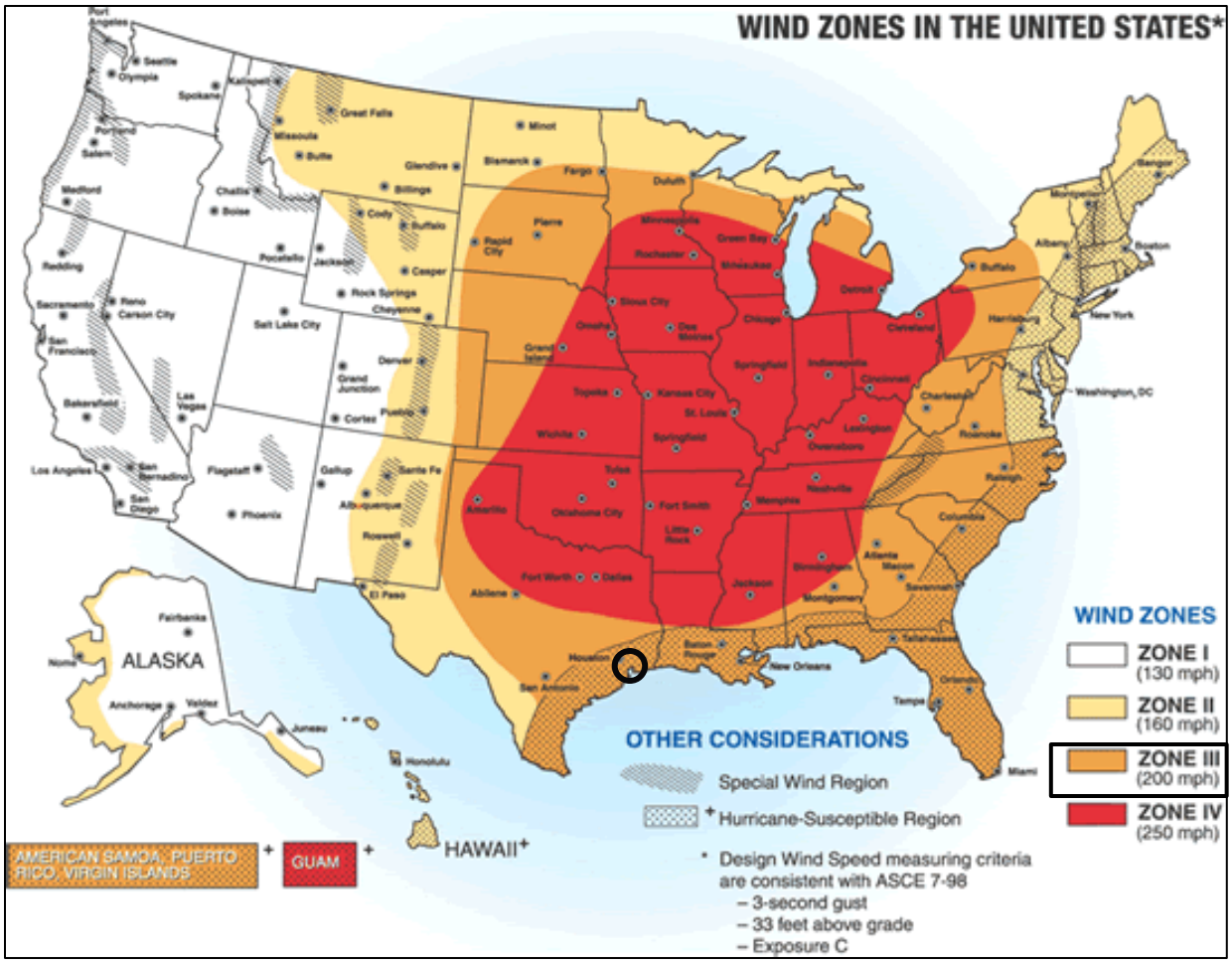
SECTION 15: THUNDERSTORM WIND

FORCE	WIND		WMO CLASSIFICATION	APPEARANCE OF WIND EFFECTS
	(mph)	(knots)		
8	39-46	34-40	Gale	Whole trees in motion, resistance felt walking against wind
9	47-54	41-47	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	55-63	48-55	Storm	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	64-72	56-63	Violent Storm	If experienced on land, widespread damage
12	72-83	64-71	Hurricane	Violence and destruction

Figure 15-1 displays the wind zones as derived from NOAA.

SECTION 15: THUNDERSTORM WIND

Figure 15-1. Wind Zones in the United States[2]



On average, the planning area experiences approximately eleven thunderstorm wind events every year. The City of Baytown planning area is located within Wind Zone III, meaning the planning area can experience maximum wind speeds up to 200 mph. The City of Baytown planning area has experienced a significant wind event, or an event with winds in the range of "Force 12" on the Beaufort Wind Scale with winds above 72 mph. This is the worst to be anticipated for the entire planning area based on historic events.

Based on a search of past events between 1955 through 2024, the greatest magnitude wind event in the vicinity of the planning area was 90 knots, or 104 mph, during an event occurring on May 16, 2024 in Harris County.

[2] The City of Baytown planning area is indicated by the black circle.

SECTION 15: THUNDERSTORM WIND

HISTORICAL OCCURRENCES

The National Centers for Environmental Information (NCEI) Storm Events database is a national data source organized under the National Oceanic and Atmospheric Administration. The NCEI is the largest archive available for historic storm events data; however, it is important to note that only incidents recorded in the NCEI have been factored into this risk assessment unless otherwise noted. It is likely that a high number of occurrences have gone unreported over the past 69 years. Tables 15-2, 15-3, and 15-4 depict historical occurrences of thunderstorm wind events for the City of Baytown planning area according to the NCEI database.

Since 1955, 7 thunderstorm wind events are known to have occurred in the City of Baytown planning area. Within all of Chambers and Harris Counties, 774 thunderstorm wind events have been reported in the NCEI database. Thunderstorm wind events for both Chambers and Harris Counties have been incorporated to ensure the most comprehensive dataset possible, as the City of Baytown spans both counties. Given that some thunderstorm wind events are reported at the county level rather than by individual jurisdiction, this approach provides a more accurate representation of historical thunderstorm wind risk exposure for the planning area.

Table 15-3 presents information on known historical events impacting the City of Baytown, Harris County, or Chambers County which resulted in damages, injuries, or fatalities. Table 15-4 summarizes all thunderstorm wind events and their associated impacts by jurisdiction.

It is important to note that high wind events associated with other hazards, such as tornadoes, are not accounted for in this section. Property damage estimates are not always available. Where an estimate has been provided in a table for losses, the dollar amounts have been modified for inflation to indicate the damage in 2024 dollars.

Table 15-2. Historical Thunderstorm Wind Speeds, 1955 – 2024

MAXIMUM WIND SPEED RECORDED (knots)	NUMBER OF REPORTED EVENTS
0-30	0
31-40	1
41-50	117
51-60	268

61-70	61
71-80	9
81-90	7
91-100+	0
Unknown	311

Table 15-3. Damaging Historical Thunderstorm Wind Events, 1955 – 2024[3]

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	8/6/1984	-	0	2	$0	$0
Harris County	3/29/1990	-	0	5	$0	$0
Harris County	4/27/1990	-	0	1	$0	$0
Harris County	4/25/1993	-	0	0	$1,100	$0
Harris County	5/2/1993	-	0	0	$109,152,600	$0
Harris County	5/9/1993	-	0	0	$11,000	$0
Harris County	5/9/1993	-	0	0	$11,000	$0
Harris County	5/9/1993	-	0	0	$1,100	$0
Harris County	5/9/1993	-	0	0	$1,100	$0
Harris County	11/16/1993	-	0	0	$10,800	$0
Harris County	4/15/1994	-	0	0	$10,700	$0
Harris County	4/15/1994	-	0	0	$10,700	$0
Chambers County	8/9/1994	-	0	0	$10,600	$6,400
Harris County	8/17/1994	60	0	0	$0	$211,300
Harris County	10/8/1994	58	0	0	$105,300	$0
Harris County	3/7/1995	-	0	0	$104,000	$0
Harris County	5/8/1995	-	0	0	$8,300	$0

[3] Only recorded events with fatalities, injuries or damages are listed. Magnitude is listed where available. Damage values are in 2024 dollars. The database was searched for events between 1950 and 2024. 111 events were reported prior to August 6, 1984, however none of these events included reported damages and therefore have not been listed in this table.

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/8/1995	-	0	0	$8,300	$0
Harris County	5/8/1995	-	0	0	$4,200	$0
Harris County	5/8/1995	-	0	0	$4,200	$0
Chambers County	5/8/1995	-	0	0	$2,100	$0
Chambers County	5/8/1995	-	0	0	$2,100	$0
Harris County	5/30/1995	-	0	0	$6,300	$0
Harris County	5/30/1995	-	0	0	$6,300	$0
Harris County	6/1/1995	-	0	0	$51,700	$0
Harris County	6/1/1995	60	0	0	$10,400	$0
Harris County	6/1/1995	-	0	0	$2,100	$0
Harris County	6/11/1995	-	0	0	$206,500	$0
Harris County	6/11/1995	-	0	0	$10,400	$0
Harris County	6/11/1995	-	0	0	$2,100	$0
Chambers County	7/29/1995	-	0	0	$20,700	$0
Harris County	8/21/1995	-	0	0	$4,200	$0
Harris County	9/21/1995	-	0	0	$102,800	$0
Chambers County	11/11/1995	-	0	0	$61,500	$0
Harris County	11/11/1995	-	0	0	$30,800	$0
Harris County	11/11/1995	-	0	0	$10,300	$0
Harris County	12/17/1995	-	0	2	$41,100	$0
Chambers County	12/17/1995	50	0	0	$20,600	$0
Harris County	12/17/1995	-	0	0	$10,300	$0
Harris County	12/18/1995	-	0	0	$2,050,800	$0
Harris County	12/18/1995	-	0	0	$20,600	$0
Harris County	4/22/1996	-	0	0	$10,100	$0
Harris County	4/22/1996	-	0	0	$10,100	$0
Harris County	4/29/1996	-	0	0	$1,007,100	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/11/1996	-	0	0	$40,300	$0
Harris County	5/29/1996	50	0	0	$10,100	$0
Harris County	6/2/1996	-	0	0	$10,100	$0
Harris County	6/2/1996	50	0	0	$10,100	$0
Harris County	6/2/1996	-	0	0	$10,100	$0
Harris County	6/3/1996	-	0	0	$10,100	$0
Harris County	6/4/1996	-	0	0	$10,100	$0
Harris County	6/4/1996	-	0	0	$10,100	$0
Harris County	6/13/1996	-	0	0	$10,100	$0
Harris County	6/15/1996	-	0	0	$10,100	$0
Harris County	6/18/1996	55	0	0	$10,100	$0
Harris County	6/18/1996	-	0	0	$10,100	$0
Harris County	6/18/1996	-	0	0	$6,100	$0
Harris County	6/20/1996	-	0	0	$502,300	$0
Harris County	6/20/1996	-	0	0	$30,200	$0
Harris County	6/20/1996	-	0	0	$10,100	$0
Harris County	6/20/1996	50	0	0	$10,100	$0
Harris County	7/24/1996	-	0	0	$20,100	$0
Harris County	8/10/1996	-	0	0	$10,100	$0
Harris County	8/10/1996	-	0	0	$10,100	$0
Harris County	8/10/1996	50	0	0	$10,100	$0
Harris County	8/10/1996	-	0	0	$10,100	$0
Harris County	8/12/1996	-	0	0	$60,100	$0
Harris County	8/12/1996	-	0	0	$30,100	$0
Harris County	8/12/1996	-	0	0	$10,100	$0
Harris County	8/19/1996	-	0	0	$100,100	$0
Harris County	9/15/1996	-	0	0	$10,000	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	9/17/1996	-	0	0	$10,000	$0
Harris County	9/17/1996	-	0	0	$10,000	$0
Harris County	11/7/1996	-	0	0	$10,000	$0
Harris County	11/24/1996	-	0	0	$19,900	$0
Chambers County	1/27/1997	-	0	0	$9,900	$0
Harris County	2/20/1997	-	0	0	$19,800	$0
Harris County	2/20/1997	-	0	0	$9,900	$0
Harris County	2/20/1997	-	0	0	$4,000	$0
Harris County	4/5/1997	-	0	0	$19,700	$0
Harris County	4/11/1997	-	0	0	$9,900	$0
Harris County	4/11/1997	-	0	0	$4,000	$0
Harris County	5/28/1997	-	0	0	$9,900	$0
Harris County	5/30/1997	-	0	0	$49,200	$0
Harris County	5/30/1997	-	0	0	$39,400	$0
Harris County	5/30/1997	-	0	0	$19,700	$0
Harris County	5/30/1997	-	0	0	$9,900	$0
Harris County	5/30/1997	-	0	0	$9,900	$0
Harris County	5/30/1997	-	0	0	$9,900	$0
Harris County	5/30/1997	-	0	0	$9,900	$0
City of Baytown	5/31/1997	-	0	0	$9,900	$0
Chambers County	5/31/1997	-	0	0	$9,900	$0
Harris County	6/17/1997	-	0	0	$392,800	$0
Harris County	6/17/1997	65	0	6	$59,000	$0
Harris County	6/17/1997	65	0	2	$59,000	$0
Harris County	6/17/1997	-	0	0	$59,000	$0
Harris County	6/17/1997	-	0	0	$49,100	$0
Harris County	6/17/1997	-	0	0	$49,100	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/17/1997	65	0	0	$29,500	$0
Harris County	6/17/1997	60	0	0	$29,500	$0
Harris County	6/17/1997	-	0	0	$19,700	$0
Harris County	6/17/1997	-	0	0	$9,900	$0
Harris County	6/17/1997	-	0	0	$9,900	$0
Chambers County	6/17/1997	-	0	0	$9,900	$0
Harris County	6/21/1997	50	0	0	$9,900	$0
Harris County	7/14/1997	-	0	0	$9,900	$0
Chambers County	7/14/1997	-	0	0	$9,900	$0
Harris County	7/21/1997	-	0	1	$19,700	$0
Harris County	9/2/1997	-	0	0	$9,800	$0
Harris County	9/9/1997	-	0	0	$29,300	$0
Chambers County	9/9/1997	-	0	0	$29,300	$0
Harris County	9/9/1997	-	0	0	$19,600	$0
Chambers County	10/3/1997	80	0	0	$97,400	$0
Chambers County	12/3/1997	80	0	0	$146,400	$0
Harris County	12/3/1997	-	0	0	$58,600	$0
Harris County	12/7/1997	-	0	0	$29,300	$0
Harris County	12/7/1997	-	0	0	$9,800	$0
Chambers County	12/7/1997	-	0	0	$5,900	$0
Chambers County	12/7/1997	-	0	0	$5,900	$0
Harris County	12/23/1997	-	0	0	$78,100	$0
Harris County	12/23/1997	-	0	0	$39,100	$0
Chambers County	12/23/1997	-	0	0	$5,900	$0
Harris County	1/6/1998	60	0	0	$3,900	$0
Harris County	2/10/1998	-	0	2	$145,900	$0
Harris County	2/10/1998	52	0	0	$58,400	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	2/10/1998	-	0	0	$19,500	$0
Chambers County	2/10/1998	-	0	0	$9,800	$0
Harris County	2/16/1998	-	0	0	$13,700	$0
Harris County	2/16/1998	51	0	0	$5,900	$0
Chambers County	6/6/1998	-	0	0	$5,800	$0
Harris County	7/14/1998	-	0	0	$48,300	$0
Harris County	7/14/1998	61	0	0	$19,300	$0
Harris County	7/14/1998	-	0	0	$19,300	$0
Harris County	7/14/1998	-	0	0	$19,300	$0
Harris County	7/14/1998	61	0	0	$9,700	$0
Harris County	7/14/1998	-	0	0	$9,700	$0
Harris County	7/17/1998	-	0	0	$77,200	$0
City of Baytown	7/17/1998	-	0	0	$29,000	$0
Harris County	7/17/1998	-	0	0	$29,000	$0
Harris County	7/17/1998	-	0	0	$19,300	$0
Harris County	7/17/1998	-	0	0	$19,300	$0
Harris County	7/17/1998	-	0	0	$5,800	$0
Chambers County	7/17/1998	-	0	0	$5,800	$0
Harris County	8/3/1998	-	0	0	$48,200	$0
Harris County	8/3/1998	-	0	0	$9,700	$0
Harris County	8/3/1998	-	0	0	$5,800	$0
Harris County	8/5/1998	-	0	0	$19,300	$0
Harris County	8/20/1998	-	0	0	$57,800	$0
Harris County	10/6/1998	52	0	0	$5,800	$0
Chambers County	10/6/1998	-	0	0	$5,800	$0
Harris County	10/17/1998	-	0	0	$9,600	$0
Harris County	1/1/1999	52	0	0	$9,600	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	3/13/1999	-	0	0	$47,700	$0
Harris County	3/13/1999	-	0	0	$28,700	$0
Harris County	5/10/1999	-	0	0	$947,100	$0
City of Baytown	5/10/1999	-	0	0	$568,300	$0
Harris County	5/10/1999	-	0	0	$189,500	$0
Harris County	5/10/1999	-	0	0	$189,500	$0
Harris County	5/10/1999	-	0	0	$94,800	$0
Harris County	5/10/1999	-	0	0	$47,400	$0
Harris County	5/10/1999	-	0	0	$47,400	$0
Harris County	5/10/1999	52	0	0	$19,000	$0
Harris County	5/12/1999	-	0	0	$47,400	$0
Harris County	5/12/1999	-	0	0	$28,500	$0
Chambers County	5/17/1999	-	0	0	$28,500	$0
Harris County	8/31/1999	-	1	0	$1,865,100	$0
Harris County	8/31/1999	-	0	0	$376,800	$0
Harris County	8/31/1999	-	0	0	$28,300	$0
Chambers County	8/31/1999	-	0	0	$28,300	$0
Harris County	4/2/2000	-	0	2	$1,470,200	$0
Harris County	4/2/2000	-	0	0	$46,000	$0
Harris County	5/2/2000	-	0	0	$367,200	$0
Harris County	5/2/2000	-	0	0	$91,800	$0
Harris County	5/2/2000	69	0	0	$45,900	$0
City of Baytown	5/2/2000	-	0	0	$27,600	$0
Harris County	5/2/2000	-	0	0	$27,600	$0
Harris County	5/2/2000	69	0	0	$27,600	$0
Harris County	5/3/2000	-	0	0	$183,600	$0
Harris County	5/3/2000	-	0	0	$91,800	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/4/2000	-	0	0	$27,600	$0
Harris County	5/19/2000	-	0	0	$45,900	$0
Harris County	5/19/2000	-	0	0	$45,900	$0
Harris County	7/23/2000	52	0	0	$182,200	$0
Harris County	7/23/2000	-	0	0	$91,100	$0
Harris County	7/23/2000	-	0	0	$91,100	$0
Chambers County	7/23/2000	-	0	0	$45,600	$0
Harris County	7/23/2000	-	0	0	$27,400	$0
Chambers County	7/23/2000	69	0	0	$27,400	$0
Harris County	8/2/2000	-	0	0	$182,200	$0
Harris County	8/2/2000	-	0	0	$182,200	$0
Harris County	8/11/2000	-	0	0	$182,200	$0
Harris County	8/11/2000	-	0	0	$182,200	$0
Chambers County	8/11/2000	52	0	0	$27,400	$0
Harris County	8/22/2000	68	0	0	$182,200	$0
Harris County	9/1/2000	-	0	0	$27,200	$0
Chambers County	9/2/2000	-	0	0	$271,900	$0
Chambers County	9/2/2000	-	0	0	$181,300	$0
Chambers County	9/2/2000	-	0	0	$45,400	$0
Chambers County	9/3/2000	-	0	0	$181,300	$0
Chambers County	9/3/2000	-	0	0	$45,400	$0
Harris County	9/5/2000	-	0	0	$72,500	$0
Chambers County	9/5/2000	-	0	0	$27,200	$0
Harris County	9/22/2000	-	0	0	$90,700	$0
Harris County	11/5/2000	-	0	0	$180,900	$0
Harris County	11/5/2000	-	0	0	$90,500	$0
Harris County	11/5/2000	-	0	0	$27,200	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	11/12/2000	-	0	2	$271,300	$0
Harris County	11/12/2000	-	0	0	$271,300	$0
Harris County	11/12/2000	68	0	0	$27,200	$0
Harris County	11/12/2000	-	0	0	$27,200	$0
Harris County	11/24/2000	-	0	0	$723,300	$0
Harris County	1/29/2001	-	0	0	$36,000	$0
Harris County	3/14/2001	-	0	0	$35,800	$0
Harris County	3/14/2001	-	0	0	$35,800	$0
Harris County	3/14/2001	-	0	0	$26,800	$0
Harris County	3/14/2001	-	0	0	$9,000	$0
Harris County	4/16/2001	-	0	0	$26,692,800	$0
Harris County	4/16/2001	-	0	0	$17,795,200	$0
Harris County	6/1/2001	-	0	0	$17,700	$0
Harris County	6/21/2001	-	0	0	$17,700	$0
Harris County	6/28/2001	-	0	0	$53,100	$0
Harris County	8/6/2001	-	0	0	$35,500	$0
Harris County	8/6/2001	-	0	0	$26,700	$0
Harris County	8/6/2001	-	0	0	$26,700	$0
Harris County	8/6/2001	-	0	0	$17,800	$0
Harris County	8/26/2001	-	0	0	$17,800	$0
Harris County	8/26/2001	-	0	0	$17,800	$0
Harris County	9/20/2001	-	0	0	$26,500	$0
Harris County	9/20/2001	-	0	0	$8,900	$0
Harris County	9/21/2001	-	0	0	$17,700	$0
Harris County	10/11/2001	-	0	0	$26,600	$0
Harris County	6/16/2002	-	0	0	$17,500	$0
Harris County	6/16/2002	55	0	0	$3,500	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/29/2002	-	0	0	$87,500	$0
Harris County	8/3/2002	-	0	0	$52,300	$0
Harris County	8/3/2002	-	1	0	$26,200	$0
Harris County	8/4/2002	-	0	0	$43,600	$0
Chambers County	8/26/2002	-	0	0	$43,600	$0
Harris County	12/23/2002	61	0	0	$130,600	$0
Harris County	12/23/2002	52	0	0	$95,800	$0
Chambers County	12/23/2002	52	0	0	$34,900	$0
Harris County	12/23/2002	50	0	0	$17,500	$0
Harris County	12/23/2002	52	0	0	$1,800	$0
Harris County	12/23/2002	52	0	0	$1,800	$0
Harris County	3/18/2003	59	0	0	$13,700	$0
Chambers County	6/2/2003	65	0	0	$12,000	$0
Harris County	7/11/2003	60	0	0	$18,900	$0
Harris County	7/18/2003	58	0	0	$5,200	$0
Harris County	8/9/2003	58	0	0	$5,200	$0
Harris County	4/10/2004	50	0	0	$167,500	$0
City of Baytown	4/10/2004	60	0	0	$125,600	$0
Harris County	4/10/2004	50	0	0	$16,800	$0
Harris County	5/1/2004	58	0	0	$83,300	$0
Harris County	5/11/2004	50	0	0	$25,000	$0
Harris County	7/8/2004	50	0	0	$8,400	$0
Harris County	7/25/2004	50	0	0	$124,700	$0
Harris County	8/28/2004	52	0	0	$41,600	$0
City of Baytown	11/23/2004	60	0	0	$82,500	$0
Chambers County	11/23/2004	60	0	0	$57,700	$0
Chambers County	11/23/2004	55	0	0	$33,000	$0

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JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	11/23/2004	50	0	0	$16,500	$0
Harris County	11/23/2004	55	0	0	$12,400	$0
Harris County	3/7/2005	60	0	0	$16,300	$0
Harris County	3/7/2005	63	0	0	$5,700	$0
Harris County	3/7/2005	58	0	0	$3,300	$0
Harris County	5/8/2005	52	0	0	$21,100	$0
Harris County	5/8/2005	51	0	0	$8,100	$0
Harris County	5/29/2005	53	0	0	$11,400	$0
Harris County	6/15/2005	55	0	0	$14,600	$0
Harris County	7/6/2005	55	0	0	$185,300	$0
Harris County	7/6/2005	55	0	0	$16,200	$0
Harris County	7/6/2005	50	0	0	$12,900	$0
Harris County	7/7/2005	55	0	0	$22,600	$0
Harris County	7/11/2005	54	0	0	$24,200	$0
Harris County	7/13/2005	57	0	0	$104,800	$0
Harris County	8/9/2005	50	0	0	$24,100	$0
Harris County	8/15/2005	50	0	0	$40,100	$0
Harris County	10/31/2005	60	0	0	$39,600	$0
Harris County	10/31/2005	60	0	0	$28,500	$0
Harris County	10/31/2005	52	0	0	$19,000	$0
Harris County	10/31/2005	52	0	0	$19,000	$0
Harris County	1/17/2006	40	1	1	$63,500	$0
Harris County	2/10/2006	43	0	0	$23,800	$0
Harris County	4/21/2006	60	0	0	$7,900	$0
Chambers County	4/29/2006	55	0	0	$54,700	$0
Harris County	5/14/2006	53	0	0	$12,500	$0
Harris County	5/14/2006	50	0	0	$10,900	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/13/2006	50	0	0	$46,600	$0
Harris County	6/13/2006	50	0	0	$15,600	$0
Harris County	7/18/2006	55	0	0	$31,000	$0
Harris County	7/22/2006	51	0	0	$4,700	$0
Harris County	8/22/2006	53	0	0	$15,500	$0
Harris County	10/10/2006	56	0	0	$46,800	$0
Harris County	10/10/2006	50	0	0	$1,600	$0
Harris County	3/12/2007	65	0	0	$69,000	$0
Harris County	3/13/2007	52	0	0	$23,000	$0
Harris County	3/31/2007	59	0	0	$299,000	$0
Harris County	4/25/2007	50	0	0	$3,100	$0
Harris County	5/14/2007	55	0	0	$53,000	$0
Harris County	5/14/2007	50	0	0	$7,600	$0
Harris County	6/14/2007	65	0	0	$7,600	$0
Harris County	6/28/2007	56	0	0	$105,800	$0
Harris County	9/4/2007	52	0	0	$7,600	$0
Harris County	10/15/2007	52	0	0	$7,600	$0
Harris County	1/31/2008	52	0	0	$7,500	$0
Harris County	2/12/2008	52	0	0	$22,400	$0
Harris County	6/19/2008	58	1	7	$43,200	$0
Harris County	6/19/2008	53	0	0	$21,600	$0
Harris County	6/19/2008	50	0	0	$11,600	$0
Harris County	6/19/2008	50	0	0	$2,900	$0
Chambers County	8/3/2008	52	0	0	$11,500	$0
Harris County	8/26/2008	70	0	0	$43,200	$0
Harris County	2/11/2009	53	0	0	$44,600	$0
Harris County	4/18/2009	70	0	0	$44,300	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	4/24/2009	55	0	0	$14,800	$0
Harris County	4/27/2009	50	0	0	$1,500	$0
Harris County	4/27/2009	50	0	0	$800	$0
Harris County	8/12/2009	52	0	0	$7,300	$0
Harris County	9/21/2009	52	0	0	$3,000	$0
Harris County	5/28/2010	50	0	0	$4,400	$0
Harris County	6/8/2010	56	0	0	$36,200	$0
Harris County	6/8/2010	56	0	0	$14,500	$0
Harris County	8/23/2010	56	0	0	$11,600	$0
Harris County	2/1/2011	56	0	0	$7,200	$0
Harris County	5/12/2011	50	0	0	$1,400	$0
Harris County	6/5/2011	65	0	0	$34,900	$0
Harris County	6/5/2011	61	0	0	$21,000	$0
Harris County	6/5/2011	63	0	0	$21,000	$0
Harris County	6/5/2011	61	0	0	$15,400	$0
Harris County	6/5/2011	56	0	0	$4,200	$0
Harris County	6/6/2011	54	0	0	$14,000	$0
Harris County	3/20/2012	62	0	0	$41,200	$0
Harris County	3/20/2012	52	0	0	$9,700	$0
Harris County	3/20/2012	52	0	0	$6,900	$0
Harris County	3/20/2012	52	0	0	$5,500	$0
Harris County	4/20/2012	65	0	0	$6,900	$0
Harris County	4/20/2012	61	0	0	$2,800	$0
Harris County	6/7/2012	52	0	0	$41,200	$0
Harris County	6/7/2012	61	0	0	$13,800	$0
Harris County	6/12/2012	61	0	0	$13,800	$0
Harris County	6/12/2012	56	0	0	$5,500	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/12/2012	56	0	0	$4,200	$0
Harris County	6/26/2012	65	0	0	$20,600	$0
Harris County	8/10/2012	50	0	0	$6,900	$0
Harris County	12/25/2012	52	0	0	$4,200	$0
Harris County	12/25/2012	43	1	0	$0	$0
Harris County	4/2/2013	55	0	0	$700	$0
Harris County	4/27/2013	60	0	0	$4,100	$0
Chambers County	5/22/2013	65	0	0	$5,500	$0
Chambers County	5/22/2013	65	0	0	$5,500	$0
Chambers County	5/22/2013	65	0	0	$3,800	$0
Harris County	6/9/2013	60	0	0	$10,800	$0
Harris County	8/16/2013	55	0	0	$13,500	$0
Harris County	8/16/2013	56	0	0	$0	$10,800
Harris County	9/2/2013	50	0	0	$6,800	$0
Harris County	10/27/2013	52	0	0	$2,700	$0
Harris County	5/27/2014	65	0	15	$26,500	$0
Harris County	5/27/2014	60	0	0	$26,500	$0
Harris County	5/27/2014	60	0	0	$17,300	$0
Harris County	5/27/2014	50	1	0	$0	$0
Harris County	6/22/2014	50	0	0	$15,900	$0
Harris County	7/7/2014	55	0	0	$9,300	$0
Harris County	10/6/2014	50	1	0	$4,000	$0
Harris County	10/6/2014	50	0	0	$2,700	$0
Harris County	10/6/2014	53	0	0	$1,400	$0
Harris County	10/6/2014	53	0	0	$1,400	$0
Harris County	12/27/2014	50	0	0	$20,200	$0
Harris County	4/17/2015	50	0	0	$13,400	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	4/17/2015	60	0	0	$5,400	$0
Harris County	4/17/2015	71	0	0	$0	$20,000
Harris County	4/25/2015	50	0	0	$9,400	$0
Harris County	4/25/2015	50	0	0	$2,000	$0
Harris County	6/20/2015	50	0	0	$6,600	$0
Harris County	5/21/2016	54	0	0	$0	$4,000
Harris County	1/22/2017	45	0	0	$26,000	$0
Harris County	2/14/2017	50	0	0	$2,600	$0
Harris County	3/25/2017	52	0	0	$19,400	$0
Harris County	3/29/2017	50	0	0	$0	$5,200
Harris County	3/29/2017	50	0	0	$0	$5,200
Harris County	3/28/2018	50	0	0	$2,600	$1,300
Harris County	4/3/2018	70	0	0	$2,512,900	$0
Chambers County	5/26/2018	55	0	0	$31,300	$0
Harris County	5/26/2018	51	0	0	$0	$3,800
Harris County	7/31/2018	52	0	0	$1,900	$0
Harris County	8/10/2018	51	0	0	$1,300	$0
Harris County	10/31/2018	53	0	0	$6,300	$0
Harris County	12/7/2018	52	0	0	$18,800	$0
Harris County	12/27/2018	52	0	0	$5,100	$0
Harris County	4/7/2019	52	0	0	$18,500	$6,200
Harris County	4/7/2019	52	0	0	$0	$18,500
Harris County	4/7/2019	52	0	0	$0	$8,700
Harris County	4/7/2019	52	0	0	$0	$6,200
Harris County	5/4/2019	50	0	0	$6,200	$0
Harris County	7/30/2019	53	0	0	$0	$7,400
Harris County	7/30/2019	54	0	0	$0	$3,700

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	8/28/2019	50	0	1	$61,400	$0
Harris County	8/28/2019	50	0	0	$7,400	$0
Harris County	1/10/2020	50	0	0	$7,400	$0
Harris County	1/10/2020	50	0	0	$3,700	$0
Harris County	1/11/2020	51	0	0	$19,600	$0
Harris County	1/11/2020	50	0	0	$19,600	$0
Harris County	1/11/2020	50	0	0	$13,500	$0
Harris County	1/11/2020	51	0	0	$6,200	$0
Harris County	4/9/2020	50	0	1	$12,300	$0
Harris County	5/27/2020	56	0	0	$0	$2,600
Harris County	5/27/2020	52	0	0	$0	$2,400
Harris County	10/23/2020	50	0	0	$500	$0
Harris County	5/18/2021	55	0	0	$5,900	$0
Harris County	5/20/2021	55	0	0	$11,700	$0
Harris County	6/3/2021	60	0	0	$34,800	$0
Harris County	6/15/2021	60	0	0	$58,000	$0
Harris County	6/15/2021	50	0	0	$29,000	$0
Harris County	6/15/2021	50	0	0	$5,800	$0
Harris County	10/27/2021	52	0	0	$55,800	$0
Chambers County	10/27/2021	50	0	0	$20,500	$0
Harris County	10/27/2021	50	0	0	$19,400	$0
Harris County	10/27/2021	51	0	0	$8,000	$0
Harris County	10/27/2021	51	0	0	$3,500	$0
Harris County	3/30/2022	50	0	0	$5,500	$0
Harris County	3/27/2023	55	0	0	$10,500	$0
Harris County	4/20/2023	50	0	0	$5,200	$0
Harris County	5/8/2023	50	1	1	$0	$0

SECTION 15: THUNDERSTORM WIND

JURISDICTION	DATE	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/8/2023	52	0	0	$5,200	$0
Harris County	6/8/2023	52	0	0	$2,100	$0
Harris County	6/21/2023	70	0	0	$1,031,800	$0
Harris County	6/21/2023	71	0	0	$1,031,800	$0
Harris County	6/21/2023	65	0	0	$515,900	$0
Harris County	6/21/2023	54	0	0	$15,500	$0
Harris County	9/26/2023	55	0	0	$3,100	$0
Harris County	5/2/2024	55	0	0	$3,100	$0
Harris County	5/16/2024	70	0	0	$70,162,100	$0
Harris County	5/16/2024	80	0	0	$1,002,400	$0
Harris County	5/16/2024	90	0	0	$300,700	$0
Harris County	5/16/2024	70	4	0	$0	$0
TOTALS		(MAX EXTENT)	12	51	$253,523,600	$323,700

Table 15-4. Summary of Historical Events by Jurisdiction, 1955 – 2024

JURISDICTION	NUMBER OF EVENTS	MAGNITUDE (knots)	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
City of Baytown	7	60	0	0	$842,900	$0
Chambers County	75	85	0	0	$1,698,900	$6,400
Harris County	692	90	12	51	$250,981,800	$317,300
TOTALS	774	(MAX EXTENT)	12	51	$253,847,300	

Based on the list of historical thunderstorm wind events for the City of Baytown planning area, there has been one reported event since the 2020 Plan. However, there have been 113 reported events in Harris and Chambers Counties since 2020.

SECTION 15: THUNDERSTORM WIND

SIGNIFICANT EVENTS

May 2, 1993 – Harris County

Thunderstorms in a fast-moving squall line moved across Harris County in the afternoon, bringing damaging winds to the area. Harris County Emergency Management reported that approximately 200,000 Houston Power and Light Company customers lost power. Other impacts included numerous downed or uprooted trees, roof damage, blown down billboards, and damage too traffic signals. Total property damages were estimated at $109,152,600 (2024 dollars).

May 10, 1999 – City of Baytown and Harris County

A line of thunderstorms tracked across Harris County, and eventually into the City of Baytown, bringing wind gusts estimated at 60-70 mph in most areas. Across Harris County, widespread damage was reported including downed power poles and trees, damaged traffic signals, blown down street signs, and roof damage. Within the City of Baytown planning area, roof damage occurred at Sterling High School, an apartment complex in the Cloverleaf area, and a parking garage on Texas Avenue. Additionally, a tractor-trailer was blown over at I-10 and Thompson Road and widespread reports of downed trees, fences, and portable signs occurred in the Baytown area. An estimated $568,300 (2024 dollars) of damage occurred within the City of Baytown, with $1,534,700 (2024 dollars) in damages occurring elsewhere in Harris County.

April 10, 2004 – City of Baytown and Harris County

Severe thunderstorms brought straight-line winds up to 70 mph to the City of Baytown planning area. The strong winds caused significant damage to an apartment complex on Baker Drive, where one building's roof was ripped off and other surrounding buildings received siding damage. The damages to this apartment complex were estimated at $125,600 (2024 dollars). Elsewhere in Harris County, downed trees and fences, as well as a gas station's canopy being blown off, resulted in a total estimate of $184,300 (2024 dollars) in property damage.

May 8, 2023 – Harris County

A cluster of severe thunderstorms moved across the region, producing damaging wind gusts over 50 mph. Law enforcement reported a tree being blown onto a vehicle near the intersection of East Cypresswood Drive and Whitewood Drive in the City of Spring, resulting in one fatality and one injury.

May 16, 2024 – Harris County

In the evening, a derecho moved into southeastern Texas, resulting in extensive wind damage across much of the Greater Houston area. Maximum wind gusts were estimated to have reached above 100 mph. The severe storm resulted in power outages for thousands of people which lasted several days. Widespread downed trees and property damage occurred due to the strong winds, including numerous skyscraper windows being blown out across downtown Houston. Nine total fatalities were reported during the derecho, four of which were directly attributed to the strong winds. Total property damage across Harris County was estimated at $71,465,200 (2024 dollars).

PROBABILITY OF FUTURE EVENTS

Most thunderstorm winds occur during the spring and fall seasons and during the months of March, April, May, and September. Based on available records of historic events, there are 7 recorded historical occurrences of thunderstorm wind events within the City of Baytown planning area. However, thunderstorm wind events are often reported at the county level as they impact several jurisdictions at one time. Between Harris and Chambers Counties, there has been a total of 774 events in a 69-year reporting period, which provides an estimated annual frequency of approximately 11 events every year. Even though the intensity of thunderstorm wind events is not always damaging for the City of Baytown planning area, the frequency of occurrence for a thunderstorm wind event is “Highly Likely”. This means that an event is probable within the next year for the City of Baytown planning area.

CLIMATE CHANGE CONSIDERATIONS

The impacts on the frequency and severity of severe thunderstorm wind events due to climate change are unclear. According to the Texas A&M 2021 Climate Report Update, changes in severe thunderstorm reports over time have been more closely linked to changes in population than changes in the hazard event. Currently there is low confidence of an ongoing trend in the overall frequency and severity of thunderstorm events, due to the lack of climate data records for severe thunderstorms. Based on climate models that are available, the environmental conditions needed for severe

thunderstorms are estimated to become more likely, resulting in an overall increase in the number of days capable of producing a severe thunderstorm event.[4]

VULNERABILITY AND IMPACT

Vulnerability is difficult to evaluate since thunderstorm wind events can occur at different strength levels, in random locations, and can create relatively narrow paths of destruction. Due to the randomness of these events, all existing and future structures and facilities within the City of Baytown planning area could potentially be impacted and remain vulnerable to possible injury and property loss from strong winds.

Trees, power lines and poles, signage, manufactured housing, radio towers, concrete block walls, storage barns, windows, garbage recepticles, brick facades, and vehicles, unless reinforced, are vulnerable to thunderstorm wind events. More severe damage involves windborne debris; in some instances, patio furniture and other lawn items have been reported to have been blown around by wind and, very commonly, debris from damaged structures in turn have caused damage to other buildings not directly impacted by the event. In more severe instances, roofs have been reported as having been torn off of buildings. The portable buildings typically used at schools and construction sites would be more vulnerable to thunderstorm wind events than typical site-built structures and could potentially pose a greater risk for wind-blown debris.

According to the American Community Survey (ACS) five-year estimates for 2023, a total of 2,038 manufactured homes are located in the City of Baytown planning area (6 percent of total housing stock). In addition, 49 percent (16,575 structures) of the housing units were built before 1980. These structures would typically be built to lower or less stringent construction standards than newer construction and may be more susceptible to damage during significant wind events.

Table 15-5. Structures at Greater Risk

JURISDICTION	BUILT PRIOR TO 1980	MANUFACTURED HOME
City of Baytown	16,575	2,038

[4] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 Update.

SECTION 15: THUNDERSTORM WIND

While all citizens are vulnerable to the impacts of thunderstorm wind, forced relocation and disaster recovery disproportionately impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. An estimated 18 percent of the planning area population live below the poverty level (Table 15-6). While warning times for these types of hazard events should be substantial enough for these individuals to seek shelter, the elderly, children, and people with a disability may have trouble taking shelter due to mobility issues or a lack of awareness, making them more susceptible to injury or harm. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures.

Table 15-6. Populations at Greater Risk[5]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

The City of Baytown Planning Team identified the following critical facilities (Table 15-7) as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by thunderstorm wind events. The critical infrastructure with the greatest vulnerability to thunderstorms are power and communications facilities. Failures of these facilities can result in a loss of service and cascading impacts such as posing enormous risk to individuals dependent on electricity as a medical necessity. For a comprehensive list by participating jurisdiction, please see Appendix F.

[5] US Census Bureau 2023 data for the City of Baytown.

Table 15-7. Critical Facilities Vulnerable to Thunderstorm Wind Event

CRITICAL FACILITY TYPE	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by falling trees or flying debris. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Debris/downed trees can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/ Assisted Living Facilities	• Structures can be damaged by falling trees or flying debris. • Power outages could disrupt critical care. • Backup power sources could be damaged. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Evacuations may be necessary due to extended power outages, gas line ruptures, or structural damage to facilities. • Power outages and infrastructure damage may prevent larger airports from acting as temporary command centers for logistics, communications, and emergency operations. • Temporary break in operations may significantly inhibit post event evacuations. • Damaged or destroyed highway infrastructure may substantially increase the need for airport operations.
Commercial Supplier (food, fuel, etc.)	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed. • Economic disruption due to power outages and fires negatively impact airport services as well as area businesses reliant on airport operations.

CRITICAL FACILITY TYPE	POTENTIAL IMPACTS
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by falling trees or flying debris. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Debris/downed trees can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel.

A thunderstorm wind event can also result in traffic disruptions, injuries and in rare cases, fatalities. Overall, in the past 69 years there has been an estimated total of $842,900 in damages (2024 dollars) in the City of Baytown planning area due to thunderstorm wind events with an estimated average annual loss of $12,200. In all of Harris and Chambers Counties, the estimated damage total is $253,847,300 (2024 dollars) with an average annualized loss of $3,678,900. There have been 51 injuries and 12 fatalities due to thunderstorm wind, all of which were reported in Harris County.

Table 15-8. Estimated Annualized Losses by Jurisdiction

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
City of Baytown	$842,900	$12,200
Chambers County	$1,705,300	$24,700
Harris County	$251,299,100	$3,642,000
TOTALS	**$253,847,300**	**$3,678,900**

In terms of structural damages, the impact of thunderstorm wind damages on the City of Baytown planning area would be considered Limited severity of impact, meaning a shutdown of critical facilities and services for 24-hours or less and less than ten percent of properties damaged or destroyed. However, with the number of fatalities reported regionally, the impact is considered “Substantial”, with multiple deaths possible depending on the severity and duration of the event.

SECTION 15: THUNDERSTORM WIND

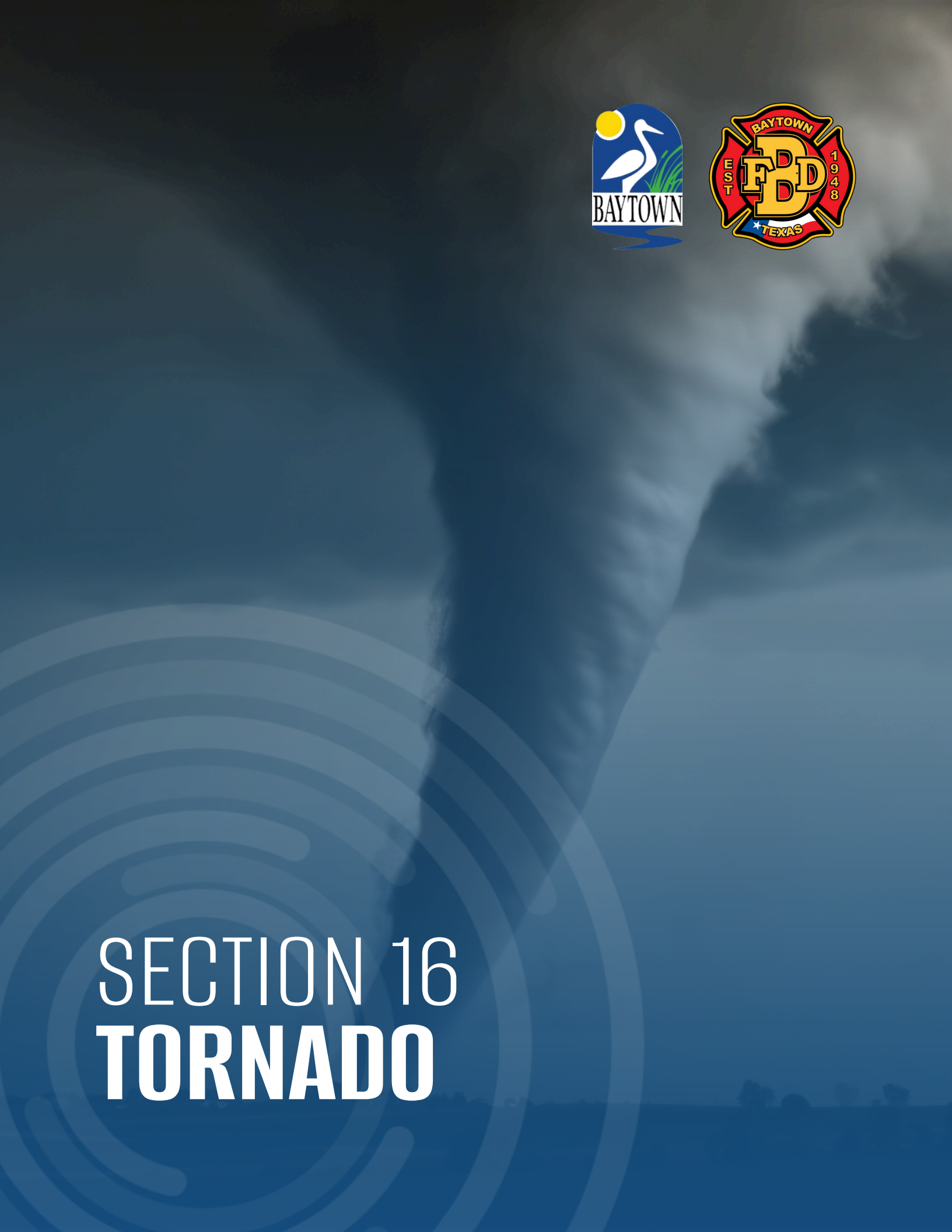
ASSESSMENT OF IMPACTS

Thunderstorm wind events have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. Thunderstorm wind conditions can be frequently associated with a variety of impacts, including:

- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.
- Thunderstorm wind events often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outage often results in an increase in structure fires and carbon monoxide poisoning, as individuals attempt to cook or heat their homes with alternate, unsafe cooking or heating devices, such as grills.
- Critical staff may be unable to report for duty, limiting response capabilities.
- Private sector entities that residents rely on, such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Some businesses not directly damaged by thunderstorm wind events may be negatively impacted while roads are cleared and utilities are being restored, further slowing economic recovery.
- Older structures, specifically those built before 1980 (49 percent of the planning area), were built to less stringent building codes may suffer greater damage as they are typically more vulnerable to thunderstorm winds.
- Recreational areas such as community parks and green spaces may be damaged or inaccessible due to downed trees or debris, causing temporary impacts to associated businesses in the area.
- Historical sites and properties are placed at a higher risk of impact due to materials used and the inability to change properties due to their historic status.

Two historical sites are listed on the National Register of Historic Places for the City of Baytown.

The economic and financial impacts of thunderstorm winds on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will also contribute to the overall economic and financial conditions in the aftermath of any thunderstorm wind event.



SECTION 16
TORNADO

SECTION 16: TORNADO

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HAZARD DESCRIPTION



Tornadoes are among the most violent storms on the planet. A tornado is a rapidly rotating column of air extending between, and in contact with, a cloud and the surface of the earth. The most violent tornadoes are capable of tremendous destruction and have wind speeds of 250 miles per hour (mph) or more. In extreme cases, winds may approach 300 mph. Damage paths can be in excess of one mile wide and 50 miles long.

The most powerful tornadoes are produced by "Supercell Thunderstorms." These thunderstorms are created when horizontal wind shears (winds moving in different directions at different altitudes) begin to rotate the storm. This horizontal rotation can be tilted vertically by violent updrafts, and the rotation radius can shrink, forming a vertical column of very quickly swirling air. This rotating air can eventually reach the ground, forming a tornado.

Table 16-1. Variations among Tornadoes

WEAK TORNADOES	STRONG TORNADOES	VIOLENT TORNADOES
• 69% of all tornadoes • Less than 5% of tornado deaths • Lifetime 1-10+ minutes • Winds less than 110 mph	• 29% of all tornadoes • Nearly 30% of all tornado deaths • May last 20 minutes or longer • Winds 110–205 mph	• 2% of all tornadoes • 70% of all tornado deaths • Lifetime can exceed one hour • Winds greater than 205 mph

LOCATION

Tornadoes do not have any specific geographic boundary and can occur throughout the county uniformly. It is assumed that the entire City of Baytown planning area is uniformly exposed to tornado activity. The City of Baytown planning area is located within Wind Zone III. This means the planning area can experience maximum wind speeds up to 200 mph.

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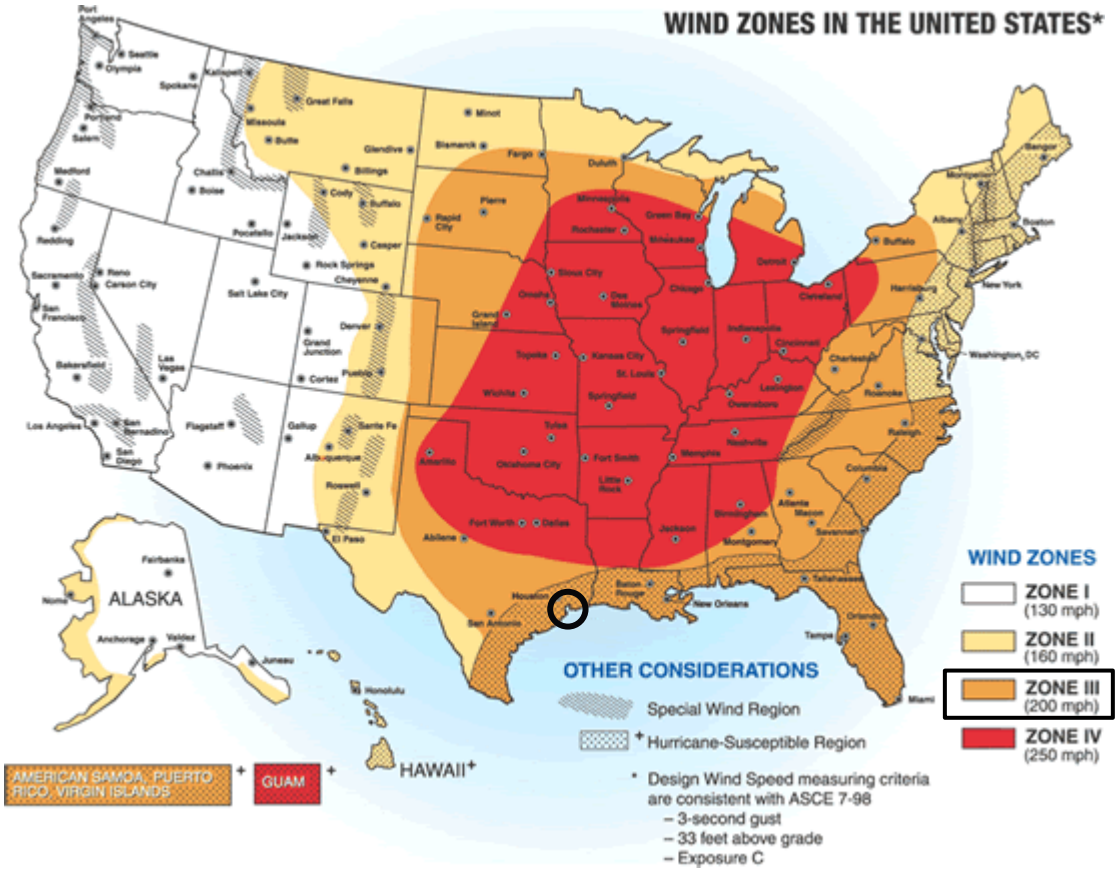
Figure 16-1. FEMA Wind Zones in the United States[1]



EXTENT

The destruction caused by tornadoes ranges from light to inconceivable, depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, such as residential homes (particularly mobile homes).

Tornado magnitudes prior to 2007 were determined using the traditional version of the Fujita Scale, which estimated tornado wind speeds based on the damage caused by an event. Since February 2007, the Enhanced Fujita Scale has been utilized to classify tornadoes, which included improvements to the original scale. The original Fujita scale had limitations, such as a lack of damage indicators, no account for construction quality and variability, and no definitive correlation between damage and wind speed. These limitations led to some tornadoes being rated in an inconsistent manner and, in some

[1] The City of Baytown planning area is indicated by the circle.

cases, an overestimate of tornado wind speeds. The Enhanced Fujita scale retains the same basic design and six strength categories as the previous scale. The newer scale reflects more refined assessments of tornado damage surveys, standardization, and damage consideration to a wider range of structures. Table 16-2 includes both scales for reference when analyzing historical tornadoes since tornado events prior to 2007 will follow the original Fujita Scale.

Table 16-2. The Fujita and Enhanced Fujita Tornado Scale[2]

Enhanced Fujita Scale				Fujita Scale			
Category	**Wind Speed**	**Damage Level**	**Damage**	**Category**	**Wind Speed**	**Intensity**	**Damage**
EF0	65-85 MPH	Gale	The environment sustained minor damage: tree branches are broken, some shallow-rooted trees are uprooted, and some chimneys are damaged.	**F0**	45-78 MPH	Gale	Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
EF1	86-110 MPH	Weak	The environment sustained moderate damage: mobile homes are tipped over, windows are broken, roof tiles may be blown off, and some tree trunks have snapped.	**F1**	79-117 MPH	Moderate	Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
EF2	111-135 MPH	Strong	The environment sustained considerable damage: mobile homes are destroyed, roofs are damaged, debris flies in the air, and large trees are snapped or uprooted.	**F2**	118-161 MPH	Significant	Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165 MPH	Severe	The environment sustained severe damage: roofs and walls are ripped off buildings, small buildings are destroyed, and most trees are uprooted.	**F3**	162-209 MPH	Severe	Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
EF4	166-200 MPH	Devastating	The environment sustained devastating damage: well-built homes are destroyed, buildings are lifted off their foundations, cars are blown away, and large debris flies in the air.	**F4**	210-261 MPH	Devastating	Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown, and large missiles generated.

[2] Source: http://www.tornadoproject.com/fscale/fscale.htm

Enhanced Fujita Scale				Fujita Scale			
Category	Wind Speed	Damage Level	Damage	Category	Wind Speed	Intensity	Damage
EF5	200+ MPH	Incredible	The environment sustained incredible damage: well-built homes are lifted from their foundations, reinforced concrete buildings are damaged, the bark is stripped from trees, and car-sized debris flies through the air.	F5	262-317 MPH	Incredible	Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

Both the Fujita Scale and Enhanced Fujita Scale should be referenced in reviewing previous occurrences since tornado events that occurred before 2007 will follow the original Fujita Scale. Of the events reported directly within the City of Baytown, the greatest magnitude reported is an F1 (an EF0, EF1, or EF2 when converted to the Enhanced Fujita Scale, depending on exact windspeed). However, many tornado events are reported at the county level as they may impact multiple jurisdictions. In Harris and Chambers Counties, in which the City of Baytown is located, the greatest magnitude reported within the planning area is F4 (an EF5 when converted to the Enhanced Fujita Scale), an incredible tornado. Based on the planning area's location in Wind Zone III, the planning area has the potential to experience anywhere from an EF0 to an EF5 depending on the wind speed. Previous tornado events in Harris and Chambers Counties (converted from the Fujita Scale) have been between EF0 and EF5 (Figure 16-2).

HISTORICAL OCCURRENCES

The National Centers for Environmental Information (NCEI) Storm Events database is a national data source organized under the National Oceanic and Atmospheric Administration (NOAA). The NCEI is the largest archive available for historic storm events data; however, it is important to note that only incidents recorded in the NCEI have been factored into this risk assessment unless otherwise noted. It is likely that a number of occurrences have gone unreported over time.

Figure 16-2 identifies the locations of previous occurrences in the City of Baytown planning area from 1950 through 2024. Within all of Chambers and Harris Counties, a total of 282 reported historical tornado events occurred between 1950 and 2024. Of those, seven events were reported directly within the City of Baytown planning area.

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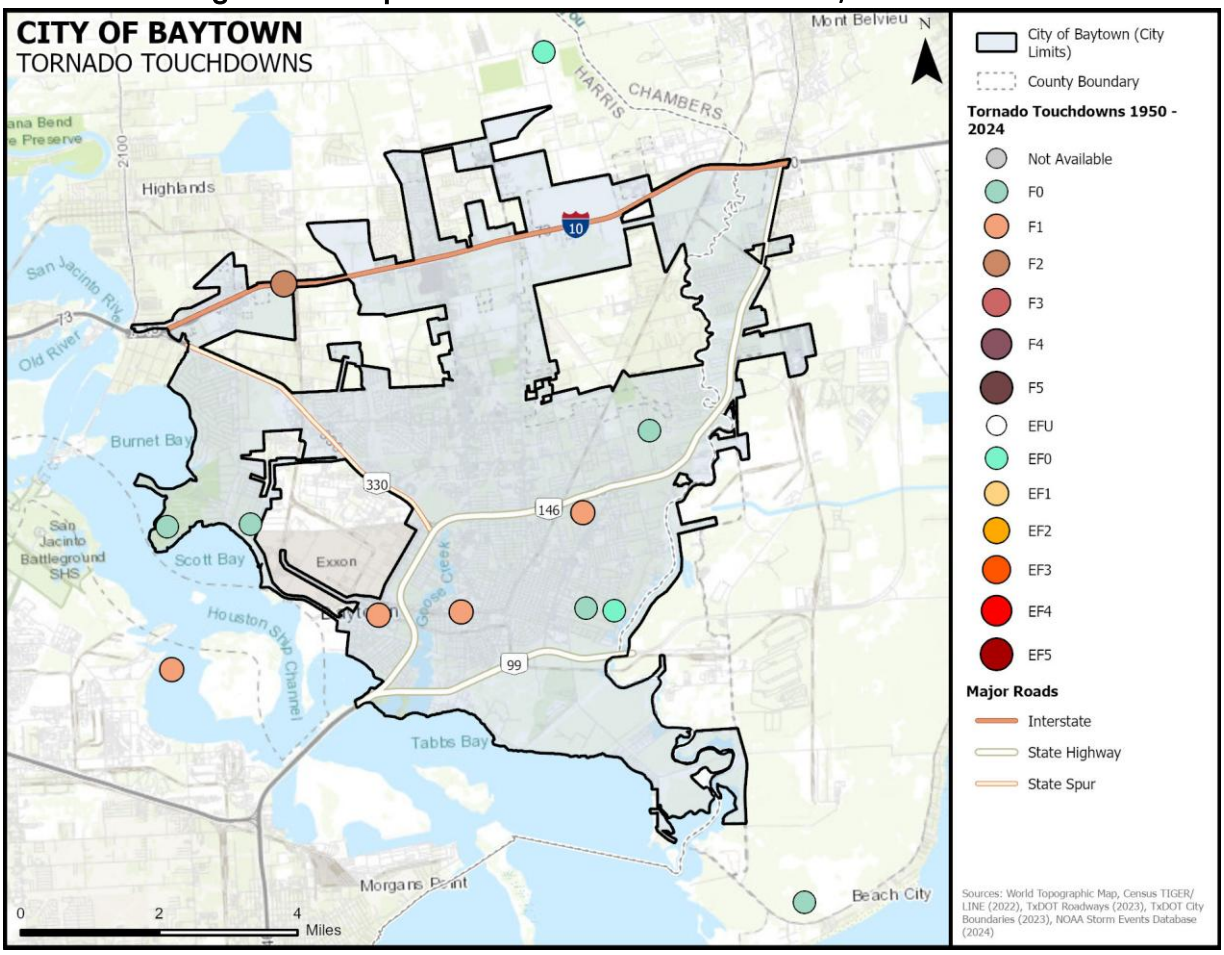
Tornado event data for both Chambers and Harris Counties have been incorporated to ensure the most comprehensive dataset possible, as the City of Baytown spans both counties. Given that some tornado events are reported at the county level rather than by individual jurisdiction, this approach provides a more accurate representation of historical tornado risk in the area. Table 16-3 lists all reported tornado events which resulted in reported damages, injuries, or fatalities. Table 16-4 summarizes these impacts by jurisdiction.

Figure 16-2. Spatial Historical Tornado Events, 1950 – 2024[3]



[3] Source: NOAA Storm Prediction Center

Table 16-3. Damaging Historical Tornado Events, 1950 – 2024[4]

JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	2/11/1950	F3	1	12	$334,900	$0
Harris County	8/15/1953	F1	0	0	$29,300	$0
Harris County	5/29/1958	F1	0	0	$27,300	$0
Harris County	4/8/1959	F1	0	0	$271,400	$0
Chambers County	8/13/1959		0	0	$2,700	$0
Harris County	2/17/1960	F2	0	3	$267,700	$0
Harris County	9/11/1961	F3	0	22	$0	$0
Harris County	3/19/1964	F1	0	0	$2,546,900	$0
Harris County	3/19/1964	F2	0	0	$2,546,900	$0
Harris County	4/17/1964	F2	1	2	$25,500	$0
Harris County	9/21/1967	F2	0	3	$23,500	$0
Harris County	9/21/1967	F0	0	0	$2,400	$0
Harris County	12/2/1967	F0	0	0	$23,300	$0
Harris County	11/5/1968	F1	0	0	$2,223,200	$0
Harris County	11/5/1968	F0	0	0	$2,223,200	$0
Harris County	11/15/1968	F1	0	0	$22,300	$0
Harris County	4/27/1969	F1	0	0	$2,200	$0
Chambers County	5/27/1969	F3	3	0	$216,300	$0
Harris County	9/8/1969	F3	0	0	$212,200	$0
Harris County	2/1/1970	F1	0	0	$20,800	$0
Harris County	7/4/1970	F1	0	1	$201,800	$0
Harris County	10/27/1970	F1	0	1	$1,997,500	$0
Harris County	3/9/1971	F2	0	4	$196,800	$0
Chambers County	3/9/1971	F2	0	1	$196,800	$0

[4] Only recorded events with fatalities, injuries or damages are listed. Magnitude is listed when available. Damage values are in 2024 dollars.

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	6/20/1971	F2	0	20	$1,938,400	$0
Harris County	7/29/1971	F2	0	8	$193,400	$0
Harris County	8/8/1971	F1	0	0	$19,300	$0
Harris County	8/25/1971	F1	0	0	$192,900	$0
Harris County	3/20/1972	F1	0	0	$190,100	$0
Harris County	5/12/1972	F1	0	0	$1,891,900	$0
Harris County	5/12/1972	F1	0	7	$0	$0
Harris County	6/16/1972	F0	0	0	$18,900	$0
Harris County	2/13/1973	F2	0	1	$183,500	$0
Harris County	6/12/1973	F1	0	0	$178,100	$0
Harris County	6/12/1973	F1	0	0	$178,100	$0
Harris County	7/14/1974	F2	0	0	$15,931,000	$0
Harris County	8/29/1974	F2	0	0	$1,574,000	$0
Harris County	9/12/1974	F0	0	0	$200	$0
Harris County	10/28/1974	F3	1	7	$15,401,000	$0
Chambers County	10/28/1974	F2	0	0	$1,540,100	$0
Chambers County	10/28/1974	F3	1	0	$0	$0
Harris County	10/31/1974	F2	0	1	$1,540,100	$0
Chambers County	4/10/1975	F0	0	0	$14,900	$0
Harris County	5/7/1976	F1	0	1	$1,393,000	$0
Harris County	9/1/1976	F1	0	0	$13,700	$0
Harris County	12/13/1977	F3	1	35	$126,729,500	$0
Harris County	5/29/1978	F2	0	0	$1,220,200	$0
Harris County	4/18/1979	F1	0	0	$111,500	$0
Harris County	4/19/1979	F0	0	0	$111,500	$0
Harris County	5/22/1979	F0	0	0	$200	$0
Harris County	9/18/1979	F2	0	1	$10,549,500	$0

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	9/18/1979	F1	0	0	$1,055,000	$0
Harris County	10/30/1979	F1	0	0	$1,046,600	$0
Harris County	5/17/1980	F1	0	0	$962,100	$0
Harris County	6/22/1980	F1	0	0	$95,200	$0
Chambers County	9/19/1980	F1	0	1	$93,700	$0
Harris County	10/18/1980	F1	0	0	$92,900	$0
Harris County	4/23/1981	F1	0	0	$88,400	$0
Harris County	5/3/1981	F1	0	0	$876,400	$0
Chambers County	6/5/1981	F2	0	1	$868,700	$0
Chambers County	6/5/1981	F0	0	0	$86,900	$0
Harris County	8/4/1981	F0	0	0	$85,300	$0
Chambers County	9/2/1981	F1	0	0	$84,500	$0
Harris County	10/11/1981	F1	0	1	$84,300	$0
Harris County	6/26/1982	F1	0	0	$81,200	$0
Chambers County	7/14/1982	F1	0	0	$8,100	$0
Harris County	9/3/1982	F1	1	2	$803,900	$0
Harris County	2/9/1983	F2	0	3	$803,900	$0
Harris County	2/9/1983	F1	0	0	$803,900	$0
Harris County	2/9/1983	F1	0	0	$80,400	$0
Harris County	3/30/1983	F1	0	2	$80,400	$0
Harris County	5/20/1983	F2	1	7	$7,933,400	$0
Harris County	5/20/1983	F2	1	5	$7,933,400	$0
Harris County	5/20/1983	F2	1	2	$793,400	$0
Chambers County	5/20/1983	F0	0	0	$793,400	$0
Harris County	5/20/1983	F1	0	0	$100	$0
Harris County	5/20/1983	F0	0	0	$100	$0
Harris County	5/20/1983	F0	0	0	$100	$0

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/20/1983	F0	0	0	$100	$0
Chambers County	5/20/1983	F0	0	0	$100	$0
Harris County	5/21/1983	F0	0	0	$100	$0
Harris County	5/21/1983	F0	0	0	$100	$0
Harris County	5/21/1983	F0	0	0	$100	$0
Harris County	5/21/1983	F0	0	0	$100	$0
Harris County	7/15/1983	F1	0	0	$78,800	$0
Harris County	8/17/1983	F0	0	0	$100	$0
Harris County	8/17/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$785,500	$0
Harris County	8/18/1983	F0	0	0	$7,900	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F1	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	8/18/1983	F0	0	0	$100	$0
Harris County	12/10/1983	F0	0	0	$776,900	$0
Harris County	12/10/1983	F0	0	0	$7,800	$0
Harris County	2/12/1984	F0	0	0	$768,600	$0
Harris County	10/22/1984	F1	0	0	$74,737,900	$0
Harris County	12/31/1984	F2	0	53	$74,737,900	$0
Harris County	12/31/1984	F1	0	0	$747,400	$0
Harris County	2/5/1986	F3	2	0	$72,002,800	$0
Harris County	2/5/1986	F2	0	0	$7,200,300	$0

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	2/5/1986	F2	0	0	$720,100	$0
Harris County	11/16/1987	F1	0	0	$6,819,700	$0
Harris County	1/18/1991	F1	0	3	$58,500	$0
Harris County	1/18/1991	F0	0	1	$5,900	$0
Harris County	1/18/1991	F0	0	0	$5,900	$0
Harris County	1/18/1991	F0	0	0	$5,900	$0
Harris County	4/8/1991	F0	0	0	$5,900	$0
Harris County	5/8/1991	F0	0	0	$5,900	$0
Chambers County	3/18/1992	F1	0	0	$56,500	$0
Harris County	6/1/1992	F1	0	2	$561,400	$0
Harris County	11/21/1992	F4	0	15	$554,218,400	$0
Harris County	11/21/1992	F2	0	6	$55,421,900	$0
Harris County	11/21/1992	F2	0	6	$55,421,900	$0
Harris County	11/21/1992	F2	0	5	$55,421,900	$0
Harris County	11/21/1992	F3	0	0	$55,421,900	$0
Harris County	11/21/1992	F1	0	0	$554,300	$0
Harris County	11/21/1992	F1	0	0	$55,500	$0
Harris County	2/25/1993	F0	0	0	$1,100,000	$0
Harris County	4/7/1993	F1	0	0	$11,000	$0
Chambers County	5/18/1993	F0	0	0	$109,200	$0
Harris County	11/16/1993	F1	0	26	$10,795,500	$0
Chambers County	11/16/1993	F1	0	0	$108,000	$0
Harris County	11/16/1993	F0	0	0	$0	$10,800
Harris County	4/15/1994	F2	1	20	$106,800	$0
Harris County	4/15/1994	F2	1	20	$106,800	$0
Harris County	3/13/1995	F0	0	0	$41,600	$0
Harris County	4/20/1995	F0	0	0	$114,000	$0

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	4/20/1995	F0	0	0	$103,700	$0
Harris County	4/22/1996	F0	0	0	$80,600	$0
Harris County	1/27/1997	F1	0	0	$23,743,300	$0
Harris County	1/27/1997	F0	0	0	$39,600	$0
City of Baytown	1/27/1997	F0	0	0	$29,700	$0
Harris County	1/27/1997	F0	0	0	$29,700	$0
Harris County	1/27/1997	F0	0	0	$9,900	$0
Harris County	5/30/1997	F1	0	0	$9,900	$0
Harris County	10/23/1997	F2	0	0	$292,200	$0
City of Baytown	2/10/1998	F1	0	4	$5,833,200	$0
City of Baytown	2/10/1998	F1	0	0	$1,458,300	$0
City of Baytown	2/10/1998	F1	0	0	$486,100	$0
Harris County	10/18/1998	F0	0	0	$48,000	$0
Harris County	10/18/1998	F0	0	0	$38,400	$0
Harris County	10/18/1998	F0	0	0	$19,200	$0
Harris County	3/19/1999	F0	0	0	$47,700	$0
Harris County	6/8/1999	F0	0	0	$47,400	$0
Chambers County	4/3/2000	F1	0	0	$183,800	$0
Harris County	11/12/2000	F0	0	0	$27,200	$0
Harris County	11/24/2000	F1	0	0	$632,900	$0
Harris County	11/24/2000	F1	0	1	$452,100	$0
Harris County	10/11/2001	F2	0	0	$6,643,200	$0
Harris County	3/30/2002	F3	0	0	$616,300	$0
Harris County	8/22/2002	F0	0	0	$17,500	$0
Harris County	10/28/2002	F0	0	0	$95,500	$0
Harris County	12/30/2002	F0	0	0	$435,100	$0
Harris County	12/30/2002	F0	0	0	$8,800	$0

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	10/9/2003	F0	0	0	$33,700	$0
Harris County	10/9/2003	F0	0	0	$5,200	$0
Harris County	11/17/2003	F2	0	0	$938,500	$0
Harris County	11/17/2003	F2	0	0	$853,200	$0
Chambers County	11/17/2003	F1	0	0	$511,900	$0
City of Baytown	11/17/2003	F1	0	3	$383,900	$0
Chambers County	11/17/2003	F1	0	5	$170,700	$0
City of Baytown	11/17/2003	F0	0	0	$85,400	$0
Harris County	11/17/2003	F0	0	0	$51,200	$0
Harris County	11/17/2003	F0	0	0	$5,200	$0
Harris County	4/10/2004	F1	0	0	$418,700	$0
Harris County	5/1/2004	F1	0	1	$457,800	$0
Harris County	11/17/2004	F1	0	0	$494,500	$0
Harris County	11/17/2004	F0	0	0	$66,000	$0
Harris County	11/17/2004	F0	0	0	$49,500	$0
Harris County	11/17/2004	F0	0	0	$49,500	$0
Harris County	11/22/2004	F0	0	0	$24,800	$0
Harris County	11/22/2004	F0	0	0	$9,100	$0
Harris County	5/29/2005	F1	0	2	$388,700	$0
Harris County	12/14/2005	F0	0	0	$16,000	$0
Harris County	2/10/2006	F0	0	0	$55,500	$0
Harris County	4/29/2006	F0	0	0	$43,800	$0
Harris County	6/21/2008	EF0	0	0	$158,300	$0
Harris County	6/3/2009	EF0	0	0	$4,400	$0
Harris County	6/8/2010	EF0	0	0	$361,100	$0
Harris County	11/8/2011	EF1	0	0	$139,200	$0
Harris County	6/28/2014	EF0	0	0	$59,500	$0

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JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	5/24/2015	EF0	0	4	$264,800	$0
Harris County	10/31/2015	EF2	0	0	$15,882,900	$0
Harris County	10/31/2015	EF0	0	0	$264,800	$0
Harris County	10/31/2015	EF0	0	0	$99,300	$0
City of Baytown	10/31/2015	EF0	0	0	$26,500	$0
Harris County	4/17/2016	EF0	0	0	$39,500	$0
Harris County	4/18/2016	EF0	0	0	$39,500	$0
Harris County	4/18/2016	EF0	0	0	$13,200	$0
Harris County	4/27/2016	EF0	1	0	$263,200	$0
Harris County	3/24/2017	EF0	0	0	$19,400	$0
Harris County	3/29/2017	EF1	0	2	$387,400	$0
Harris County	3/29/2017	EF0	0	0	$193,700	$0
Harris County	3/29/2017	EF0	0	0	$129,200	$0
Harris County	3/29/2017	EF1	0	0	$34,900	$0
Chambers County	3/29/2017	EF0	0	0	$0	$16,800
Harris County	8/26/2017	EF1	0	0	$641,100	$0
Harris County	8/26/2017	EF0	0	0	$128,300	$0
Harris County	8/26/2017	EF0	0	0	$64,200	$0
Harris County	8/26/2017	EF0	0	0	$38,500	$0
Harris County	8/27/2017	EF0	0	0	$64,200	$0
Chambers County	10/31/2018	EF1	0	0	$62,300	$0
Harris County	4/7/2019	EF1	0	0	$184,800	$0
Harris County	9/18/2019	EF1	0	0	$367,900	$0
Harris County	5/27/2020	EF0	0	0	$36,900	$0
Harris County	8/12/2021	EF0	0	0	$5,800	$0
Harris County	1/8/2022	EF0	0	0	$78,400	$0
Harris County	1/8/2022	EF0	0	0	$56,000	$0

JURISDICTION	DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
Harris County	1/9/2022	EF1	0	0	$336,000	$0
Harris County	1/9/2022	EF1	0	0	$224,000	$0
Harris County	1/24/2023	EF3	0	0	$6,944,800	$0
Harris County	4/10/2024	EF1	0	0	$502,000	$0
Harris County	5/16/2024	EF1	0	0	$751,800	$0
Harris County	5/16/2024	EF1	0	0	$501,200	$0
TOTALS		(MAX EXTENT)	17	333	$1,325,384,500	$27,600

Table 16-4. Summary of Historical Tornado Events, January 1950 – June 2024

JURISDICTION	NUMBER OF EVENTS	MAX MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
City of Baytown	7	F1	0	7	$8,303,100	$0
Chambers County	32	F3	4	8	$5,108,600	$16,800
Harris County	243	F4	13	318	$1,311,972,800	$10,800
TOTALS	282	(MAX EXTENT)	17	333	$1,325,412,100	

Based on the list of historical tornado events in Harris and Chambers Counties, which includes the City of Baytown planning area, there have been 11 recorded events since the 2020 Plan.

SIGNIFICANT EVENTS

November 21, 1992 – Harris County

Severe afternoon storms led to the formation of seven total tornadoes within Harris County, several of which were on the ground at the same time. The most violent of these was an F4 tornado which touched down at the intersection of I-10 and Beltway 8 in the Channelview area. At it's strongest, the tornado was over a mile in diameter before reducing down to approximately 200 yards and F2 magnitude as it continued into Liberty County. This tornado destroyed over 200 homes and damaged 1,000 others; no fatalities were reported, however 15 injuries did occur. Though the other tornadoes, ranging from

F1 to F3 magnitude, did not have the same destructive power as the F4 tornado, significant damages and 17 additional injuries occurred elsewhere in Harris County. These damages included a destroyed hangar and aircrafts in the City of Katy and varying degrees of damage to hundreds of homes, apartment buildings, and commercial properties. Across Harris County, total property damage was estimated at $776,515,800 (2024 dollars).

February 10, 1998 – City of Baytown

Three tornadoes, all estimated at F1 magnitude, occurred in the City of Baytown in the early afternoon. The first touched down on the Exxon refinery before travelling northeast for 3 miles. This tornado was the most destructive, damaging the Exxon cooling tower, a hotel, and over 150 residential structures. Additionally, 56 apartments were totally destroyed and four injuries were sustained from flying debris. The second tornado formed just east of the first, travelling northeast for four miles before lifting. This tornado caused significant structural damage to homes in the Chapparal Village neighborhood. The third tornado was estimated as the least destructive, with impacts including snapped billboards and damaged mobile homes. The total combined property damage from these three tornadoes was estimated at $7,777,600 (2024 dollars).

November 17, 2003 – City of Baytown, Chambers County, and Harris County

During a historic severe weather outbreak in southeastern Texas, a total of 24 tornadoes touched down during a 15-hour period. Two of these occurred in the City of Baytown, one in the northern portion and the other in southeastern Baytown. The northern tornado, estimated as an F0, caused minor roof and tree damage before dissipating. The southeastern tornado, an F1 magnitude tornado, damaged 54 apartment units in 4 different complexes, damaged roofs on several homes, and caused 3 minor injuries. These Baytown tornadoes caused an estimated $469,300 (2024 dollars) in property damage. Multiple other tornadoes, measured between F0 and F2 magnitude, touched down elsewhere in Chambers and Harris Counties and caused hundreds of structures to be damaged or destroyed. In total, these other tornadoes caused an estimated $2,530,700 (2024 dollars) in damages across both counties.

October 31, 2015 – Harris County

Several tornadoes formed across Harris County, the most severe of which being an EF2 tornado which began near the Genoa Red Bluff and Red Bluff intersection in Pasadena. This tornado caused extensive damage to trees, fences, and power lines. An industrial building was demolished and significant roof loss was observed on several homes. Three

smaller tornadoes, all EF0 magnitude, caused minor damage to roofs, power lines, and trees, as well as rolling several RV campers. Total property damage was estimated at $16,273,500 (2024 dollars).

January 24, 2023 – City of Baytown and Harris County

Several tornadoes occurred across southeastern Texas in the afternoon, one of which touched down in Harris County. The path of damage extended across portions of southeast Houston, Pasadena, Deer Park, and Baytown. At its peak, this tornado was estimated at EF3 magnitude, though the damage indicated it was between EF0 and EF2 strength for much of its duration. Severe impacts included 3 high tension electrical towers which were flattened; severe damage to apartments, homes, and a church in Deer Park; and a mobile home and single-family home destroyed in Baytown. Other minor impacts were widespread, such as damage to roofs, trees, and fences. Total property damage was estimated at $6,944,800 (2024 dollars).

PROBABILITY OF FUTURE EVENTS

Tornadoes can occur at any time of year and at any time of day, but they are typically more common in the spring months during the late afternoon and evening hours. A smaller, high frequency period can emerge in the fall during the brief transition between the warm and cold seasons. There are 7 recorded tornado events within the City of Baytown planning area over a 27.5 year reporting period. This supports a “Likely” probability of future events, meaning a tornado event is probable in the next three years. It is noted however, that tornado events are often reported at the county level as they can impact several jurisdictions at one time. Between Harris and Chambers Counties, there have been 282 historical events over a 75-year reporting period, indicating a frequency of three to four tornadoes a year. This frequency supports a highly likely probability of future events for the region, meaning a tornado event probable within the next year.

CLIMATE CHANGE CONSIDERATIONS

The impacts on the frequency and severity of tornado events due to climate change are unclear. According to the Texas A&M 2021 Climate Report Update, the most robust trend in tornado activity in Texas is a likelihood for a greater number of tornadoes in large outbreaks, although the factors contributing to this trend are not expected to continue. Tornadoes spawn from less than 10 percent of thunderstorms, usually supercell

thunderstorms that are in a wind shear environment that promotes rotation.[5] Based on climate models that are available, the environmental conditions needed for severe thunderstorm events are estimated to become more likely, resulting in an overall increase in the number of days capable of producing a severe thunderstorm event and potential tornadoes to develop from these storms.[6]

VULNERABILITY AND IMPACT

Because tornadoes often cross jurisdictional boundaries, all existing and future buildings, facilities, and populations in the entire City of Baytown planning area is considered to be exposed to this hazard and could potentially be impacted. The damage caused by a tornado is typically a result of high wind velocity, wind-blown debris, lightning, and large hail.

The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction. Consequently, vulnerability of humans and property is difficult to evaluate since tornadoes form at different strengths, in random locations, and create relatively narrow paths of destruction. Although tornadoes strike at random, making all buildings vulnerable, three types of structures are more likely to suffer damage:

- Manufactured Homes;
- Homes built of peer and beam construction (more susceptible to lift); and
- Buildings with large spans, such as shopping malls, gymnasiums, and factories.

Tornadoes can cause a significant threat to people as they could be struck by flying debris, falling trees or branches, utility lines, and poles. Blocked roads could prevent first responders from responding to calls. Tornadoes commonly cause power outages which could cause health and safety risks to residents and visitors, as well as to patients in hospitals.

The City of Baytown planning area features mobile or manufactured home parks throughout the planning area. These parks are typically more vulnerable to tornado

[5] Treisman, Rachel. *The exact link between tornadoes and climate change is hard to draw. Here's why*. NPR. December 13, 2021. https://www.npr.org/2021/12/13/1063676832/the-exact-link-between-tornadoes-and-climate-change-is-hard-to-draw-heres-why

[6] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 update.

events than typical site-built structures. In addition, manufactured homes are located sporadically throughout the planning area, which would also be more vulnerable. The U.S. Census data indicates a total of 2,038 (6 percent of total housing stock) manufactured homes located in the City of Baytown planning area. In addition, 49 percent (16,575 structures) of the housing structures in the City of Baytown planning area were built before 1980. These structures would typically be built to lower or less stringent construction standards than newer construction and may be more susceptible to damage during significant tornado events (Table 16-5).

Table 16-5. Structures at Greater Risk

JURISDICTION	BUILT PRIOR TO 1980	MANUFACTURED HOME
City of Baytown	16,575	2,038

While all citizens are at risk to the impacts of a tornado, forced relocation and disaster recovery disproportionately impacts low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. The elderly, children, and people with a disability may have trouble taking shelter due to mobility issues or a lack of awareness, making them more susceptible to injury or harm. In addition, people who speak a language other than English may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures. The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level and 16 percent of the populations speak English 'less than very well' (Table 16-6).

Table 16-6. Populations at Greater Risk[7]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

[7] U.S. Census Bureau 2023 data for the City of Baytown

SECTION 16: TORNADO

The City of Baytown Planning Team identified the following critical facilities as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by tornado events (Table 16-7). The critical infrastructure with the greatest vulnerability to tornadoes are power and communications facilities. Failures of these facilities can result in a loss of service and cascading impacts such as posing enormous risk to individuals dependent on electricity as a medical necessity. For a comprehensive list of critical facilities, please see Appendix F.

Table 16-7. Critical Facilities Vulnerable to Tornado Event

CRITICAL FACILITIES	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by falling trees or flying debris. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Debris/downed trees can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions. • Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/ Assisted Living Facilities	• Structures can be damaged by falling trees damaged by lightning. • Power outages could disrupt critical care. • Backup power sources could be damaged. • Evacuations may be necessary due to extended power outages, fires, or other associated damage to facilities. • Power outages and infrastructure damage may prevent larger airports from acting as temporary command centers for logistics, communications, and emergency operations. • Temporary break in operations may significantly inhibit post event evacuations.

CRITICAL FACILITIES	POTENTIAL IMPACTS
	• Damaged or destroyed highway infrastructure may substantially increase the need for airport operations.
Commercial Supplier (Food, fuel, etc.)	• Facilities or infrastructure may be damaged, destroyed or otherwise inaccessible. • Essential supplies like medicines, water, food, and equipment deliveries may be significantly delayed. • Additional emergency responders and critical aid workers may not be able to reach the area for days.
Utility Services and Infrastructure (electric, water, wastewater, communications)	• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Emergency vehicles can be damaged by falling trees or flying debris. • Power outages could disrupt communications, delaying emergency response times. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities. • Debris/downed trees can impede emergency response vehicle access to areas. • Increased number of structure fires due to gas line ruptures and downed power lines, further straining the capacity and resources of emergency personnel. • First responders are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions. • Extended power outages and evacuations may lead to possible looting, destruction of property, and theft, further burdening law enforcement resources.

Tornadoes are known to cause injuries and fatalities. In Harris and Chambers Counties, tornadoes have caused 17 fatalities and 333 injuries. Of those, 7 injuries were reported directly within the City of Baytown. Over the past 75 years, the total loss estimate due to tornado events in Harris and Chambers Counties is $1,325,412,100 (2024 dollars), having an approximate average annual loss estimate of $17,863,300.

When analyzing tornado events specific to the City of Baytown, the total loss estimate (over a 27.5-year reporting period) is $8,303,100 (2024 dollars) with an average loss estimate of $301,900. Based on historic loss and damages, the impact of tornado events on the City of Baytown planning area can be considered “Minor” severity of impact,

meaning injury or illness do not result in permanent disability, complete shutdown of facilities for up to one week, and more than 10 percent of property destroyed or with major damage.

Table 16-8. Estimated Average Annual Losses by Jurisdiction

JURISDICTION	TOTAL PROPERTY & CROP LOSS	AVERAGE ANNUAL LOSS ESTIMATES
City of Baytown	$8,303,100	$301,900[8]
Chambers County	$5,125,400	$68,300
Harris County	$1,311,983,600	$17,493,100
TOTALS	**$1,325,412,100**	**$17,863,300**

ASSESSMENT OF IMPACTS

Tornadoes have the potential to pose a significant risk to the population and can create dangerous situations. Often, providing and preserving public health and safety is difficult. The impact of climate change could produce larger, more severe tornado events, exacerbating the current tornado impacts. More destructive tornado conditions can be frequently associated with a variety of impacts, including:

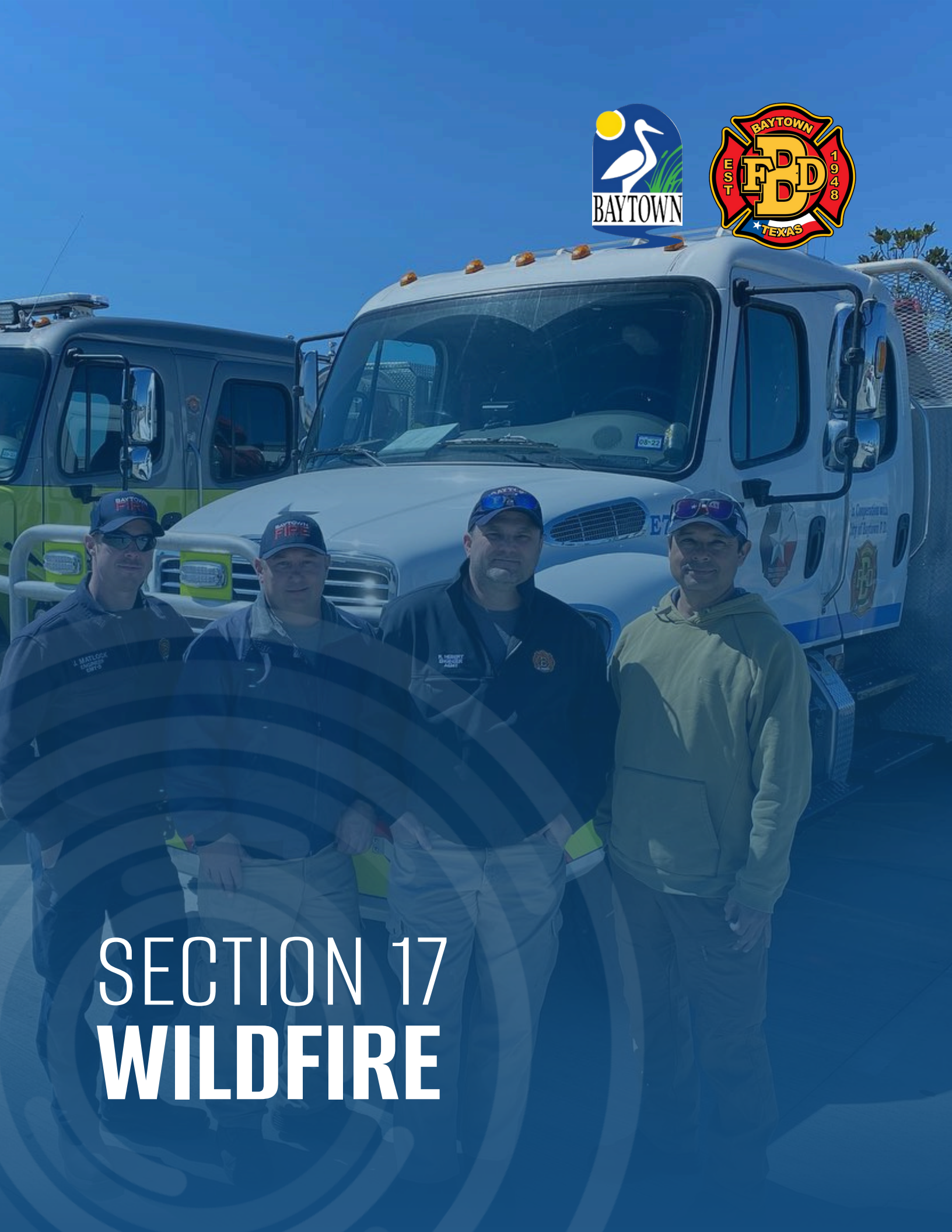
- Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees causing serious injury or death.
- Structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants.
- Manufactured homes (6 percent of total housing stock) may suffer substantial damage as they would be more vulnerable than typical site-built structures.
- Portable classrooms may also suffer substantial damage as they would be more vulnerable than other classroom structures.
- Significant debris and downed trees can result in emergency response vehicles being unable to access areas of the community.
- Downed power lines may result in roadways being unsafe for use, which may prevent first responders from answering calls for assistance or rescue.

[8] Average annualized loss for the City of Baytown has been calculated using a shorter reporting period to reflect the data available specific to the planning area.

- Tornadoes often result in widespread power outages increasing the risk to more vulnerable portions of the population who rely on power for health and/or life safety.
- Extended power outages can result in an increase in structure fires and/or carbon monoxide poisoning as individuals attempt to cook or heat their home with alternate, unsafe cooking or heating devices, such as grills.
- Tornadoes can destroy or make residential structures uninhabitable, requiring shelter or relocation of residents in the aftermath of the event.
- First responders must enter the damage area shortly after the tornado passes to begin rescue operations and to organize cleanup and assessments efforts, therefore they are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions, elevating the risk of injury to first responders and potentially diminishing emergency response capabilities.
- Emergency operations and services may be significantly impacted due to damaged facilities, loss of communications, and damaged emergency vehicles and equipment.
- Private sector entities such as utility providers, financial institutions, and medical care providers may not be fully operational and may require assistance from neighboring communities until full services can be restored.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue, especially if damage is sustained to major employers within the planning area.
- Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.
- When the community is affected by significant property damage it is anticipated that funding would be required for infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses.
- Displaced residents may not be able to immediately return to work, further slowing economic recovery.
- Residential structures destroyed by a tornado may not be rebuilt for years, reducing the tax base for the community.
- Large or intense tornadoes may result in a dramatic population fluctuation, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area.
- Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate.

- Recreation activities may be unavailable, and tourism can be unappealing for years following a large tornado, devastating directly related local businesses.
- Tornadoes may destroy or degrade endangered species habitat; currently, there are eight federally endangered, threatened, or candidate species in the planning area.
- Historical sites and properties are placed at a higher risk of impact due to materials used and the inability to change properties due to their historic status. The City of Baytown has two sites listed on the National Register of Historic Places.

The economic and financial impacts of a tornado event on the community will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a tornado event.



SECTION 17
WILDFIRE

SECTION 17: WILDFIRE

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HAZARD DESCRIPTION



Wildfire is an unplanned fire burning in natural or wildland areas such as forests, shrub lands, grasslands, or prairies.[1] Texas is one of the fastest growing states in the nation, with much of this growth occurring adjacent to metropolitan areas. This increase in population across the state will impact counties and communities that are located within the Wildland Urban Interface (WUI). The WUI is described as the area where structures and other human improvements meet and intermingle with undeveloped wildland or vegetative fuels. Population growth within the WUI substantially increases the risk of wildfire. In Texas nearly 85 percent of wildfires occur within two miles of a community. The City of Baytown planning area has an estimated 26 percent of the total planning area population that lives within the WUI.[2]

Wildfires have the potential to spread quickly given the right environmental conditions, particularly within the wildland urban interface and intermix. Most ignition sources for wildfires are a result of human activities, such as an electrical line sparking dry grasses, an improperly discarded cigarette, burning debris, or arson.

[1] Source: FEMA: https://hazards.fema.gov/nri/wildfire

[2] Source: Texas A&M Forest Service, Texas Wildfire Risk Assessment Summary Report, City of Baytown: https://texaswildfirerisk.com/

SECTION 17: WILDFIRE

Development has increased in southeastern Texas, resulting in more populated areas within the wildland interface / intermix. Additionally, the area is experiencing hotter, drier climatic conditions. These factors combine to make south Texas at risk from wildfires. While the planning area is continually at some risk for wildfires, that risk is elevated during two periods each year: the winter wildfire season (February through April) and the summer wildfire season (August through October).[3]

The City of Baytown population is expected to increase over time following population trends over the last few decades. According to the Baytown Comprehensive Plan 2040, the City of Baytown's population could increase by 28.4 percent by 2040, with an additional 26,377 residents from the 2020 estimates. Continued housing development in the WUI will put more people at a greater risk of catastrophic wildfire and put more pressure on land managers and fire department personnel to mitigate fire risk.

Wildfires spread based on the type and quantity of fuel that surrounds it. Fuel can include everything from trees, underbrush and dry grassy fields to homes. The amount of flammable material that surrounds a fire is referred to as the fuel load. Conditions in the weather and environment, such as drought, winds and extreme heat, can cause a fire to spread more quickly.[4] A wildfire event often begins unnoticed and spreads quickly, lighting brush, trees, and homes on fire. For example, a wildfire may be started by a campfire that was not doused properly, a tossed cigarette, burning debris, or arson.

Texas has seen a significant increase in the number of wildfires in the past 30 years, including wildland, urban interface, or intermix fires. Wildland fires are fueled almost exclusively by natural vegetation, while interface or intermix fires are urban / wildland fires in which vegetation and the built environment provide the fuel.

LOCATION

A wildfire incident can face devastating consequences due to human activities, drought conditions, lightning, or wind event, if the conditions allow. Wildfires can vary greatly in terms of size, location, intensity, and duration. While wildfires are not confined to any specific geographic location, they are most likely to occur in open grasslands.

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[3] Austin American Statesman, "Winter wildfire risk is rising in Central Texas. Here's what you should know." January 2023: https://www.statesman.com/story/news/environment/2023/01/30/wildfire-risk-is-rising-in-central-texas-what-you-should-know/69845234007/

[4] NOAA Weather Forecasting: https://scijinks.gov/wildfires/

SECTION 17: WILDFIRE

The Texas A&M Forest Service Wildfire Risk Assessment Portal (TxWRAP) provides historical wildfire data for Texas counties along with mapping resources that include data layers on the WUI, ignition density, and fire intensity scales for the City of Baytown planning area, along with multiple tips, recommendations and mitigation solutions for communities and residents. The TxWRAP portal was utilized to produce the maps found in this profile.

The threat to people and property from a wildfire event is greater in the fringe areas where developed areas meet open grass lands, such as the Wildland Urban Interface (WUI) (Figure 17-1). It is estimated that 26 percent of the total population in the City of Baytown planning area live within the WUI. However, the entire planning area is at some risk for wildfires.

Figure 17-1a. Wildland Urban Interface Map – City of Baytown

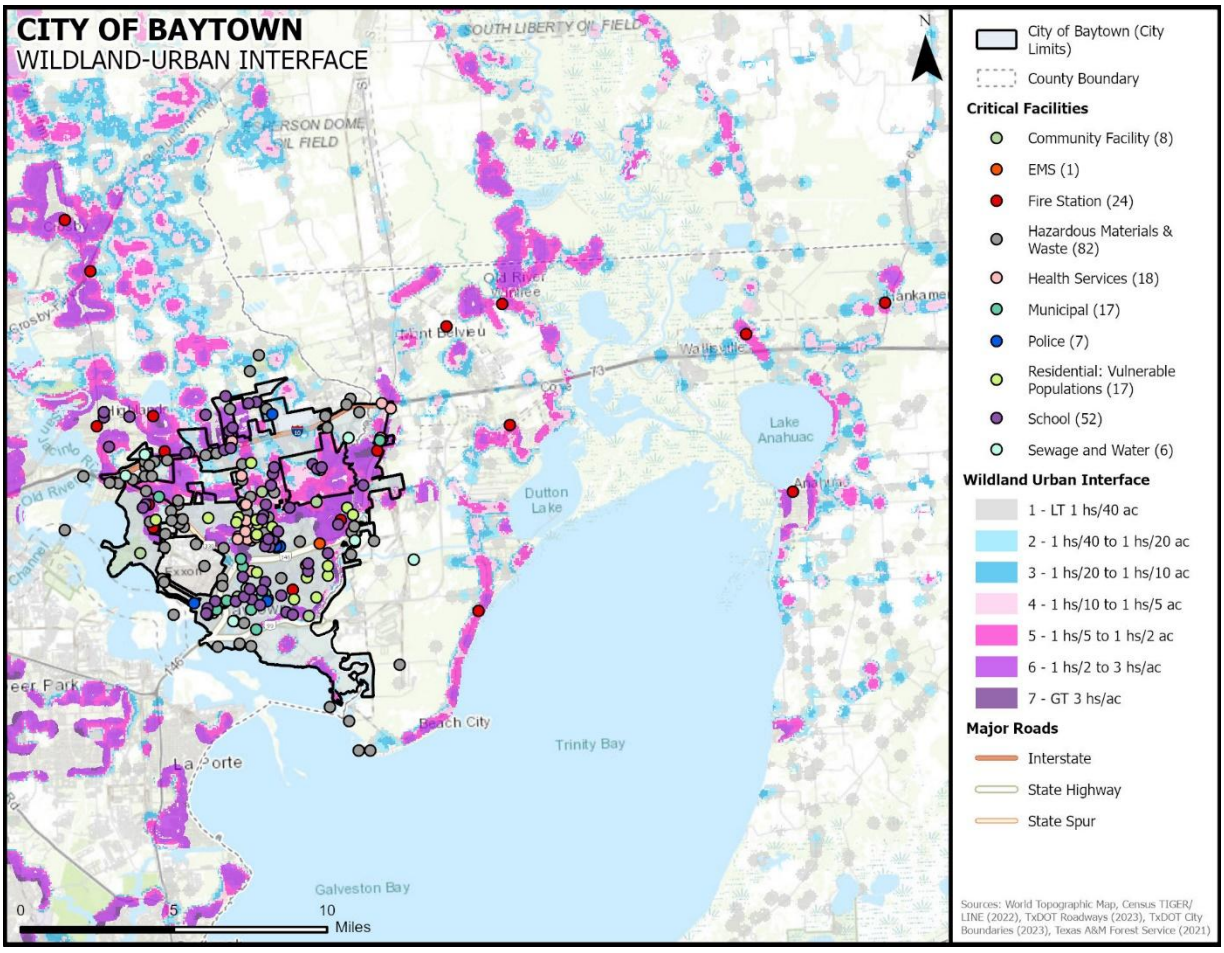
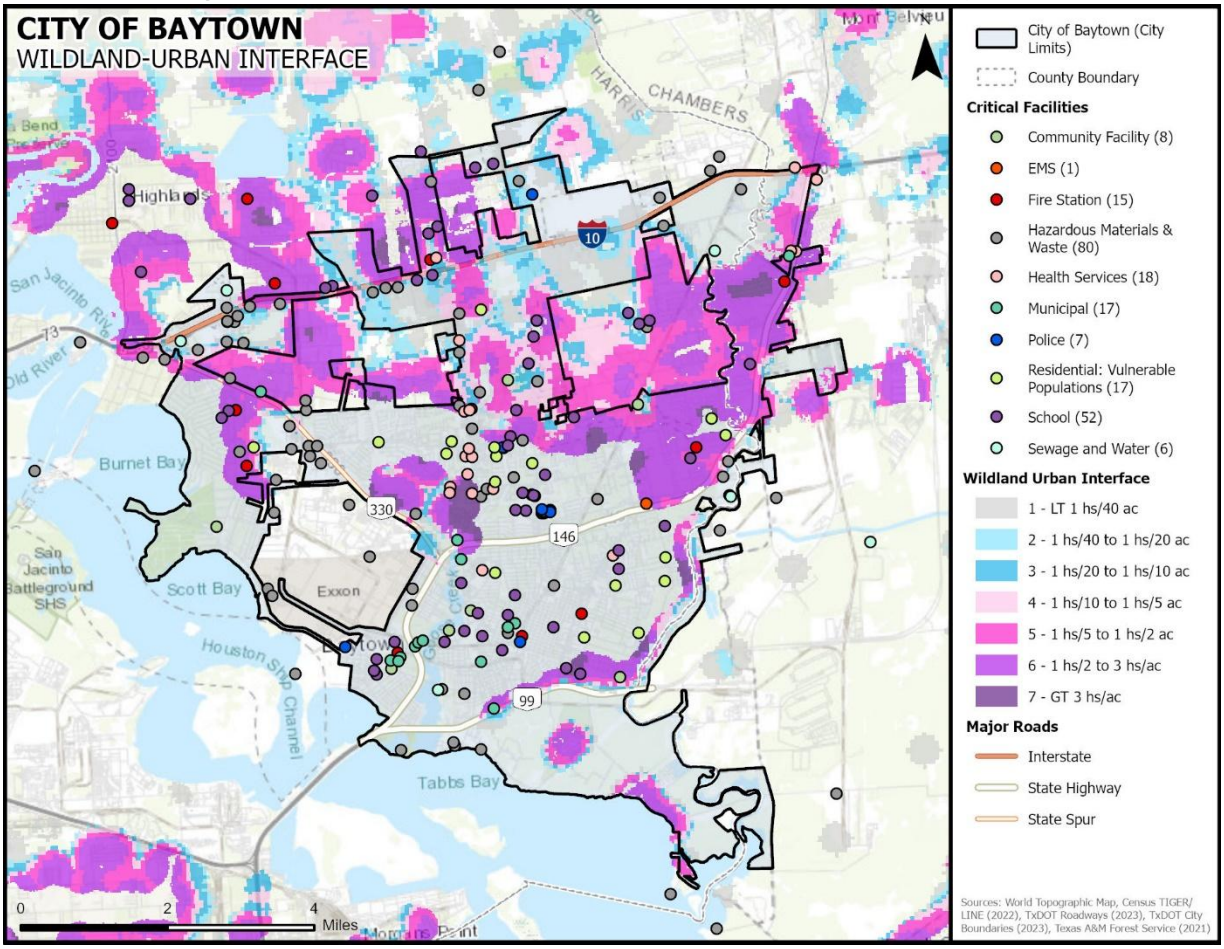


Figure 17-1b. Wildland Urban Interface Map – City of Baytown



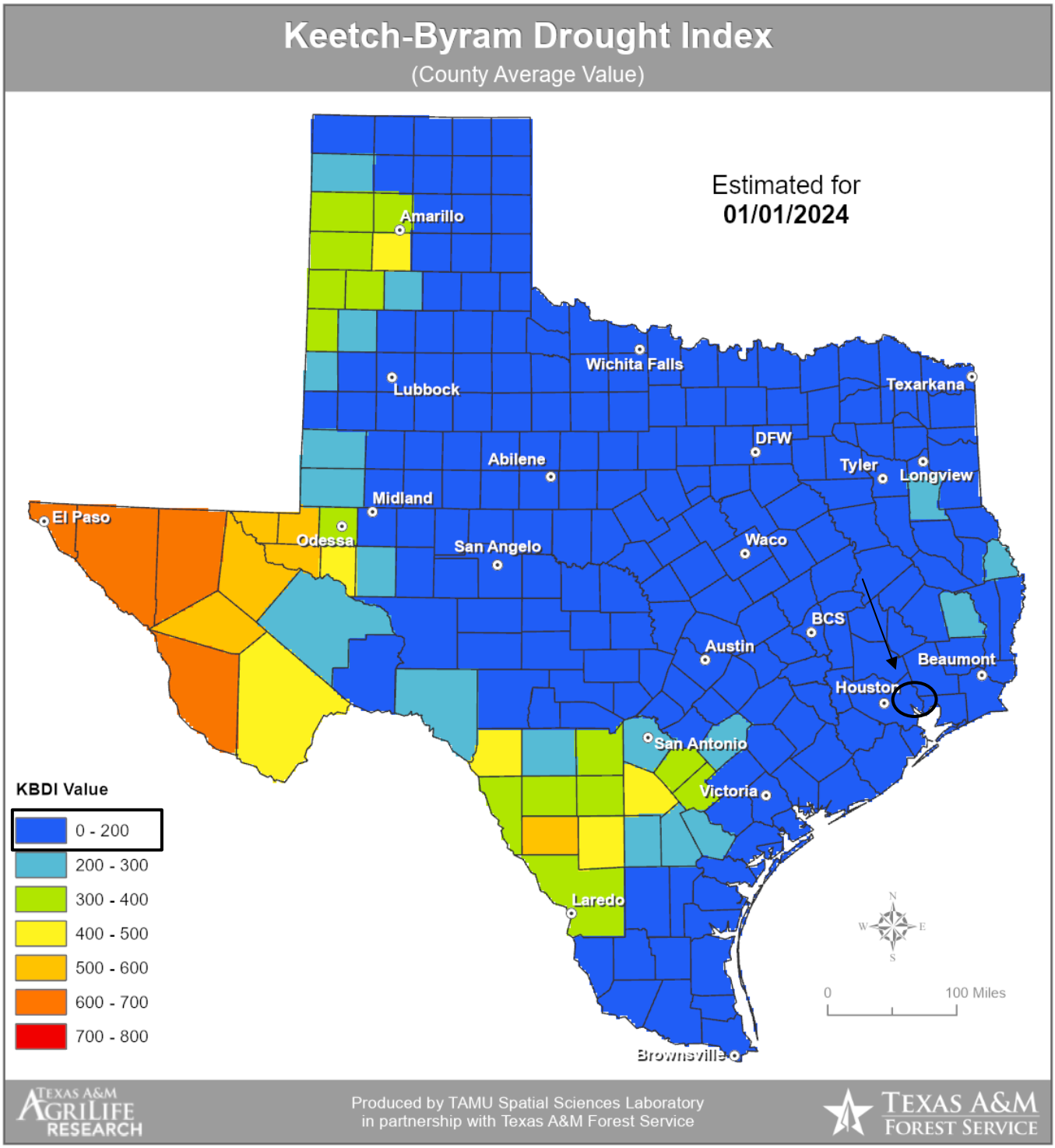
EXTENT



Risk for a wildfire event is measured in terms of magnitude and intensity using the Keetch Byram Drought Index (KBDI), a mathematical system for relating current and recent weather conditions to potential or expected fire behavior. The KBDI determines forest fire potential based on a daily water balance, derived by balancing a drought factor 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.

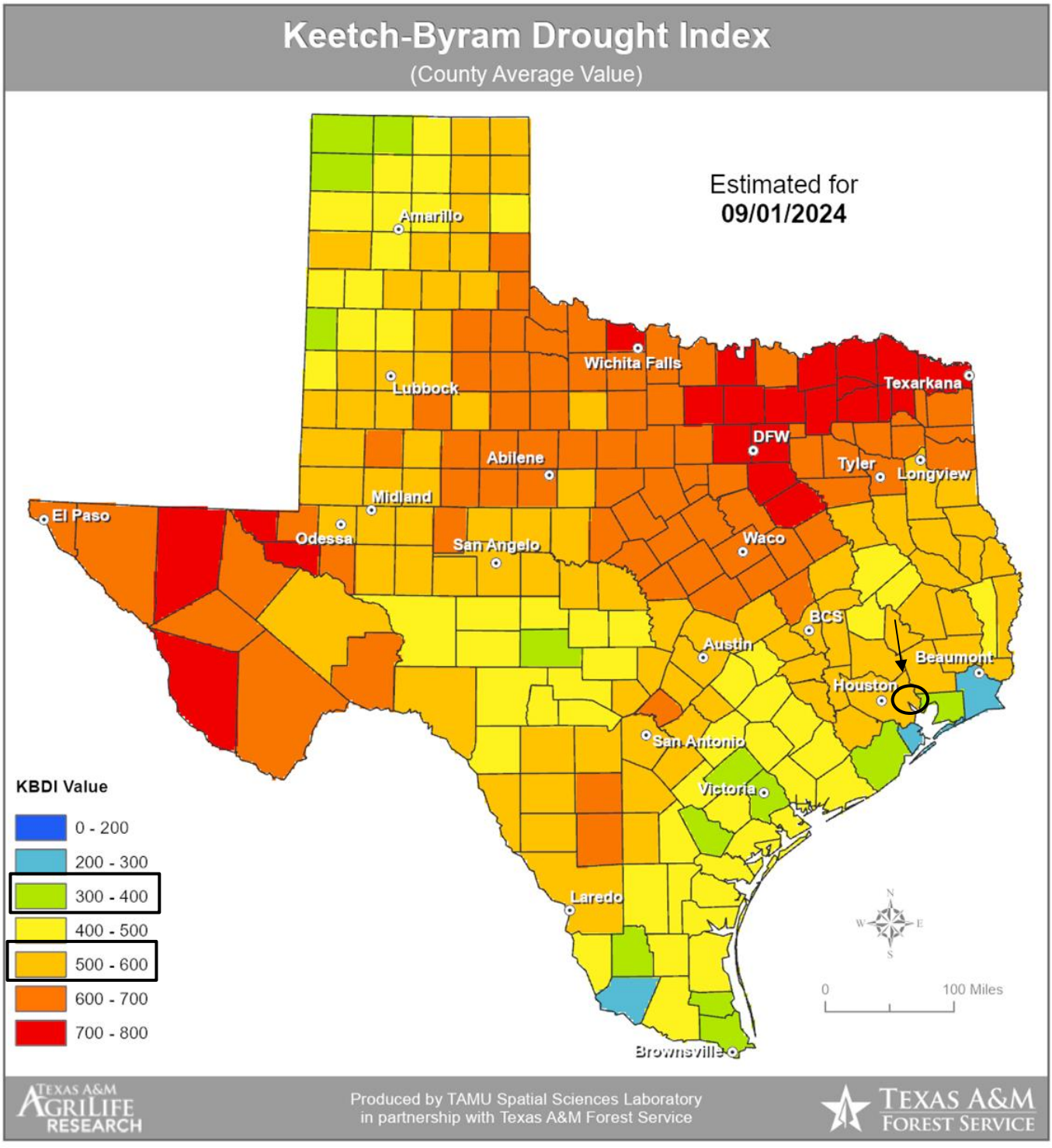
Each color in Figure 17-2 and 17-3 represents the drought index at that location, by date. The drought index ranges from 0 to 800. A drought index of 0 represents no moisture depletion, and a drought index of 800 represents absolutely dry conditions.

Figure 17-2. Keetch-Byram Drought Index (KBDI) for the State of Texas, 1/01/2024[5]



[5] City of Baytown planning area is located within the black circle.

Figure 17-3. Keetch-Byram Drought Index (KBDI) for the State of Texas, 09/01/2024



Fire behavior can be categorized at four distinct levels on the KBDI:

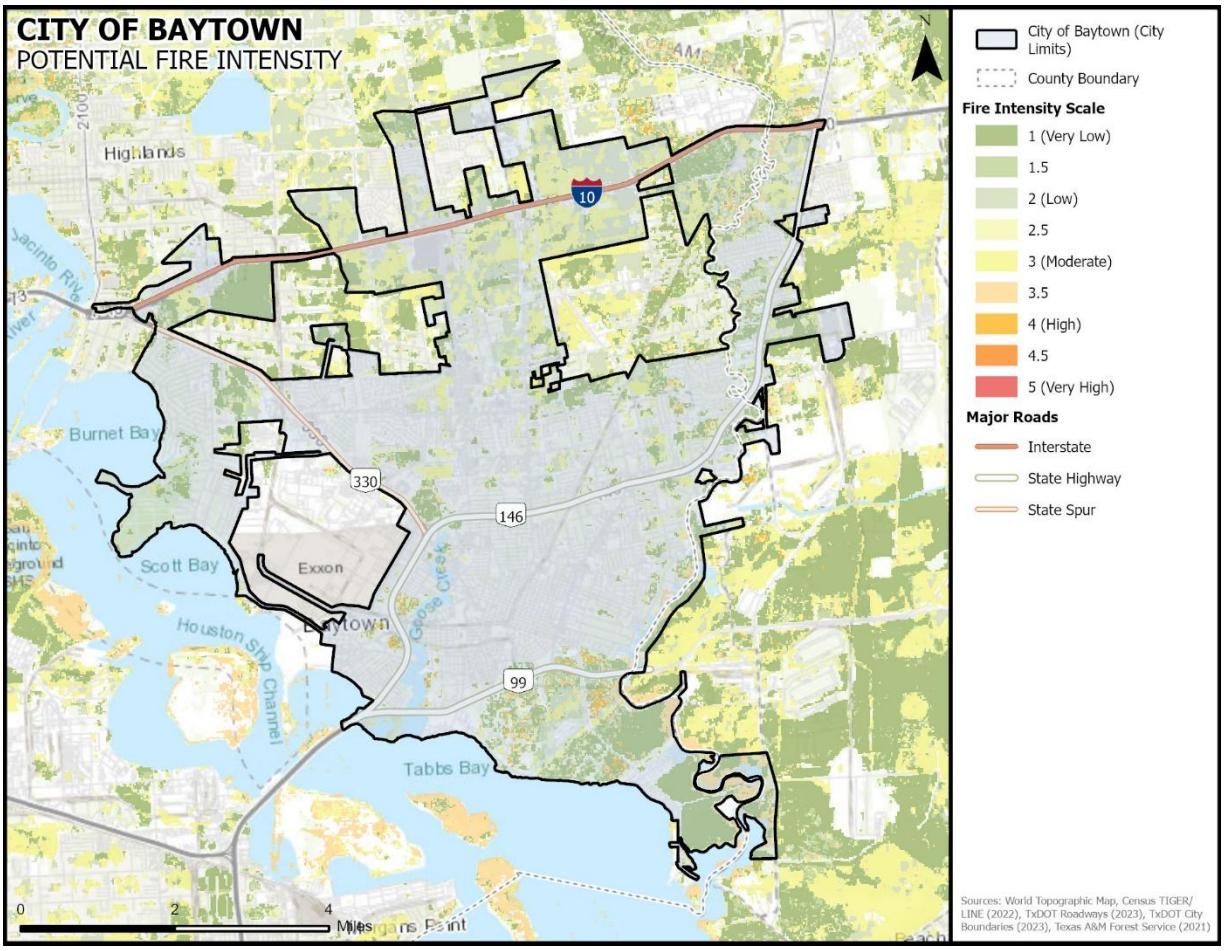
- **0 -200:** Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.
- **200 -400:** Fires more readily burn and will carry across an area with no gaps. Heavier fuels will not readily ignite and burn. Expect smoldering and the resulting smoke to carry into and possibly through the night.
- **400 -600:** Fire intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
- **600 -800:** Fires will burn down to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn through the night and heavier fuels will actively burn and contribute to fire intensity.

The KBDI is a good measure of the readiness of fuels for a wildfire event. It should be referenced as the area experiences changes in precipitation and soil moisture, while caution should be exercised in dryer, hotter conditions.

The range of intensity for the City of Baytown planning area, in a wildfire event, is 20 to 760. The average extent to be mitigated for the planning area is a KBDI of 360. Based on historical occurrences and readily available fuel, the planning area can anticipate a KBDI range from 0 to 800. At the high end of this range fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn through the night and heavier fuels will actively burn and contribute to fire intensity.

The Texas Forest Service's Fire Intensity Scale identifies areas where significant fuel hazards and associated dangerous fire behavior potential exist based on weighted average of four percentile weather categories. The City of Baytown planning area has a potential for a full range of wildfire intensities. Figure 17-4 identifies the wildfire intensity for the planning area.

Figure 17-4. Fire Intensity Scale Map – City of Baytown



HISTORICAL OCCURRENCES

The Texas Forest Service reported 2 wildfire events for the City of Baytown planning area between 2005 and 2021. There are no events, damages, injuries, or fatalities recorded for wildfire in the NCEI database for the City of Baytown planning area. The Texas A&M Forest Service (TFS) started collecting wildfire reported by volunteer fire departments in 2005. Due to a lack of recorded data for wildfire events prior to 2005 and after 2021, frequency calculations are based on a 17-year reporting period, using only data from recorded years. The map below shows approximate locations of wildfires, which can be grass or brushfires of any size (Figure 17-5). Tables 17-1 through 17-3 identify the number of wildfires and total acreage burned each year within the county boundaries.

Figure 17-5. Location and Historic Wildfire Events in the City of Baytown

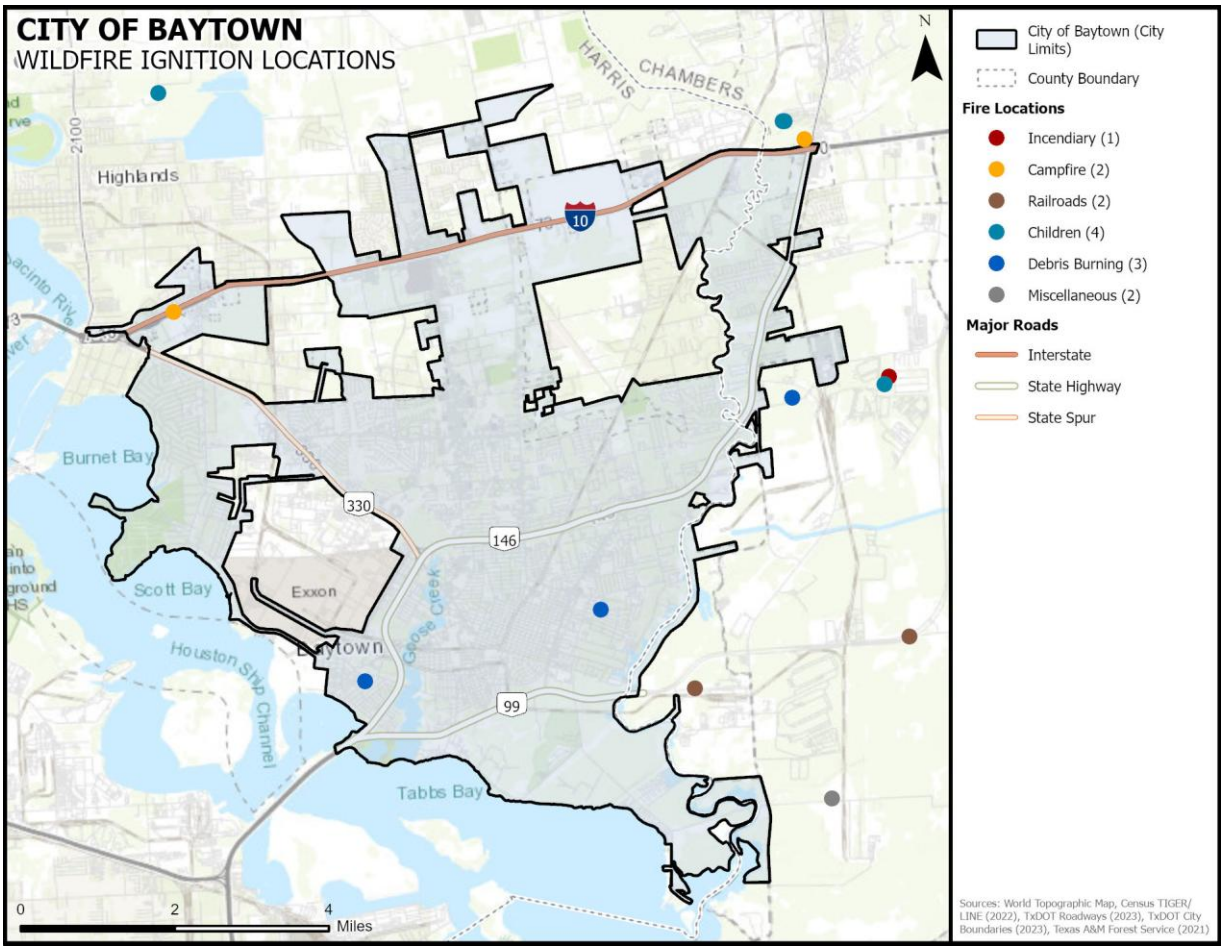


Table 17-1. Historical Wildfire Events Summary, 2005 - 2021[6]

JURISDICTION	NUMBER OF EVENTS	ACRES BURNED
City of Baytown	2	5

Table 17-2. Historical Wildfire Events by Year

YEAR	CITY OF BAYTOWN
2005	0
2006	0
2007	0
2008	0

[6] Source: Texas A&M Forest Service

YEAR	CITY OF BAYTOWN
2009	0
2010	0
2011	1
2012	0
2013	0
2014	0
2015	1
2016	0
2017	0
2018	0
2019	0
2020	0
2021	0
Total	2

Based on the list of historical wildfire events for the City of Baytown planning area (listed above), and records provided by the NCEI, no events have occurred since the 2020 plan.

Table 17-3. Acreage of Suppressed Wildfire by Year

YEAR	CITY OF BAYTOWN
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	2
2012	0
2013	0

YEAR	CITY OF BAYTOWN
2014	0
2015	3
2016	0
2017	0
2018	0
2019	0
2020	0
2021	0
Total	5

SIGNIFICANT EVENTS

There have been three declared disasters related to wildfire in Harris County and Chambers County, which includes the City of Baytown, between 1996 and 2024 (Table 17-4). Damage reports for these events were not available.

Table 17-4. Disaster Declarations for Wildfire, 1996-2024

YEAR	DECLARATION TITLE	DECLARATION TYPE	DISASTER NO.
1999	Texas Extreme Fire Hazards	EM	EM-3142-TX
2006	Extreme Wildfire Threat in Texas	DR	DR-1624-TX
2011	Texas Forest Brook Fire	FM	FM-2924-TX

PROBABILITY OF FUTURE EVENTS

Wildfires can occur at any time of the year. As the City of Baytown community moves into the wildland, the potential area of occurrence for wildfire increases. With 2 events in a 17-year period, an event within the City of Baytown planning area is “Occasional”, meaning an event is probable within the next five years.

CLIMATE CHANGE CONSIDERATIONS

Wildfires require the alignment of a number of factors, including temperature, humidity, and the lack of moisture in fuels, such as trees, shrubs, grasses, and forest debris. All these factors have strong direct or indirect ties to climate variability and climate change. Research shows that changes in climate create warmer, drier conditions, leading to longer and more active fire seasons. Increases in temperatures and the thirst of the atmosphere due to human-caused climate change have increased aridity of forest fuels during the fire season.[7]

Vapor pressure deficit, an indicator of the ability of moisture to evaporate, is projected to increase as temperatures rise and carbon dioxide fertilization reduces transpiration, leading to both lower humidity and increased surface dryness. Overall, increased dryness should extend the wildfire season in places where the fire season is presently constrained by low levels of aridity, such as eastern Texas.[8]

Additionally, it is projected that future changes to City of Baytown will include increased temperatures, which according to the U.S. Climate Explorer, the planning area may experience a 5°F increase in the average extreme heat temperatures. Historically, extreme temperatures averaged 96°F in City of Baytown, but between 2035 and 2064 the average will be 101°F, increasing the severity and frequency of extreme heat events, contributing to favorable wildfire conditions.

Extreme heat and extended periods of drought contribute to wildfire risk in the planning area. Extreme temperatures and periods of drought destroy vegetation in the area, contributing to available fuels that spread wildfires. Additional climate change impacts from drought and extreme heat are discussed in Sections 6 and 8 of this Plan. The projected increases in favorable wildfire conditions, including drought and extreme heat, indicate an increase in favorable wildfire conditions. Additional information and studies are needed to determine the degree and rate of any increased wildfire risk.

VULNERABILITY AND IMPACT

Periods of drought, dry conditions, high temperatures, and low humidity are factors that contribute to the occurrence of a wildfire event. Less developed areas, such as along

[7] NOAA Wildfire Climate Connection, August 2022: wildfire-climate-connection.

[8] Assessment of Historic and Future Trends of Extreme Weather in Texas, 1900-2036, Texas A&M University Office of the Texas State Climatologist, 2021 update.

interstates or in more remote areas where fuels are more prevalent have an increased risk of being affected by wildfire.

The more heavily populated areas of the planning area are not highly likely to experience large, sweeping fires. Unoccupied buildings and open spaces that have not been maintained have the greatest vulnerability to wildfire. The overall level of concern for wildfires is located across the county where wildland and urban areas interface. Figure 17-6[9] illustrates the areas that are the most vulnerable to wildfire throughout the City of Baytown planning area.

The City of Baytown Planning Team identified the following critical facilities (Table 17-5) as assets that are considered the most important to the planning area and are susceptible to a range of impacts caused by wildfire events. For a comprehensive list, please see Appendix F.

Table 17-5. Critical Facilities/Critical Services Vulnerable to Wildfire Events

CRITICAL FACILITIES	CRITICAL FACILITIES AT RISK	POTENTIAL IMPACTS
Emergency Response Services (EOC, Fire, Police, EMS), Hospitals and Medical Centers	1 EMS Facility, 15 Fire Stations, 10 Health Services, 1 Police Station	• Emergency services may be disrupted during a wildfire if facilities are impacted, roadways are inaccessible, or personnel are unable to report for duty. • First responders are at greater risk of injury when in close proximity to the hazard while extinguishing flames, protecting property, or evacuating residents in the area. • Critical city departments may not be able to function and provide necessary services depending on the location of the fire and the structures or personnel impacted. • Roadways in or near the WUI could be damaged or closed due to smoke and limited visibility, slowing or preventing access for emergency response vehicles. • Fire suppression costs can be substantial, exhausting the financial resources of the community. • First responders can experience heart disease, respiratory problems, and other long-term related illnesses from prolonged exposure to smoke, chemicals, and heat.

[9] Source: TxWRAP portal at the following site: https://texaswildfirerisk.com/

CRITICAL FACILITIES	CRITICAL FACILITIES AT RISK	POTENTIAL IMPACTS
		• Emergency operations and services may be significantly impacted due to damaged facilities and/or loss of communications. • Power outages could disrupt communications, delaying emergency response times. • Structures can be damaged or destroyed in the path of the wildfire. • Power outages could disrupt critical care. • Backup power sources could be damaged or destroyed. • Critical staff may be injured or otherwise unable to report for duty, limiting response capabilities.
Airport, Academic Institutions, Animal Shelter, Evacuation Centers & Shelters, Governmental Facilities, Residential/ Assisted Living Facilities	3 Community Facilities, 4 Municipal Facilities, 4 Residential Facilities (Vulnerable Populations), 26 School Facilities	• Facilities or infrastructure may be damaged, destroyed or otherwise inaccessible. • Essential supplies like medicines, water, food, and equipment deliveries may be significantly delayed. • Additional emergency responders and critical aid workers may not be able to reach the area for days. • Power outages and infrastructure damage may prevent larger airports from acting as temporary command centers for logistics, communications, and emergency operations.
Commercial Supplier (food, fuel, etc.)	N/A	• Facilities, infrastructure, or critical equipment including communications may be damaged, destroyed or otherwise inoperable. • Essential supplies like medicines, water, food, and equipment deliveries may be delayed. • Economic disruption due to power outages and fires negatively impact services as well as area businesses reliant on commercial suppliers.
Utility Services and Infrastructure (electric, water, wastewater, communications)	40 Hazardous Materials Facilities, 1 Sewage and Water Facility	• Wastewater and drinking water facilities and infrastructure may be damaged or destroyed resulting in service disruption or outage for multiple days or weeks. • Disruptions and outages impact public welfare as safe drinking water is critical.

CRITICAL FACILITIES	CRITICAL FACILITIES AT RISK	POTENTIAL IMPACTS
		• A break in essential and effective wastewater collection and treatment is a health concern, potentially spreading disease. • Exposure to untreated wastewater is harmful to people and the environment. • Any service disruptions can negatively impact or delay emergency management operations.

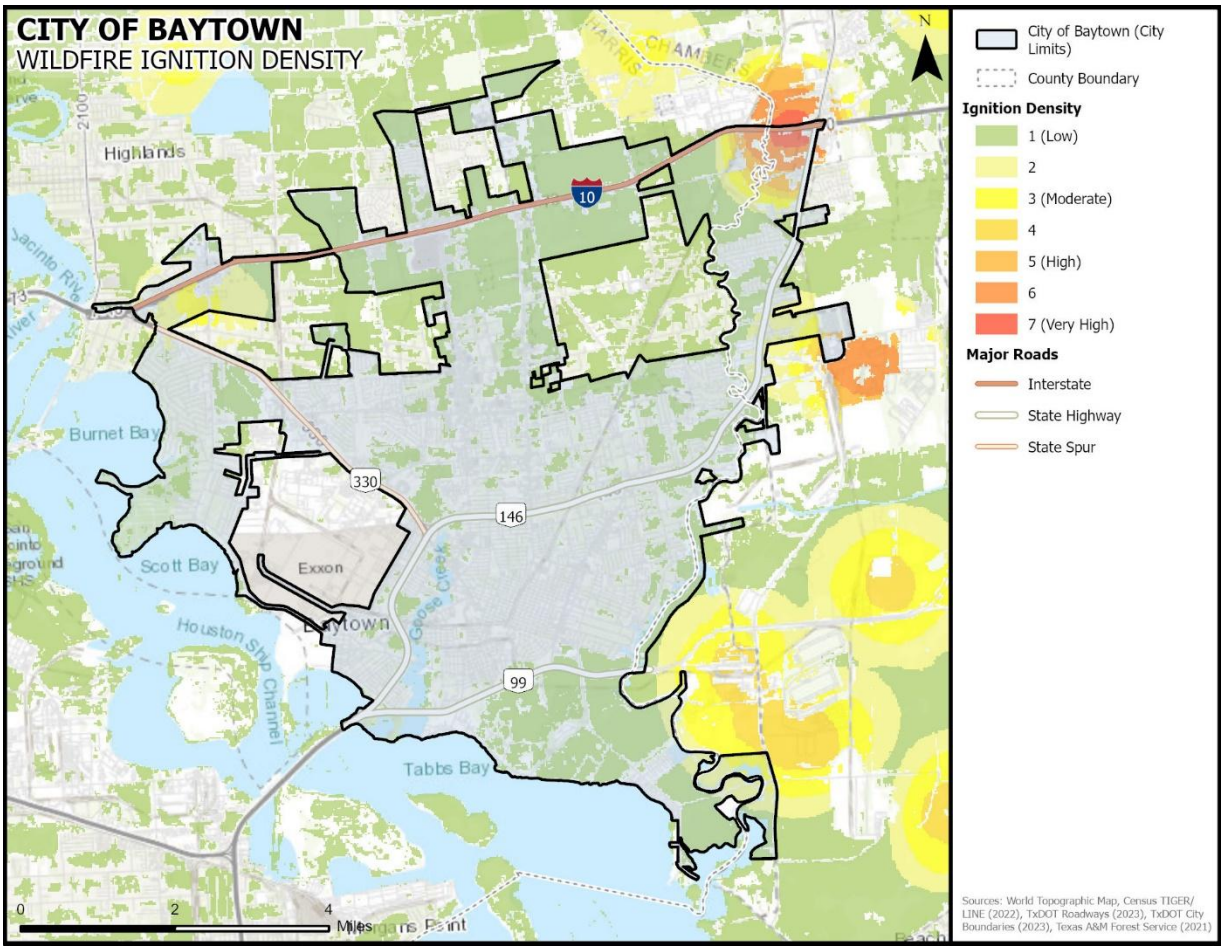
Within the City of Baytown planning area, a total of 2 fire events were reported from 2005 through 2021 by Texas A&M Forest Service. Both events were suspected wildfires. The average annualized acreage lost is minimal, with less than one acre lost per year.

Wildfire Ignition Density shows the likelihood of a wildfire starting based on historical ignition patterns. Occurrence is derived by modeling historic wildfire ignition locations to create an average ignition rate map. The ignition rate is measured in the number of fires per year per 1,000 acres. Wildfire Ignition Density is a key input into the calculation of the Wildfire Threat output. With most Texas fires being human caused, there is a repeatable spatial pattern of fire ignitions over time. This pattern identifies areas where wildfires are most likely to ignite, and prevention efforts can be planned accordingly.[10]

Figure 17-6 shows the threat of wildfire to the City of Baytown planning area.

[10] Source: TxWRAP portal at the following site: https://texaswildfirerisk.com/

Figure 17-6. Wildfire Ignition Density – City of Baytown

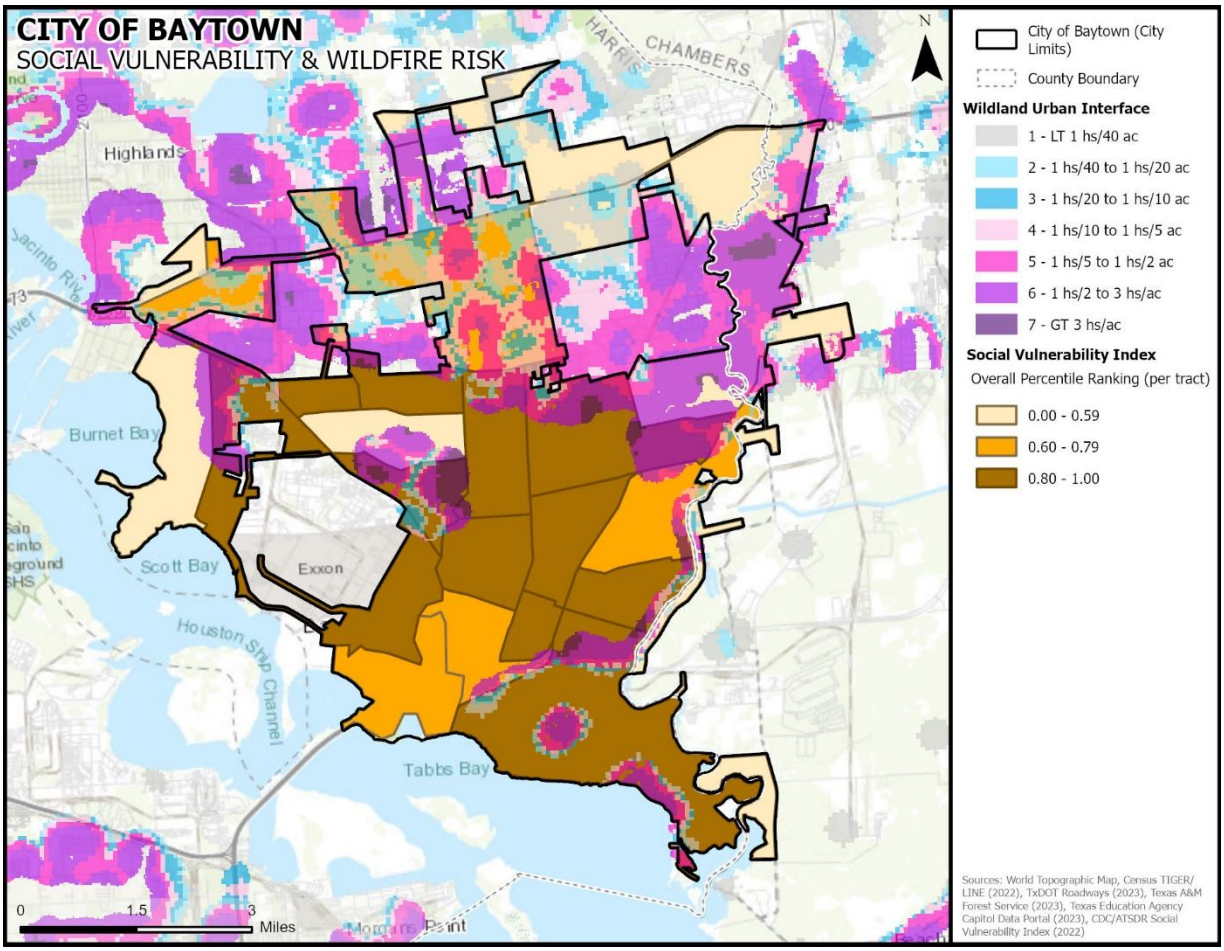


Diminished air quality is an environmental impact that can result from a wildfire event and pose a potential health risk. Wildfire smoke plumes may contain carcinogenic particles that can be inhaled. Fine particles of invisible soot and ash that are too small for the respiratory system to filter can cause immediate and possibly long-term health effects. The elderly or those individuals with compromised respiratory systems may be more vulnerable to the effects of diminished air quality after a wildfire event.

The Center for Disease Control (CDC) created a Social Vulnerability Index (SVI) which includes a database and mapping application that identifies and quantifies communities experiencing social vulnerability. The current CDC SVI uses 16 U.S. census variables from the 5-year American Community Survey (ACS) to identify communities that may need support before, during, or after disasters. All 16 variables fall under four broad categories including socioeconomic status (population in poverty, unemployment, etc.), household characteristics (age, disability status, etc.), racial and ethnic minority status, and housing type and transportation (mobile homes, no vehicles, etc.). Populations

experiencing social vulnerability may be adversely impacted by natural hazards, disasters, and other community-level stressors. Figure 17-7 identifies areas of social vulnerability using the CDC's SVI and where these areas overlap with the City of Baytown WUI areas, where wildfire risk is considered the highest.

Figure 17-7. City of Baytown's Social Vulnerability and WUI



Climatic conditions such as severe freezes and drought can significantly increase the intensity of wildfires since these conditions kill vegetation, creating a prime fuel source for wildfires. The intensity and rate at which wildfires spread are directly related to wind speed, temperature, and relative humidity.

The severity of impact from major wildfire events can be substantial. Such events can cause multiple deaths, shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. The severity of impact is gauged by acreage burned, homes and structures lost, and the number of resulting injuries and fatalities.

SECTION 17: WILDFIRE

For the City of Baytown planning area, the impact from a wildfire event can be considered "Limited," meaning injuries and/or illnesses are typically treatable with first-aid, complete shutdown of facilities and services for 24 hours or less and less than 10 percent of property is destroyed or with major damage. The severity of impact is gauged by acreage burned, homes and structures lost, injuries and fatalities.

Table 17-6. Impact on the City of Baytown

JURISDICTION	IMPACT	DESCRIPTION
City of Baytown	Limited	The City of Baytown has an estimated 19,414 people or 26 percent of the total population that live within the Wildland Urban Interface (WUI). The housing density is most commonly 1 house per 2 acres. City residents may suffer injuries that do not result in permanent disability. Critical facilities could be shut down for more than one week, and more than 10 percent of total property could be damaged.

ASSESSMENT OF IMPACTS

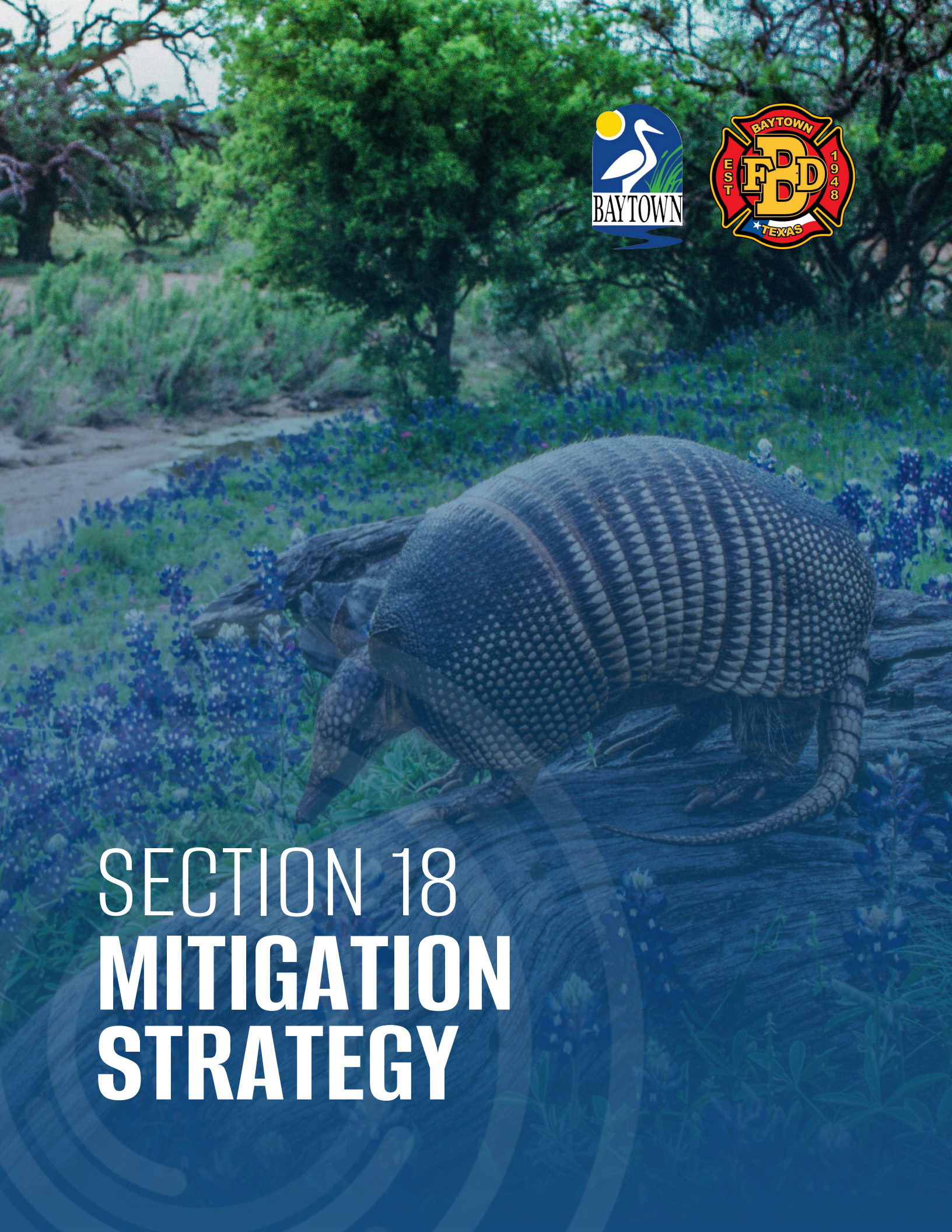
A wildfire event poses a potentially significant risk to public health and safety, particularly if the wildfire is initially unnoticed and spreads quickly. The impacts associated with wildfire are not limited to direct damage. Significant wildfire events can be frequently associated with a variety of impacts, including:

- The City of Baytown planning area contains numerous open space areas. Wildfires may adversely affect or destroy endangered species' habitats, reduce air quality, increase erosion and risk of flash flooding, contribute to increased local temperatures, and disrupt other ecological functions.
- Recreation activities throughout city parks may be unavailable and tourism can be unappealing for years following a large wildfire event, devastating directly related local businesses and negatively impacting economic recovery.
- Persons, pets, and wildlife in the area at the time of the fire are at risk for injury or death from burns and/or smoke inhalation. First responders are at greater risk of physical injury when near the hazard while extinguishing flames, protecting property, or evacuating residents in the area.
- First responders can experience heart disease, respiratory problems, and other long-term related illnesses from prolonged exposure to smoke, chemicals, and heat.

- Emergency services may be disrupted during a wildfire if facilities are impacted, roadways are inaccessible, or personnel are unable to report for duty.
- Critical city departments may not be able to function and provide necessary services depending on the location of the fire and the structures or personnel impacted.
- Non-critical businesses may be directly damaged, suffer loss of utility services, or be otherwise inaccessible, delaying normal operations and slowing the recovery process.
- Displaced residents may not be able to immediately return to work, slowing economic recovery.
- Roadways in or near the WUI could be damaged or closed due to smoke and limited visibility.
- Older homes are generally exempt from modern building code requirements, which may require fire suppression equipment in the structure. An estimated 49 percent (16,575 structures) of homes in the planning area were built before 1980. Similarly, historic buildings may lack fire mitigation materials or measures due to their historic status. There are two historical sites listed on the National Register of Historic Places for the City of Baytown.
- Some high-density neighborhoods feature small lots with structures close together, increasing the potential for fire to spread rapidly.
- Air pollution from smoke may exacerbate respiratory problems of vulnerable residents.
- Charred ground after a wildfire cannot easily absorb rainwater, increasing the risk of flooding and potential mudflows.
- Wildlife may be displaced or destroyed.
- Historical or cultural resources may be damaged or destroyed.
- Tourism can be significantly disrupted, further delaying economic recovery for the area.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Fire suppression costs can be substantial, exhausting the financial resources of the community.
- Residential structures lost in wildfire may not be rebuilt for years, reducing the tax base for the community.
- Direct impacts to municipal water supply may occur through contamination of ash and debris during the fire, destruction of aboveground delivery lines, and soil erosion or debris deposits into waterways after the fire.

The economic and financial impacts of a wildfire event on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business

days in impacted areas, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and citizens will contribute to the overall economic and financial conditions in the aftermath of a wildfire event.



SECTION 18
MITIGATION STRATEGY

SECTION 18: MITIGATION STRATEGY

Mitigation Goals 1
Goal 1 1
Goal 2 2
Goal 3 2
Goal 4 2
Goal 5 3
Goal 6 3
Goal 7 3

MITIGATION GOALS

Based on the results of the risk and capability assessments, the Planning Team developed and prioritized the mitigation strategy. This involved utilizing the results of both assessments and reviewing the goals and objectives that were included in the previous 2020 Plan. At the Mitigation Workshop in January 2025, Planning Team members reviewed the mitigation strategy from the previous Plan. The consensus among all members present was that the strategy developed for the 2020 Plan required some changes including expanding on existing goals and the addition of a goal around equity and vulnerable populations.

GOAL 1

Protect public health and safety.

OBJECTIVE 1.1

Advise the public about health and safety precautions to guard against injury and loss of life from hazards.

OBJECTIVE 1.2

Maximize utilization of the latest technology to provide adequate warning, communication, and mitigation of hazard events.

OBJECTIVE 1.3

Reduce the danger to, and enhance protection of, high risk areas during hazard events.

OBJECTIVE 1.4

Protect critical facilities and services.

GOAL 2

Build and support local capacity and commitment to continuously become less vulnerable to hazards.

OBJECTIVE 2.1

Build and support local partnerships to continuously become less vulnerable to hazards.

OBJECTIVE 2.2

Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.

OBJECTIVE 2.3

Build hazard mitigation concerns into city planning and budgeting processes.

GOAL 3

Increase public understanding, support, and demand for hazard mitigation.

OBJECTIVE 3.1

Heighten public awareness regarding the full range of natural and man-made hazards the public may face.

OBJECTIVE 3.2

Educate the public on actions they can take to prevent or reduce the loss of life or property from all hazards and increase individual efforts to respond to potential hazards.

OBJECTIVE 3.3

Publicize and encourage the adoption of appropriate hazard mitigation measures.

GOAL 4

Protect new and existing properties.

OBJECTIVE 4.1

Reduce repetitive losses to the National Flood Insurance Program (NFIP).

OBJECTIVE 4.2

Use the most cost-effective approach to protect existing buildings and public infrastructure from hazards.

OBJECTIVE 4.3

Enact and enforce regulatory measures to ensure that future development will not put people in harm's way or increase threats to existing properties.

GOAL 5

Maximize the resources for investment in hazard mitigation.

OBJECTIVE 5.1

Maximize the use of outside sources of funding.

OBJECTIVE 5.2

Maximize participation of property owners in protecting their properties.

OBJECTIVE 5.3

Maximize insurance coverage to provide financial protection against hazard events.

OBJECTIVE 5.4

Prioritize mitigation projects, based on cost-effectiveness and sites facing the greatest threat to life, health, and property.

GOAL 6

Promote growth in a sustainable manner.

OBJECTIVE 6.1

Incorporate hazard mitigation activities into long-range planning and development activities.

OBJECTIVE 6.2

Promote beneficial uses of hazardous areas while expanding open space and recreational opportunities.

OBJECTIVE 6.3

Utilize regulatory approaches to prevent creation of future hazards to life and property.

GOAL 7

Promote equity and protect vulnerable populations and underserved communities through hazard mitigation activities.

SECTION 18: MITIGATION STRATEGY

OBJECTIVE 7.1

Allocate resources and funding to implement hazard mitigation activities that directly benefit vulnerable and underserved communities.

OBJECTIVE 7.2

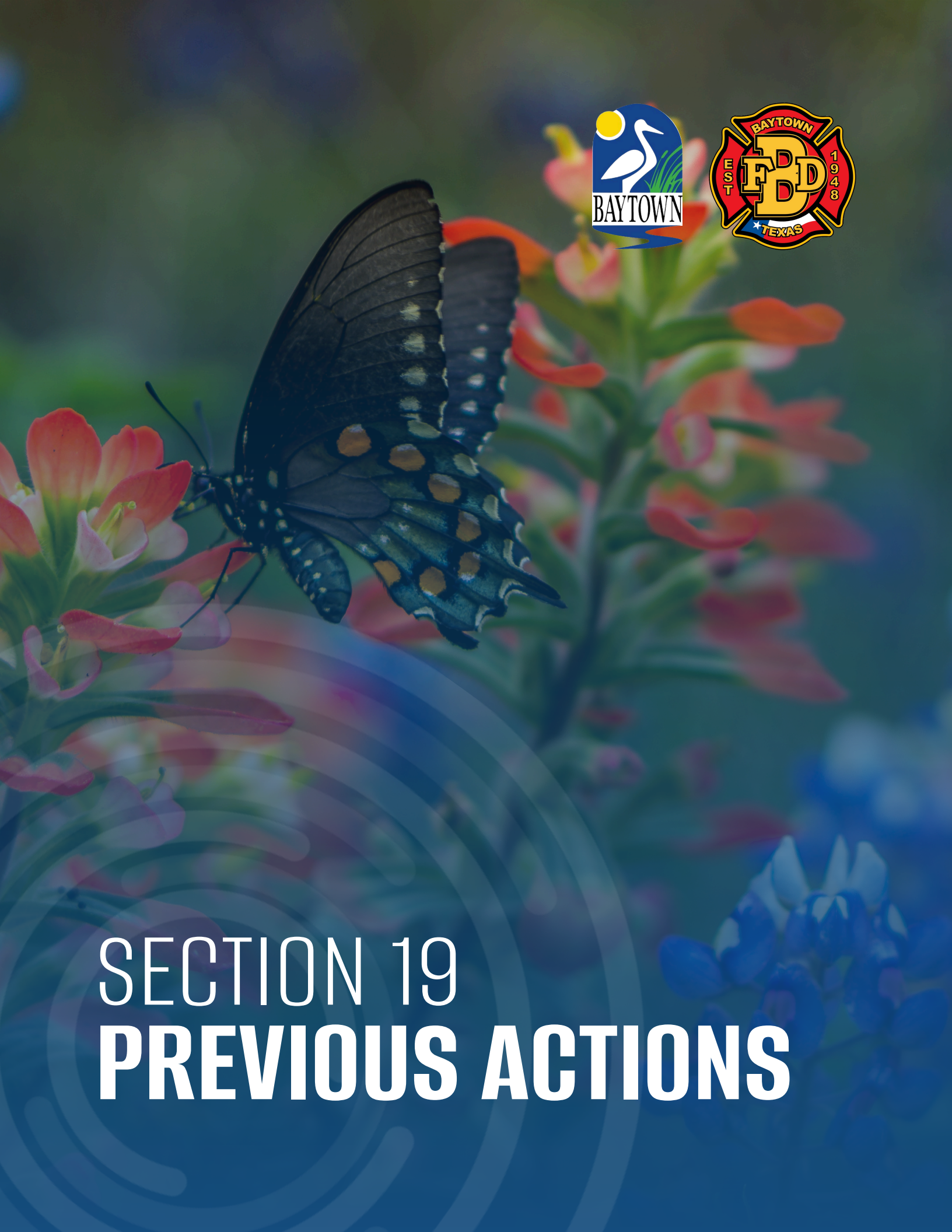
Build and support local partnerships to leverage resources and expertise in addressing hazard related equity concerns.

OBJECTIVE 7.3

Establish internal decision-making processes that integrate equity into project selection.

OBJECTIVE 7.4

Monitor and evaluate the effectiveness of mitigation activities to ensure equitable outcomes and protection of vulnerable populations.



SECTION 19
PREVIOUS ACTIONS

SECTION 19: PREVIOUS ACTIONS

Summary 1
City of Baytown 2

SUMMARY

This section includes analysis from the 2020 Harris County Multi-Hazard Hazard Mitigation Action Plan. Planning Team members were given copies of the previous mitigation actions submitted in the 2020 Harris County Multi-Hazard Hazard Mitigation Action Plan at the mitigation workshop. The City of Baytown reviewed the previous actions and provided an analysis as to whether the action had been completed, should be deferred as an ongoing activity, or be deleted from the Plan Update. The actions from the 2020 Plans are included in this section as they were written in 2020, except for the "2025 Analysis" section.

SECTION 19: PREVIOUS ACTIONS

CITY OF BAYTOWN

	City of Baytown – Previous Action #BAY1
Proposed Action:	Where appropriate, support retrofitting, purchase or relocation of structures located in hazard areas, prioritizing those that have experienced repetitive losses and/or are located in high- or medium-risk hazard areas.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Property Protection Natural Resources Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Storm, Dam Failure
Applies to New or Existing Assets:	Existing
Estimated Cost (High, Medium, Low):	High
Funding Sources:	HMGP, PDM, FMA, CDBG-DR
Lead Agency:	Engineering
Support Agency:	Emergency Management, Planning, Public Works
Timeline:	Long-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Defer to plan update. In progress, infrastructure mitigation projects implemented.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY2	
	Proposed Action:	Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including Capital Improvement Programs, Master Plans, and Strategic Plans.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Natural Resources Protection Community Capacity Building

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Coastal erosion, Dam/levee failure, Drought, Earthquakes, Flooding, Hurricanes and coastal storms, Mass movement, Severe weather, and Wildfire
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	Staff Time, General Funds
Lead Agency:	Emergency Management
Support Agency:	Engineering, Planning, Public Works
Timeline:	Ongoing
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Defer to plan update. In progress.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY3	
	Proposed Action:	Actively participate in the plan maintenance protocols outlined in Volume 1 of this hazard mitigation plan.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Coastal erosion, Dam/levee failure, Drought, Earthquakes, Flooding, Hurricanes and coastal storms, Mass movement, Severe weather, and Wildfire
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	Staff Time, General Funds
Lead Agency:	Emergency Management
Support Agency:	Engineering, Planning, Public Works
Timeline:	Short-term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Defer to plan update. Ongoing capability, ongoing during annual reviews of MAP cycle. Update verbiage to reflect Section 21 instead of Volume 1.

SECTION 19: PREVIOUS ACTIONS

City of Baytown – Previous Action #BAY4	
Proposed Action:	Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance / information on floodplain requirements and impacts.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Public Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather, Dam Failure
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	Staff Time, General Funds
Lead Agency:	Engineering
Support Agency:	Emergency Management, Planning, Public Works
Timeline:	Ongoing
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. Ongoing capability. Update floodplain maps as needed.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY5
Proposed Action:	Create 75 Stormwater Retention Ponds to increase storage capacity as identified in Master Drainage Plan.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Medium
Funding Sources:	General Funds, Bonds, and HMA
Lead Agency:	Engineering
Support Agency:	Public Works, Planning
Timeline:	Long-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Defer to plan update. In progress. Master Drainage Plan has been revised.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY6
Proposed Action:	Upgrade City Code Chapter 110 to Require Increased Freeboard (500-year + 2 feet) for Construction in Floodplain.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention, Property Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather, Dam Failure
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds
Lead Agency:	Engineering
Support Agency:	Public Works, Planning
Timeline:	Short-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Completed. Ordinance updated in January to 500 year or 100 +2.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY7	
	Proposed Action:	Elevate Electronic Controls for Sewer Lift Stations 24" above 500-year NFIP Floodplain.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	High
Funding Sources:	General Funds, Bonds, HMA, PA
Lead Agency:	Public Works
Support Agency:	Engineering
Timeline:	Short-term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. In progress. Elevation for electrical panels at lift stations utilizing FEMA funding DR-4332.

SECTION 19: PREVIOUS ACTIONS

		City of Baytown – Previous Action #BAY8
	Proposed Action:	Install Early Warning lightning detection system for critical infrastructure (EOC, 911 Communications, and Pirates Bay Water Park).
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Emergency Services

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Medium
Funding Sources:	General Funds
Lead Agency:	City Departments
Support Agency:	Public Works, Engineering, Facilities Maintenance
Timeline:	Long-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. Ongoing capability.

SECTION 19: PREVIOUS ACTIONS

		City of Baytown – Previous Action #BAY9
	Proposed Action:	Amend City Policy to require city carports and city vehicle shelters to be constructed of materials and processes to mitigate against hail damages to equipment currently parked in the open.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Hurricane, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Medium
Funding Sources:	General Funds
Lead Agency:	City Departments
Support Agency:	Public Works, Engineering, Facilities Maintenance
Timeline:	Long-Term
Priority: (High, Medium, Low)	Low

2025 ANALYSIS:
Defer to plan update. Ongoing capability. Planning for new construction.

SECTION 19: PREVIOUS ACTIONS

City of Baytown – Previous Action #BAY10	
Proposed Action:	Develop a Community Urban Wildfire Prevention Program to educate citizens on how to reduce damages to residential property from wildfires.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Public Education and Awareness Climate Resilient

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, HMA
Lead Agency:	Baytown Fire Department
Support Agency:	Emergency Management, Planning
Timeline:	Short-Term
Priority: (High, Medium, Low)	Low

2025 ANALYSIS:
Defer to plan update. No progress reported.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY11	
	Proposed Action:	Develop public education program for home owners on flood hazards and flood mitigation techniques to reduce flood damages to property.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Public Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather, Dam Failure
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, HMA
Lead Agency:	Emergency Management, Engineering
Support Agency:	Planning
Timeline:	Short-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Defer to plan update. Ongoing. Implemented to meet CRS goals.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY12	
	Proposed Action:	Improve Underperforming Stormwater System Collection/Conveyance Components to ensure system functions in accordance with design to mitigate flooding; including installation of submersible pumps.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	N/A
Funding Sources:	N/A
Lead Agency:	N/A
Support Agency:	N/A
Timeline:	N/A
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. Ongoing. S Main drainage Phase 1 complete, phase is in design Texas Ave funded with CDBG-MIT.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY13	
	Proposed Action:	Acquisition of Repetitive Flood Loss Property identified in the Regional Stormwater Master Plan.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Property Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	High
Funding Sources:	General Funds, Bonds, HMA, CDBG-DR
Lead Agency:	Engineering
Support Agency:	Planning, Emergency Management
Timeline:	Long-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Delete action. The city has determined this action is no longer a priority.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY14	
	Proposed Action:	Improve City of Baytown CRS Classification from Class 7 to Class 6.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather, Dam Failure
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, HMA
Lead Agency:	Engineering
Support Agency:	Planning, Emergency Management, Public Works
Timeline:	Short-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Defer to plan update. In progress. Ordinance updated, public outreach and StormReady certification to help lower CRS. Baytown PWE/City Engineer/ Floodplain Manager achieved a CRS Class 5 rating in 2023.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY15	
	Proposed Action:	Develop a hardened Potable Water Treatment Plant to provide an alternate water source during drought conditions.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects, Climate Resilient

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought, Mass Movement
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	High
Funding Sources:	General Funds, Bonds, HMA
Lead Agency:	Public Works
Support Agency:	Engineering
Timeline:	Long-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Completed. BAWA East is now online to supplement action item.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY16
Proposed Action:	Convert Water Treatment Plant from Surface Water to Desalination Source.
BACKGROUND INFORMATION	
Site and Location:	Water Treatment Plant
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects, Climate Resilient

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought, Mass Movement
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	High
Funding Sources:	General Funds, Bonds, HMA
Lead Agency:	Public Works
Support Agency:	Engineering
Timeline:	Long-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. No progress.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY17	
	Proposed Action:	Expand Community Warning System (sirens, reverse 911, Mass Notification, EAS, iPAWS, radio) to increase coverage to residents in hazard-prone areas of the community.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Emergency Services

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Coastal erosion, Dam/levee failure, Drought, Earthquakes, Flooding, Hurricanes and coastal storms, Mass movement, Severe weather, and Wildfire
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Medium
Funding Sources:	General Funds
Lead Agency:	Emergency Management
Support Agency:	Communications, Information Technology Services
Timeline:	Short-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. Ongoing. Added iPAWS and continue registration of residents in Swift911. Improved AM radio equipment to digital.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY18	
	Proposed Action:	Installation of generators/power back-up systems on Critical Public Infrastructure.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Property Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricane, Severe Weather, Dam Failure
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Medium
Funding Sources:	General Funds, HMA
Lead Agency:	City Departments
Support Agency:	Public Works, Facilities Maintenance
Timeline:	Short-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. In progress. Inventory of city generator and identify critical infrastructure still in need. Review available grant programs. Portable generators were all serviced and inventoried for emergency use. HMGP grant application for water wells and fire station #3 were submitted and selected for award. Update verbiage to include elevation and applicable hazards.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY19	
	Proposed Action:	Install lightning and surge protection measures for critical infrastructure.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Property Protection

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Medium
Funding Sources:	General Funds
Lead Agency:	City Departments
Support Agency:	Public Works, Facilities Maintenance
Timeline:	Short-Term
Priority: (High, Medium, Low)	Low

2025 ANALYSIS:
Defer to plan update. In progress.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY20
Proposed Action:	Implement hazard fuel reduction and fire prevention measures such as clean-up and debris removal of abandoned buildings, abandoned lands, etc.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Property Protection Climate Resilient

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Wildfire
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, HMA
Lead Agency:	Baytown Fire Department, Planning
Support Agency:	Public Works, Engineering, Emergency Management
Timeline:	Short-Term
Priority: (High, Medium, Low)	Low

2025 ANALYSIS:
Defer to plan update. Ongoing capability.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY21	
	Proposed Action:	Develop/implement home heating safety public education/outreach program to inform residents on how to reduce damages from winter storms to residential property.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Public Education and Awareness

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds
Lead Agency:	Emergency Management
Support Agency:	Baytown Fire Department
Timeline:	Short-Term
Priority: (High, Medium, Low)	Low

2025 ANALYSIS:
Defer to plan update. Ongoing. Information was distributed prior to, during, and after Winter Storm 2021. City will continue to implement as needed.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY22
Proposed Action:	Create and establish a hazard risk profile database and GIS mapping of Pipeline Risk Areas.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	N/A

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Pipeline Failure, HAZMAT
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, LEPC
Lead Agency:	Emergency Management
Support Agency:	Baytown Fire Department
Timeline:	Short-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Completed.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY23	
	Proposed Action:	Enhance air monitoring capabilities to mitigate chemical releases and exposures.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	N/A

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Pipeline Failure, HAZMAT
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, LEPC
Lead Agency:	Emergency Management
Support Agency:	Baytown Fire Department
Timeline:	Short-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. Ongoing. Harris County implemented gap analysis after ITC fire. Utilize resources added as a result of the report and adding of resources.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY24	
	Proposed Action:	Develop an updated Commodity Flow Study and inventory of chemical facilities within the community to understand risk profile and implement appropriate mitigation measures.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	N/A

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Pipeline Failure, HAZMAT
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds, LEPC
Lead Agency:	Emergency Management
Support Agency:	Baytown Fire Department
Timeline:	Short-Term
Priority: (High, Medium, Low)	Medium

2025 ANALYSIS:
Completed. Commodity flow study is currently in progress. A project is grant funded and sponsored by Baytown and Chambers County LEPCs.

SECTION 19: PREVIOUS ACTIONS

		City of Baytown – Previous Action #BAY25
	Proposed Action:	Implement appropriate Water Conservation and Drought Contingency measures to mitigate drought and subsidence.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Climate Resilient

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Drought and Mass Movements
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds
Lead Agency:	Baytown Area Water Authority
Support Agency:	Public Works, Engineering, Planning, Emergency Management
Timeline:	Short-Term
Priority: (High, Medium, Low)	Low

2025 ANALYSIS:
Defer to plan update. Ongoing. Implement appropriate Water Conservation and Drought Contingency measures to mitigate drought.

SECTION 19: PREVIOUS ACTIONS

City of Baytown – Previous Action #BAY26	
Proposed Action:	Implement drainage and infrastructure improvement projects to mitigate flooding and protect residential property through the CDBG-DR Program. (Julia Ann Villa, Lincoln Cedars, East WWTP, and South Main Street, etc.).
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Structural Projects

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Flooding, Hurricanes, Severe Weather
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	High
Funding Sources:	CDBG-DR, HMA, PA
Lead Agency:	Planning
Support Agency:	Public Works, Engineering, Emergency Management
Timeline:	Long-Term
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. In progress. Projects in progress with CDBG-MIT funds.

SECTION 19: PREVIOUS ACTIONS

		City of Baytown – Previous Action #BAY27
	Proposed Action:	Actively participate in and support the implementation of the six area-wide actions identified in Volume 1 of this plan.
	BACKGROUND INFORMATION	
	Site and Location:	Citywide
	Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Public Education and Awareness Emergency Services Community Capacity Building

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Coastal erosion, Dam/levee failure, Drought, Earthquakes, Flooding, Hurricanes and coastal storms, Mass movement, Severe weather, and Wildfire
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds
Lead Agency:	City of Baytown
Support Agency:	Harris County Office of Homeland Security and Emergency Management (HCOHSEM)
Timeline:	Ongoing
Priority: (High, Medium, Low)	High

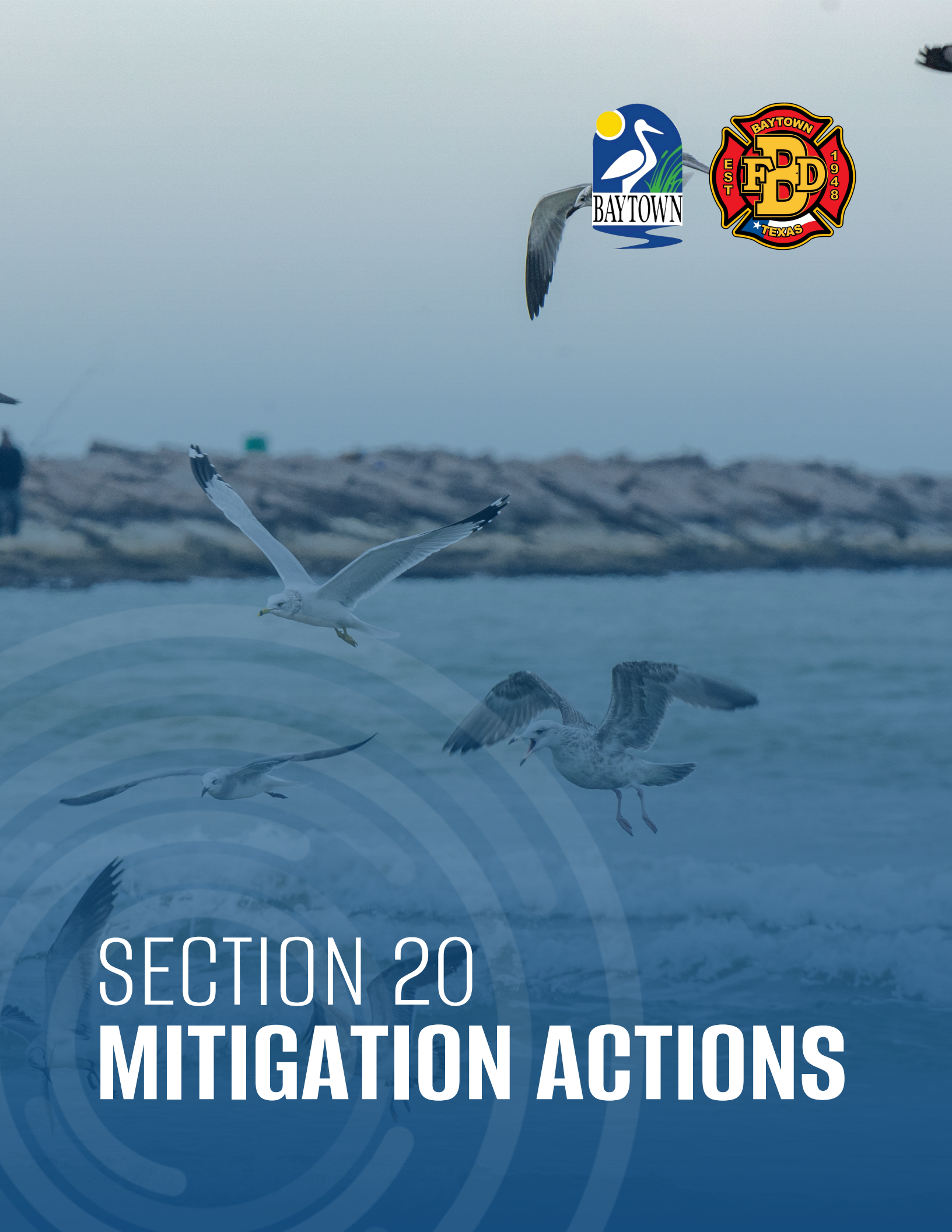
2025 ANALYSIS:
Defer to plan update. Ongoing capability. Ongoing process in the MAP cycle. Amend action to remove six and volume 1.

SECTION 19: PREVIOUS ACTIONS

	City of Baytown – Previous Action #BAY28*
Proposed Action:	Freeze protection, insultation of piping and tanks and covered structures. Winterize wastewater and water treatment, distribution, and collection facilities.
BACKGROUND INFORMATION	
Site and Location:	Citywide
Type of Action: (Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection, or Education and Awareness)	Prevention Public Education and Awareness Community Capacity Building

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	Winter Storm
Applies to New or Existing Assets:	New and Existing
Estimated Cost (High, Medium, Low):	Low
Funding Sources:	General Funds
Lead Agency:	City of Baytown
Support Agency:	N/A
Timeline:	Ongoing
Priority: (High, Medium, Low)	High

2025 ANALYSIS:
Defer to plan update. Winterize wastewater and water treatment, distribution and collection facilities. *This action was not captured in the previous actions outlines from the previous HMAP; however, it was added as it was on the annual report.



SECTION 20
MITIGATION ACTIONS

SECTION 20: MITIGATION ACTIONS

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SUMMARY

The 44 CFR § 201.6(c)(3)(ii) states that the plan must 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." The mitigation planning process is designed to help communities identify feasible and cost-effective mitigation strategies, but implementation of actions is dependent on factors such as funding, staff time, and evolving community priorities and there is no penalty for jurisdictions unable to implement projects throughout the plan's life[1].

As discussed in Section 2, at the mitigation workshop the planning team and stakeholders met to develop mitigation actions for each of the natural hazards included in the Plan Update. Each of the actions in this section were prioritized based on FEMA's Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) criteria necessary for the implementation of each action.

As part of the economic evaluation of the STAPLEE analysis, the City of Baytown analyzed each action in terms of the overall costs, measuring whether the potential benefit to be gained from the action outweighed costs associated with it. As a result of this exercise, priority was assigned to each mitigation action by marking them as High (H), Moderate (M), or Low (L). An action that is ranked as "High" indicates that the action will be implemented as soon as funding is received. A "Moderate" action is one that may not be implemented right away depending on the cost and number of citizens served by the action. Actions ranked as "Low" indicate that they will not be implemented without first seeking grant funding and after "High" and "Moderate" actions have been completed.

Within the mitigation action table, the Planning Team considered all potential funding sources that could be utilized to implement the proposed project. To ensure all potential funding resources are considered and are not limited to those sources identified within the action worksheet, please see Appendix I for a list of all available State and Federal

[1] Cost, funding sources, and implementation schedules are subject to change upon full scoping of project and grant availability.

grant programs as of 2025. The Planning Team will continue to seek out other available funding sources during the 5-year cycle as notices of funding opportunity (NOFO) are released.

All mitigation actions created by Planning Team members are presented in this section in the form of a Mitigation Action Table. More than one hazard is sometimes listed for an action, if appropriate. Actions presented in this section represent a comprehensive range of mitigation actions per current State and FEMA Guidelines, including one action, per hazard, and at least two different types.

The City of Baytown is a participant in the National Flood Insurance Program (NFIP). Flooding was identified as a significant risk for this community therefore many of the mitigation actions were developed with flood mitigation in mind. Actions related to NFIP compliance include additional narrative when deemed appropriate.

Table 20-1. City of Baytown Mitigation Action Matrix

TYPE OF ACTION	
Action #1 – Plans/Regulations (Blue)	Action #4 – Structural (Orange)
Action #2 – Education/Awareness (Red)	Action #5 – Preparedness/Response (Black)
Action #3 – Natural Systems Protections (Green)	

Jurisdiction	Coastal Erosion	Drought	Earthquake	Extreme Heat	Flood	Hail	Hurricane / Tropical Storm	Land Subsidence	Lightning	Severe Winter Storm	Thunderstorm Wind	Tornado	Wildfire
City of Baytown	●●●●●	●●●●●	●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●●	●●●●	●●●●	●●●●	●●●●	●●●●

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
1	Expand, enhance, and harden camera systems against high-winds, flooding, and power outages by retrofitting, elevating, and adding to City Traffic Camera system, city security camera systems, TranStar TXDOT camera system, PD surveillance systems, and Fire/EMS camera systems.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Structure and Infrastructure Preparedness /Response	Coastal Erosion, Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Safety/Security, Communication	Y	H	$300,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM	36 Months	Emergency Operations Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
2	Implement education and awareness program utilizing media, social media, bulletins, flyers, etc. to educate citizens of hazards that can threaten the area and mitigation measures to reduce injuries, fatalities, and property damages. Include links to weather alerts and departmental phone listings with contact personnel for residents.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Education and Awareness	Coastal Erosion, Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Communication	N/A	H	$5,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM, PWE, Public Affairs	24 Months	Emergency Management Action Plan	Promotes public safety.
3	Continue groundwater regulation to reduce the impacts of land subsidence.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Local Plans and Regulations	Land Subsidence	Safety/Security	N/A	M	$15,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE, BAWA	24 Months	Regional Groundwater Plan Regulatory Plans	N/A

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
4	Create policies or standards to protect natural landscape and plants. Support use of low-maintenance, drought and heat tolerant landscaping on city property.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure while utilizing natural landscape.	Local Plans and Regulation Natural Systems Protection	Drought, Extreme Heat, Flood	Safety/Security	N/A	M	$15,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE, PRD	24 Months	Comprehensive Plan	Promotes public safety.
5	Create codes or standards to mitigate coastal erosion to include but not limited to preservation of natural vegetation along shoreline, reduce surface runoff in all areas that will impact the shoreline or coastal bluff, and avoiding construction within 100 feet of shoreline or coastal bluff.	City-wide	Reduce the potential of natural disasters on the community by utilizing natural landscape.	Local Plans and Regulations Natural Systems Protection	Coastal Erosion	Safety/Security	N/A	H	$15,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PRD, PDS	36 Months	Comprehensive Plan	N/A

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
6	Create natural coastal erosion protection measures that include but are not limited to the use of sea walls, rip rap, beach nourishment, and dune stabilization.	City-wide	Reduce the potential of natural disasters on the community by utilizing natural environment.	Local Plans and Regulations Natural Systems Protection	Coastal Erosion	Safety/Security	N/A	H	$500,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PRD	24 Months	Comprehensive Plan	N/A
7	Create environment friendly land subsidence mitigation by developing and implementing sediment management regulations, policies, and/or plans to encourage sediment reversal by promoting the accumulation of sediment to offset subsidence and enhance resilience.	City-wide	Reduce the potential of natural disasters on the community by utilizing natural environment.	Local Plans and Regulations Natural Systems Protection	Land Subsidence	Safety/Security	N/A	H	$50,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PDS	36 Months	Comprehensive Plan	N/A

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
8	Develop and implement wetland ponds to create habitats for plant life and stormwater working in conjunction with park development projects to mitigate natural hazards impacting the local environment.	City-wide	Reduce impacts of flood through expanded greenspace and restoration of floodplains and wetlands.	Local Plans and Regulations Natural Systems Protection	Flood, Hail, Hurricane / Tropical Storm, Land Subsidence	Safety/Security, Water Systems	N/A	M	$100,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Parks Department	36-48 Months	Comprehensive Plan	Protects communities and reduces risk of flooding.
9	Create policies and standards that encourage developers to implement green infrastructure into the overall park development plan as a part of park development policies. These policies and standards could be incorporated into local policies such as the Park Dedication Policy for development of subdivisions and PIDs.	City-wide	Reduce the impacts of natural hazards utilizing the natural environment.	Local Plans and Regulations Natural Systems Protection	Flood, Hail, Hurricane / Tropical Storm	Safety/Security	N/A	M	$15,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Parks Department	48 Months	Comprehensive Plan	Protects communities and reduces risk of flooding.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
10	Establish, adopt, and implement a "green infrastructure" program for parks, nature preserves, greenbelts, etc., implementing bio-swales for parking lots and streets.	City-wide	Reduce impacts of flood through expanded greenspace and restoration of floodplains and wetlands; Reduce impacts of drought through green infrastructure that works to replenish groundwater reserves.	Local Plans and Regulations Natural Systems Protection	Drought, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm	Safety/Security	N/A	M	$10,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Parks Department	24 Months	Comprehensive Plan	Protects communities and reduces risk of flooding.
11	Develop and implement policies that encourage the inclusion of green infrastructure into City Development Projects to mitigate natural hazards.	City-wide	Reduce the impacts of natural hazards utilizing the natural environment.	Local Plans and Regulations Natural Systems Protection	Flood, Hail, Hurricane / Tropical Storm	Safety/Security	N/A	M	$15,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Parks Department, PWE, CIP	36-48 Months	Comprehensive Plan	Protects communities and reduces risk of flooding.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
12	Continue to pursue grants such projects associated nature based solutions for land conservation, habitat enhancements and restoration. This will help maintain the shoreline of our nature based facility. It may also restore some of the lost habitat along the shoreline.	City-wide	Reduce the impacts of natural hazards utilizing the natural environment.	Natural Systems Protection	Coastal Erosion	Safety/Security	N/A	M	$500,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Parks Department	24 Months	Comprehensive Plan	N/A
13	Continue to facilitate the expansion of Greenhouse Project currently under development with the Houston Port Authority. This will allow for the City to grow wetland and native species of plants to help span the restoration of shorelines.	City-wide	Reduce the impacts of natural hazards utilizing the natural environment.	Natural Systems Protection	Coastal Erosion	Safety/Security	N/A	M	$500,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Parks Department	24 Months	Comprehensive Plan	N/A

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
14	Implement a home elevation / home acquisition program to identify SRL/RL residential properties and grant funding opportunities to ensure compliance with local building codes, floodplain ordinance, and CRS requirements.	City-wide	Reduce the potential of natural disasters on structures by removing or elevating structures in the floodplain.	Structure and Infrastructure	Flood, Hurricane / Tropical Storm	Safety/Security	N/A	H	$1,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM, PWE, PDS	48 Months	Comprehensive Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.
15	Enhance and elevate generators at identified critical city facilities, utilities, and infrastructure systems by replacing end of life equipment with natural-gas powered generators.	City-wide	Provide power for critical facilities during power outages and ensure continuity of critical services.	Structure and Infrastructure	Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Energy (Power/Fuel)	Y	H	$1,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE Facilities Maintenance	36-48 Months	Emergency Management Action Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
16	Improve and harden the Baytown Emergency Operations Center to include expansion, renovation, and upgrade to sustain emergency services and core city services.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Safety/Security	Y	H	$3,000,000	CIP Budget; FEMA EOC Grant; Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM	24 Months	Capital Improvement Plan Emergency Operations Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
17	Improve and harden outdoor warning system by identifying new site locations to meet city growth, retrofitting poles to withstand higher-wind loads, and installing solar-panels to prevent power outages. Expand Community Warning System (sirens, reverse 911, Mass Notification, EAS, iPAWS, radio) to increase coverage to residents in hazard-prone areas of the community.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Structure and Infrastructure Education and Awareness Preparedness /Response	Coastal Erosion, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Safety/Security, Communication	Y	H	$500,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM	36 Months	Emergency Operations Plan Emergency Management Action Plan	Promotes public safety.

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CITY OF BAYTOWN MITIGATION ACTIONS														
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Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
18	Review and where feasible implement higher standards that incorporate disaster-resistant and hazard mitigation principles into local building codes, floodplain ordinances, and fire codes.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Safety/Security	Y	H	$125,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PDS, FD, PWE, OEM	24-36 Months	Building Codes	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

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CITY OF BAYTOWN MITIGATION ACTIONS														
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Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
19	West Texas Avenue Drainage Improvements: Improve drainage in the surrounding neighborhoods by installing new storm sewer system and stormwater detention pond, reconstructing the streets, driveways, replace sidewalks, water system and sewer system.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$4,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
20	South Main and Republic Drainage Improvements Phase I: Improve drainage in the surrounding neighborhoods by installing new storm sewer system and stormwater detention pond, reconstruct the streets, driveways, replace sidewalks, water system and sewer system.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$2,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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CITY OF BAYTOWN MITIGATION ACTIONS														
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Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
21	South Main and Republic Drainage Improvements Phase II: Improve drainage in the surrounding neighborhoods by installing new storm sewer system and stormwater detention pond, reconstruct the streets, driveways, replace sidewalks, water system and sewer system.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$2,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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22	Danubina Area Drainage System Improvements: Improve drainage in the surrounding neighborhoods by installing new storm sewer system and stormwater detention pond, The project will be completed in three phases. Phase I is planned for the project to be completed with a Harris County Flood Control Partnership grant. Phase II of the project will improve the drainage in the neighborhoods south of the trunkline constructed in phase one. Phase III of the project will improve the drainage in the neighborhoods north of the trunkline constructed in Phase I.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$63,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
23	West Baytown Drainage Improvements: Improve drainage in the surrounding neighborhoods by installing new storm sewer system and stormwater detention pond. Phase I has been submitted as a partnership grant with Harris County Pct 2 for $7,100,000 for the main trunkline into the neighborhood. Phase II would be to install all the lateral lines into the neighborhood streets.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$17,500,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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24	San Jacinto Regional Detention Drainage: Construction regional detention ponds to allow for the development according to the San Jacinto Overlay District.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$7,500,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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25	IH-10 Lift Station #1 Improvements: Rehabilitate and upsize current lift station that serves the Northwest Baytown growth and development. Project will consist of adding security grade fencing, upgrading current pumps, and force main to carry sanitary sewer to West District WWTP.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$33,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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26	Lannie Lift Station Improvements Project: Lannie Lift station pumps serve the west Chambers County service area but needs to be upgraded/upsized prior to taking any additional flow. This project will also include the creation of a Strategic Plan for the Northeast and East WWTP service areas to plan for future demands on the wastewater system. It also includes the creation of a hydraulic model for all four WWTP service areas to identify sources of Inflow and Infiltration (I&I) and potential solutions.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$11,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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27	Texas Avenue Lift Station Improvements: Texas Ave. Lift Station currently serves Baytown's Central WWTP service area and has difficulty servicing the area during rain events. This project would consist of replacing current electrical, backup generator, piping, security grade fencing, valves, and pumps at this lift station to appropriately serve the central service area.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$12,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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28	Abbe Addition Lift Station: The Abbe Lift Station (previously Cedar Bayou Community) experiences surcharging and high flows due to inflow and infiltration during wet weather events. The lift station needs to be upsized and rehabilitated to provide better service to the area and to reduce overflows during rain events and major tropical storms. Project will consist of adding security grade fencing, upgrading current pumps, and necessary gravity and force mains.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$2,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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29	Dykes Lift Station: Rehabilitate and upsize current lift station.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$250,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
30	Staples Lift Station: Rehabilitate and upsize current lift station.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$100,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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CITY OF BAYTOWN MITIGATION ACTIONS														
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31	Cedar Landing Lift Station: Rehabilitate and upsize current lift station.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$150,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.

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CITY OF BAYTOWN MITIGATION ACTIONS														
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32	IH-10 Lift Station #2 Force Main and Gravity System Improvements: This project includes improvements to I-10 Lift Station No. 2 to reduce sanitary sewer overflows and allow for development in the area. The upstream gravity pipe and downstream force main are also required to be increased in size to meet capacity requirements. This would reduce sanitary sewer overflows and allow for future development.	City-wide	Reduce the potential of natural disasters on critical facilities and infrastructure.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security, Water Systems	Y	H	$36,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	48-60 Months	Master Drainage Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents. Helps ensure critical facilities continue to provide services during extreme weather events.
33	Where appropriate, support retrofitting, purchase or relocation of structures located in hazard areas, prioritizing those that have experienced repetitive losses and/or are located in high- or medium-risk hazard areas.	City-wide	Manage new and existing development in high hazard areas, especially those known to be repetitively damaged.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security	Y	M	$1,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	60 Months	Emergency Management Action Plan Capital Improvement Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

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34	Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including Capital Improvement Programs, Master Plans, and Strategic Plans.	City-wide	Advance community resilience through preparation, adoption, and implementation of state, regional and local multi-hazard mitigation plans and projects.	Local Plans and Regulations	Coastal Erosion, Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Tornado, Wildfire, Human-Caused Hazards	Safety/Security	Y	M	$15,000	Staff Time, Local Budget	City of Baytown OEM	12-24 Months	Capital Improvement Plan Master Plans Strategic Plans	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

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Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
35	Actively participate in the plan maintenance protocols outlined in Section 21 of this hazard mitigation plan.	City-wide	Advance community resilience through preparation adoption, and implementation of state, regional and local multi-hazard mitigation plans and projects.	Preparedness /Response	Coastal Erosion, Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Human-Caused Hazards	Safety/Security	Y	M	$10,000	Staff Time, Local Budget	City of Baytown OEM, PWE	12-24 Months	Capital Improvement Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

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**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
36	Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: - Enforce the flood damage prevention ordinance. - Participate in floodplain identification and mapping updates. - Provide public assistance/information on floodplain requirements and impacts.	City-wide	Provide access to flood insurance for local residents; Reduce flood risk and build resiliency.	Education and Awareness	Flood, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security	Y	H	$10,000	Staff Time, Local Budget	City of Baytown PWE	24-36 Months	Floodplain Ordinance	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
37	Create 75 Stormwater Retention Ponds to increase storage capacity as identified in Master Drainage Plan.	City-wide	Reduce flood risk through improved drainage capacity; Reduce risk of damages and injuries; Reduce emergency response demands.	Structure and Infrastructure	Flood, Hurricane / Tropical Storm, Thunderstorm Wind	Safety/Security	Y	M	$10,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	60 Months	Stormwater Management Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.
38	Elevate Electronic Controls for Sewer Lift Stations 24" above 500-year NFIP Floodplain.	City-wide	Reduce risk of flood water contamination; Reduce risk of surface water infiltration and sewage backup; Ensure continuity of critical services.	Structure and Infrastructure	Flood, Hurricane / Tropical Storm, Thunderstorm Wind	Safety/Security	Y	H	$2,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	60 Months	Capital Improvement Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
39	Install Weather Stations with early warning lightning detection systems for critical infrastructure (EOC, 911 Communications, and Pirates Bay Water Park, Fire SOCO).	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Education and Awareness Structure and Infrastructure	Lightning, Thunderstorm Wind, Tornado	Safety/Security, Communication	Y	H	$1,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown City Departments	60 Months	Emergency Management Action Plan	N/A
40	Identify city facilities that require city carports and city vehicle shelters to be constructed of materials and processes to mitigate against hail damages to equipment currently parked in the open.	City-wide	Support the protection, strengthening or replacement of buildings, infrastructure.	Structure and Infrastructure	Hail, Hurricane / Tropical Storm, Severe Winter Weather, Thunderstorm Wind, Tornado	Safety/Security	Y	L	$1,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE Facilities Maintenance	60 Months	Capital Improvement Plan	N/A

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
41	Develop a Community Urban Wildfire Prevention Program to educate citizens on how to reduce damages to residential property from wildfires.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Education and Awareness	Wildfire	Safety/Security, Communication	Y	L	$150,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown FD	48-60 Months	CWPP	N/A
42	Develop public education program for home owners on flood hazards and flood mitigation techniques to reduce flood damages to property.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Education and Awareness	Flood, Hail, Hurricane / Tropical Storm	Safety/Security, Communication	Y	M	$20,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM, PWE	36-48 Months	Floodplain Ordinance	Promotes public safety.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
43	Improve Underperforming Stormwater System Collection/Conveyance Components to ensure system functions in accordance with design to mitigate flooding; including installation of submersible pumps.	City-wide	Reduce flood risk through improved drainage capacity; Reduce risk of damages and injuries; Reduce emergency response demands.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm	Safety/Security	Y	H	$1,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	60 Months	Stormwater Management Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.
	Notes: S Main drainage Phase I complete. Phase II is in design. Texas Ave funded with CDBG-MIT													
44	Improve City of Baytown CRS Classification from Class 5 to Class 4.	City-wide	Reduce flood insurance premiums for local residents; Reduce flood risk and build resiliency.	Preparedness /Response	Flood, Hurricane / Tropical Storm	Safety/Security	Y	M	$50,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	36-48 Months	Capital Improvement Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
45	Convert Water Treatment Plant from Surface Water to Desalination Source.	City-wide	Promote disaster resistant development.	Natural Systems Protection Structure and Infrastructure	Drought	Safety/Security	Y	H	$15,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE, BAWA	60 Months	Drought Contingency Plan Capital Improvement Plan	N/A
46	Install lightning and surge protection measures for critical infrastructure.	City-wide	Reduce damages at critical facilities; Ensure continuity of critical services during and after event.	Structure and Infrastructure	Earthquake, Flood, Hail, Hurricane / Tropical Storm, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire	Safety/Security	Y	L	$250,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE Facilities Maintenance	24-36 Months	Emergency Management Action Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
47	Implement hazard fuel reduction and fire prevention measures such as clean-up and debris removal of abandoned buildings, abandoned lands, etc.	City-wide	Reduce risk of wildfires and the spread of wildfire through targeted fuels reduction programs.	Local Plans and Regulations	Wildfire	Safety/Security	Y	L	$50,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown FD, Planning	24 Months	CWPP	N/A
48	Develop/implement home heating safety public education/outreach program to inform residents on how to reduce damages from winter storms to residential property.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Education and Awareness	Severe Winter Weather	Safety/Security, Communication	Y	L	$15,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown FD	24 Months	Emergency Management Action Plan	N/A

SECTION 20: MITIGATION ACTIONS

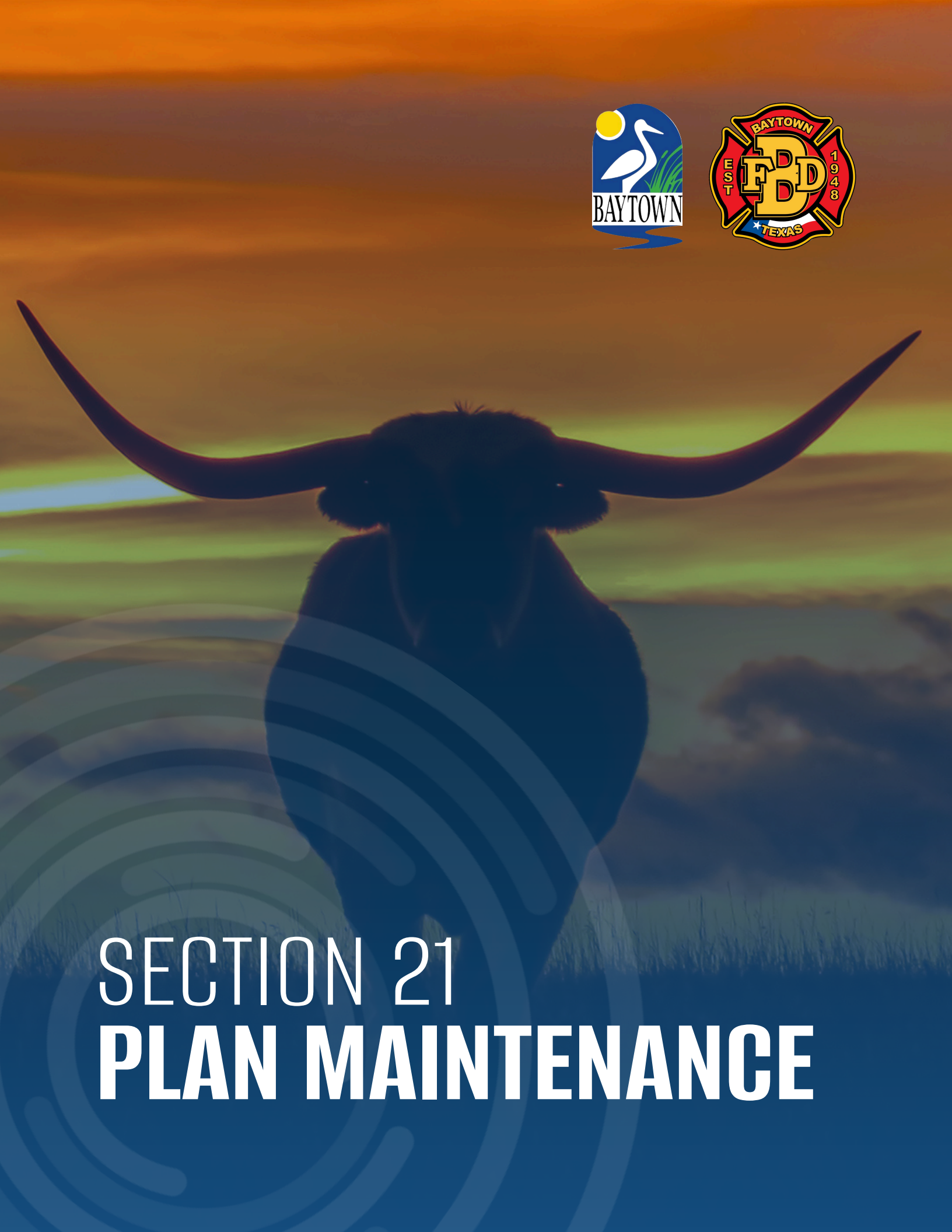
CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
49	Enhance air monitoring capabilities to mitigate chemical releases and exposures.	City-wide	Promote hazard awareness and protect citizens from potential injuries and damages.	Natural Systems Protection Preparedness /Response	Human-Caused Hazards	Safety/Security, Hazardous Materials	Y	H	$150,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown OEM, LEPC, FD HAZMAT	60 Months	Transportation Plan	N/A
50	Implement appropriate Water Conservation and Drought Contingency measures to mitigate drought and subsidence.	City-wide	Reduce damages at critical facilities.	Natural Systems Protection	Drought, Land Subsidence	Safety/Security	Y	L	$150,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE, BAWA	60 Months	Drought Contingency Plan	N/A

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
51	Implement drainage and infrastructure improvement projects to mitigate flooding and protect residential property through the CDBG-DR Program. (Julia Ann Villa, Lincoln Cedars, East WWTP, and South Main Street, etc.)	City-wide	Reduce damages caused by flooding by maintaining or restoring drainage capacity.	Structure and Infrastructure	Flood, Hail, Hurricane / Tropical Storm, Severe Winter Storm	Safety/Security	Y	H	$15,000,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown Planning, PWE	60 Months	Capital Improvement Plan	Protects communities and reduces risk of flooding.
	Notes: Projects in progress with CDBG-MIT funds.													
52	Actively participate in and support the implementation of the area-wide actions identified in this plan.	City-wide	Advance community resilience through preparation, adoption, and implementation of state, regional and local multi-hazard mitigation plans and projects.	Preparedness /Response	Coastal Erosion, Drought, Earthquake, Extreme Heat, Flood, Hail, Hurricane / Tropical Storm, Land Subsidence, Lightning, Severe Winter Storm, Thunderstorm Wind, Tornado, Wildfire, Cyber Attack, Human-Caused Hazards	Safety/Security	Y	H	$15,000	Staff Time, Local Budget	City of Baytown	60 Months	Capital Improvement Plan	Protects infrastructure, reduces cost of reparation, and prevents injury to residents.

SECTION 20: MITIGATION ACTIONS

CITY OF BAYTOWN MITIGATION ACTIONS														
**Reduces risk to new and/or existing buildings and infrastructure*														
Action #	Proposed Action	Site	Benefit	Action Type	Hazards	Community Lifeline	Infra.*	Priority (High, Mod., Low)	Cost	Potential Funding Sources	Lead Agency	Timeline	Existing Plans	NFIP / CRS
53	Freeze protection, insultation of piping and tanks and covered structures. Winterize wastewater and water treatment, distribution, and collection facilities.	City-wide	Reduce damages at critical facilities; Ensure continuity of critical services during and after event.	Structure and Infrastructure	Severe Winter Storm	Safety/Security	Y	H	$100,000	Local Budget; State Grants (GLO, TAMFS, TDA, TDEM, TWDB, TXDOT); Federal Grants (FEMA HMA Grants, CDBG, CDC, DOH, EDA, EPA, HUD, NFIP, NFWF, NOAA, NRCS, SBA, USACE, USDA, USFS, USFWS)	City of Baytown PWE	24 Months	Emergency Management Action Plan	N/A



SECTION 21
PLAN MAINTENANCE

SECTION 21: PLAN MAINTENANCE

Plan Maintenance Procedures....1
Incorporation....1
Process of Incorporation....1
Monitoring and Evaluation....4
Monitoring....5
Evaluation....5
Updating....6
Plan Revisions....6
Five (5) Year Review....6
Continued Public Involvement....7

PLAN MAINTENANCE PROCEDURES

The following is an explanation of how the City of Baytown and the general public will be involved in implementing, evaluating, and enhancing the Plan over time. When the plan is discussed in all maintenance procedures it includes mitigation actions and hazard assessments. The sustained hazard mitigation planning process consists of four main parts:

- Incorporation
- Monitoring and Evaluation
- Updating
- Continued Public Involvement

INCORPORATION

The City of Baytown will be responsible for further development and implementation of mitigation actions. Each action has been assigned to a specific department within the city. The following describes the process by which the city will incorporate elements of the mitigation plan into other planning mechanisms.

PROCESS OF INCORPORATION

Once the Plan Update is adopted, the City of Baytown will implement actions based on priority and the availability of funding. The city currently implements policies and programs to reduce loss to life and property from hazards. The mitigation actions

developed for this Plan Update enhance this ongoing effort and will be implemented through other program mechanisms where possible.

The potential funding sources listed for each identified action may be used when the City seeks funds to implement actions. An implementation time period or a specific implementation date has been assigned to each action as an incentive for completing each task and gauging whether actions are implemented in a timely manner.

The City of Baytown will integrate implementation of their mitigation actions with other plans and policies such as construction standards and emergency management plans, and ensure that these actions, or proposed projects, are reflected in other planning efforts. Coordinating and integrating components of other plans and policies into goals and objectives of the Plan Update will further maximize funding and provide possible cost-sharing of key projects, thereby reducing loss of lives and property and mitigating hazards affecting the area.

Upon formal adoption of the Plan Update, Planning Team members will work to integrate the hazard mitigation strategies into other plans and codes as they are developed. Participating team members will conduct periodic reviews of plans and policies, once per year at a minimum, and analyze the need for revisions in light of the approved Plan. The planning team will review the comprehensive plan, capital improvement plan, annual budget reviews, emergency operations plan, and transportation plans, among others, to guide and control development. The City will ensure that capital improvement planning in the future will also contribute to the goals of this Hazard Mitigation Plan Update to reduce the long-term risk to life and property from all hazards. Within one year of formal adoption of the Hazard Mitigation Plan Update, existing planning mechanisms will be reviewed by each jurisdiction.

The City of Baytown is committed to implementing their mitigation actions. Planning team members will review and revise, as necessary, the long-range goals and objectives in strategic plan and budgets to ensure that they are consistent with this mitigation action plan. Additionally, the team will work to advance the goals of this hazard mitigation plan through its routine, ongoing, long-range planning, budgeting, and work processes.

Table 21-1 identifies types of planning mechanisms and examples of methods for incorporating the Plan Update into other planning efforts. The team members, listed in Table 21-2 below, will be responsible for the review of these planning mechanisms and their incorporation of the plan, with the exception of the Floodplain Management Plans;

the Floodplain Administrator on staff will be responsible for incorporating the plan when floodplain management plans are updated, or new plans are developed.

Table 21-1. Methods of Incorporation of the Plan

PLANNING MECHANISM	DEPARTMENT / TITLE RESPONSIBLE	INCORPORATION OF PLAN
Annual Budget Review	**Emergency Management**: Emergency Management Coordinator	Various departments and key personnel that participated in the planning process will review this Plan Update and mitigation actions therein when conducting their annual budget review. Allowances will be made in accordance with grant applications sought, and mitigation actions that will be undertaken, according to the implementation schedule of the specific action.
Capital Improvement Plan	**Public Works and Engineering Department**: Assistant Director	Prior to any revisions to the Capital Improvement Plan (CIP), City departments will review the risk assessment and mitigation strategy sections of this Plan Update, as limiting public spending in hazardous zones is one of the most effective long-term mitigation actions available to local governments.
Community Wildfire Protection Plan	**Emergency Management**: Emergency Management Coordinator	Community Wildfire Protection Plans (CWPPs) include preventative and corrective actions to address a community's risk of damage from wildfire. Information found in Section 17 of this Plan Update discussing the people and property at risk to wildfire will be reviewed and revised when the City of Baytown updates their CWPP.

SECTION 21: PLAN MAINTENANCE

PLANNING MECHANISM	DEPARTMENT / TITLE RESPONSIBLE	INCORPORATION OF PLAN
Comprehensive Plan	**Planning and Development Services**: Assistant Director	The City of Baytown has a Comprehensive Plan in place. Since comprehensive plans involve developing a unified vision for a community, the mitigation vision and goals of the Plan Update will be reviewed in the revision of the Comprehensive Plan.
Floodplain Management Plan	**Public Works and Engineering Department**: Assistant Director / Floodplain Administrator	Floodplain management plans include preventative and corrective actions to address the flood hazard. Therefore, the actions for flooding and information found in Section 9 of this Plan Update discussing the people and property at risk to flood, will be reviewed and revised when updating the flood management plan.
Grant Applications	**Emergency Management**: Emergency Management Coordinator	This Plan Update will be evaluated when grant funding is sought for mitigation projects. If a project is not in the Plan Update, a Plan Revision may be necessary to include the action in the Plan.
Regulatory Plans	**Emergency Management**: Emergency Management Coordinator	Currently, the City of Baytown has regulatory plans in place, such as a Drought Contingency Plan, Land Use Plan, and Evacuation Plan. The Plan Update will be consulted when departments review or revise their current regulatory planning mechanisms, or in the development of regulatory plans that are not currently in place.

MONITORING AND EVALUATION

Periodic revisions of the Plan are required to ensure that goals, objectives, and mitigation actions are kept current. When the plan is discussed in these sections, it includes the risk assessment and mitigation actions as a part of the monitoring, evaluating, updating and review process. Revisions may be required to ensure the Plan is in compliance with federal and state statutes and regulations. This section outlines the procedures for

completing Plan revisions, updates, and review. Table 21-2 indicates the department and title of the party responsible for Plan monitoring, evaluating, updating, and review of the Plan.

Table 21-2. Team Members Responsible for Plan Monitoring, Evaluating, Updating, and Review of the Plan

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Emergency Management	Emergency Management Coordinator
City of Baytown – Emergency Management	Deputy Emergency Management Coordinator

MONITORING

Designated Planning Team members are responsible for monitoring, evaluating, updating, and reviewing the Plan, as shown in Table 21-2. Individuals holding the title listed in Table 21-2 will be responsible for monitoring the Plan on an annual basis. Plan monitoring includes reviewing and incorporating into the Plan other existing planning mechanisms that relate or support goals and objectives of the Plan; monitoring the incorporation of the Plan into future updates of other existing planning mechanisms as appropriate; reviewing mitigation actions submitted and coordinating with various departments to determine if mitigation actions need to be re-evaluated and updated; evaluating and updating the Plan as necessary; and monitoring plan maintenance to ensure that the process described is being followed, on an annual basis, throughout the planning process. The Planning Team will develop a brief report that identifies policies and actions in the plan that have been successfully implemented and any changes in the implementation process needed for continued success. A summary of meeting notes will report the particulars involved in developing an action into a project. In addition to the annual monitoring, the Plan will be similarly reviewed immediately after extreme weather events include but not limited to state and federally declared disasters.

EVALUATION

As part of the evaluation process, the Planning Team will assess changes in risk; determine whether the implementation of mitigation actions is on schedule; determine whether there are any implementation problems, such as technical, political, legal, or coordination issues; and identify changes in land development or programs that affect mitigation priorities for each respective department or organization.

SECTION 21: PLAN MAINTENANCE

The Planning Team will meet on an annual basis to evaluate the Plan and identify any needed changes and assess the effectiveness of the plan achieving its stated purpose and goals. The team will evaluate the number of mitigation actions implemented along with the loss-reduction associated with each action. Actions that have not been implemented will be evaluated to determine if any social, political, or financial barriers are impeding implementation and if any changes are necessary to improve the viability of an action. The team will evaluate changes in land development and/or programs that affect mitigation priorities. The annual evaluation process will help to determine if any changes are necessary. In addition, the Plan will be similarly evaluated immediately after extreme weather events including but not limited to state and federally declared disasters.

UPDATING

PLAN REVISIONS

At any time, minor technical changes may be made to update the City of Baytown Hazard Mitigation Action Plan Update 2025. Material changes to mitigation actions or major changes in the overall direction of the Plan or the policies contained within it, must be subject to formal adoption by the city.

The City of Baytown will review proposed revisions and vote to accept, reject, or amend the proposed change. Upon ratification, the Revision will be transmitted to the Texas Division of Emergency Management (TDEM).

In determining whether to recommend approval or denial of a Plan Revision request, the City will consider the following factors:

- Errors or omissions made in the identification of issues or needs during the preparation of the Plan Update;
- New issues or needs that were not adequately addressed in the Plan Update; and
- Changes in information, data, or assumptions from those on which the Plan Update was based.

FIVE (5) YEAR REVIEW

The Plan will be thoroughly reviewed by the Planning Team at the end of three years from the approval date, to determine whether there have been significant changes in the planning area that necessitate changes in the types of mitigation actions proposed. Factors that may affect the content of the Plan include new development in identified

hazard areas, increased exposure to hazards, disaster declarations, increase or decrease in capability to address hazards, and changes to federal or state legislation.

The Plan review process provides the City of Baytown an opportunity to evaluate mitigation actions that have been successful, identify losses avoided due to the implementation of specific mitigation measures, and address mitigation actions that may not have been successfully implemented as assigned.

It is recommended that the full Executive and Advisory Planning Team (Section 2, Tables 2-1 and 2-2) meet to review the Plan at the end of three years because grant funds may be necessary for the development of a five-year update. Reviewing planning grant options in advance of the five-year Plan update deadline is recommended considering the timelines for grant and planning cycles can be in excess of a year.

Following the Plan review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and Plan Revision process outlined herein. Upon completion of the review, update, and revision process the revised Plan will be submitted to TDEM for final review and approval in coordination with FEMA.

CONTINUED PUBLIC INVOLVEMENT

Public input was an integral part of the preparation of this Plan and will continue to be essential for Plan updates. The Public will be directly involved in the annual evaluation, monitoring, reviews and cyclical updates. Changes or suggestions to improve or update the Plan will provide opportunities for additional public input.

The public can review the Plan on the City of Baytown's website, where officials and the public are invited to provide ongoing feedback, via email.

The Planning Team may also designate voluntary citizens from the planning area or willing stakeholder members from the private sector businesses that were involved in the Plan's development to provide feedback on an annual basis. It is important that stakeholders and the immediate community maintain a vested interest in preserving the functionality of the planning area as it pertains to the overall goals of the mitigation plan. The Planning Team is responsible for notifying stakeholders and community members on an annual basis and maintaining the Plan.

Media, including local newspaper and radio stations, will be used to notify the public of any maintenance or periodic review activities during the implementation, monitoring, and evaluation phases. Additionally, local news media will be contacted to cover

information regarding Plan updates, status of grant applications, and project implementation. Local and social media outlets, such as Facebook and Instagram, will keep the public and stakeholders apprised of potential opportunities to fund and implement mitigation projects identified in the Plan.



APPENDIX A
HUMAN-CAUSED HAZARDS

APPENDIX A: HUMAN-CAUSED HAZARDS

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Hazard Profiles, Vulnerability, and Impact 2
Aviation Accident 3
Cyber Attack 6
Disruption of Services 14
Hazardous Materials (Fixed and Mobile) 18
Infectious Disease 31
Terrorism 44

OVERVIEW

During the early stages of the planning process the Planning Team analyzed a broad range of hazards that had the potential to impact the planning area. This comprehensive review included human-caused and technological hazards including Aviation Accident, Cyber Attack, Disruption of Services, Hazardous Materials, Infectious Disease, and Terrorism, which are profiled in this appendix.

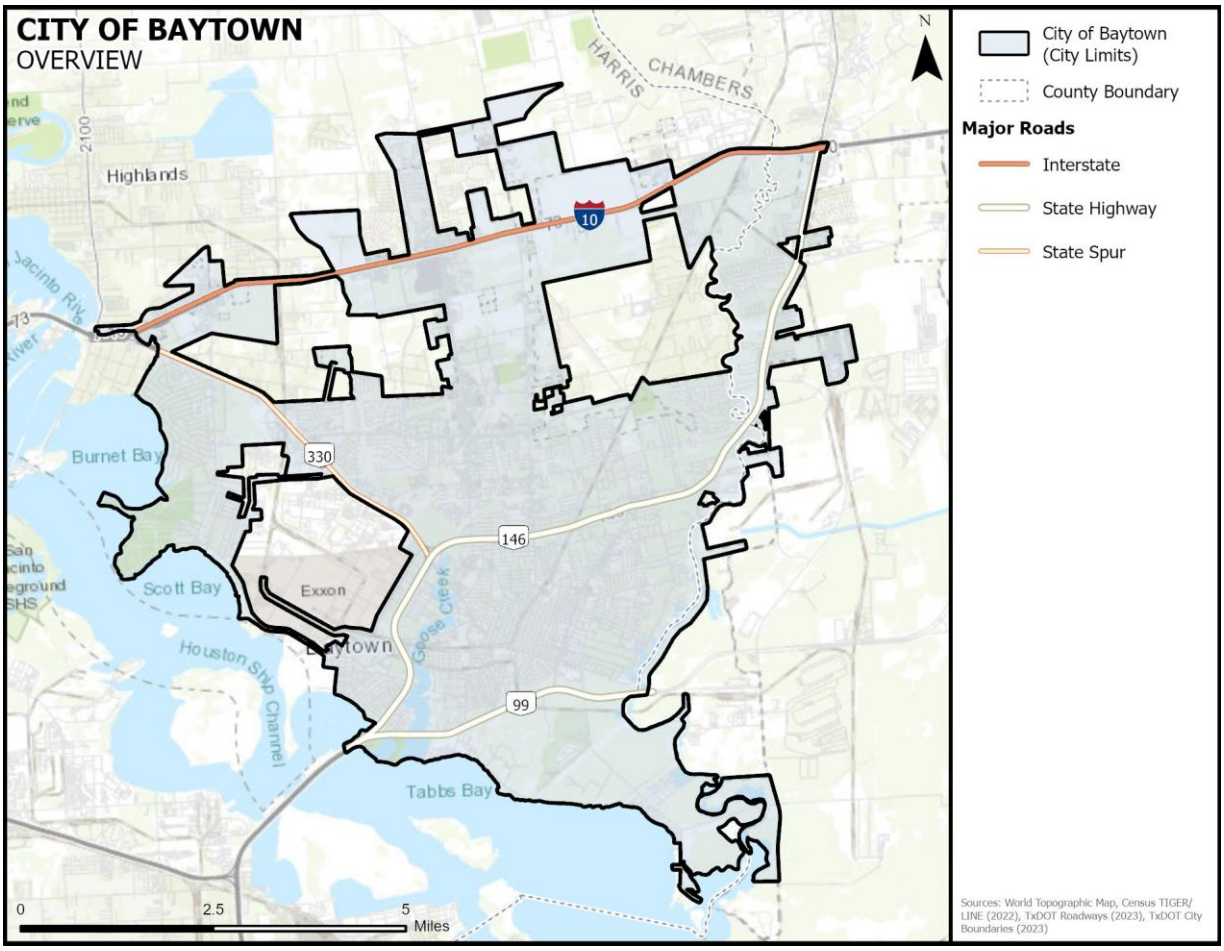
The analysis herein includes a description of each hazard along with the City of Baytown's overall vulnerability to that hazard. Annualized loss data is provided where available and impact is addressed looking at the warning time or potential speed of onset of the hazard, where appropriate. The Planning Team provided data regarding the human-caused and technological hazards included, and all available data was incorporated where applicable.

STUDY AREA DEFINITION

All areas of the City of Baytown are included. Figure A-1 shows the study area for the City of Baytown Hazard Mitigation Action Plan Update 2025.

APPENDIX A: HUMAN-CAUSED HAZARDS

Figure A-1. City of Baytown Study Area



HAZARD PROFILES, VULNERABILITY, AND IMPACT

For each of the human-caused and technological hazards, a description of the hazard and the City of Baytown's overall vulnerability to that hazard was developed. Impact is addressed looking at the warning time or potential speed of onset of the hazard. Impact statements are defined in Table A-1 below.

Table A-1. Impact Statements

POTENTIAL SEVERITY	DESCRIPTION
Substantial	Multiple deaths. Complete shutdown of facilities for 30 days or more. More than 50 percent of property destroyed or with major damage.
Major	Injuries and illnesses resulting in permanent disability. Complete shutdown of critical facilities between one and four

POTENTIAL SEVERITY	DESCRIPTION
	weeks. More than 25 percent of property destroyed or with major damage.
Minor	Injuries and illnesses do not result in permanent disability. Complete shutdown of critical facilities for up to one week. More than 10 percent of property destroyed or with major damage.
Limited	Injuries and illnesses are treatable with first aid. Shutdown of critical facilities and services for 24 hours or less. Less than 10 percent of property destroyed or with major damage.

The term "technological hazards" refers to incidents that usually originate from technological malfunctions, structural failure, industrial accidents, negligence, and certain human activities. Some examples of technological hazards include aviation accidents, internet outages, communications and computer failure, power and water outages, and radiological release. The use of hazardous materials across all industries is a technological hazard, as well as water contamination and acts of terrorism.

The scope of this risk assessment assumes that hazardous material incidents addressed in this section would be accidental in nature and that their consequences are unplanned and unintended.

AVIATION ACCIDENT

HAZARD DESCRIPTION

An aviation accident is defined as an occurrence associated with the operation of an aircraft that takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

- A person is fatally or seriously injured;
- The aircraft sustains damage or structural failure;
- The aircraft is missing or is completely inaccessible.

Air transportation accidents can occur under four conditions:

- A mid-air collision between an airliner and another aircraft;
- A crash during the cruise phase of a flight caused by mechanical issues, sabotage, or other factors;
- A crash while taking off or landing;

- A ground collision between two or more airliners during staging or taxiing.

LOCATION

The City of Baytown is within a short distance of some major airports, making it prone to aviation accidents. The George Bush Intercontinental Airport (IAH) and William P. Hobby Airport (HOU) provide passenger and cargo operations. In addition, Ellington Airport (EFD) supports civilian and military aviation operations. Ellington Airport is also a spaceport, providing support for NASA and aerospace operations. The Baytown Airport is a public use airport located near the business district of the City. These airports play a critical role in the movement of people, goods, and hazardous materials. There is no geographic boundary to aviation accidents, and one may occur anywhere within the City of Baytown planning area.

EXTENT

Aviation accidents can vary widely in severity, ranging from minor incidents with no injuries to catastrophic crashes with significant loss of life and property. Minor accidents often involve issues such as hard landings, minor runway overruns, or ground collisions during taxiing, typically resulting in minimal injuries and limited aircraft damage. However, more severe accidents can occur during critical phases of flight, such as takeoff, landing, or cruising at high altitudes. These accidents may involve mechanical failures, human errors, adverse weather conditions, or intentional acts of terrorism, leading to substantial damage.

An aircraft accident in the City could have significant impacts. The magnitude and intensity of an accident varies depending on the size of the plane, and where it may land. In the case where a large commercial airplane crash lands into a highly populated area, it would lead to significant loss of life and property.

HISTORICAL OCCURRENCES

There are no previous significant aviation accidents known or recorded with the City of Baytown planning area. According to local news articles, one minor incident occurred on July 8, 2014. A Cessna 172 crashed shortly after takeoff from Baytown Airport due to engine failure. The aircraft struck a power line, flipped over, and landed on a baseball field in Walter L. Jenkins Park. The pilot, his wife, and an 8-year-old boy were seriously injured but survived.[1]

[1] Source: https://abc13.com/baytown-park-plane-crash-landing-jenkins/166721/

Another incident occurred on June 23, 2023. A small plane experienced engine failure while attempting to land at Baytown Airport. The pilot conducted an emergency landing in a field north of the airport on Barkaloo Road. The pilot sustained minor injuries and was taken to a local hospital.[2]

PROBABILITY OF FUTURE EVENTS

Aviation is held to stringent safety regulations, advanced technology, rigorous pilot training, and thorough maintenance practices. There is some potential for an aviation accident to occur anywhere and at any time. However, based on historical occurrences and best available data, it is "Unlikely" for a major aviation accident to occur in the planning area in the next ten years. Major aviation accidents involving severe damage, loss of life, or catastrophic crashes are exceedingly rare.

CLIMATE CHANGE CONSIDERATIONS

The frequency and intensity of extreme weather events such as thunderstorms, heatwaves, hurricanes, and heavy precipitation are increasing with climate change. These conditions can disrupt flight operations, making takeoffs, landings, and in-flight navigation more hazardous. Furthermore, rising sea levels and increased flooding threaten coastal airports and their infrastructure, potentially disrupting navigation systems, runways, and emergency response capabilities.

There is some recent research that indicates the severity and frequency of clear-air turbulence is increasing due to climate change as warming temperatures strengthen wind shear in the jet streams. However, more research is needed to fully understand the impact of climate change of the occurrence and severity of aviation accidents.

VULNERABILITY AND IMPACT

There are no defined geographic boundaries for aviation accidents. All populations, buildings, critical facilities, and infrastructure within the City of Baytown planning area are considered exposed to potential aviation accidents and could be affected. There is often little to no warning time for these events.

While all structures are technically at risk, certain facilities may be more vulnerable due to their proximity to airports and areas with high air traffic. Critical infrastructure such as power plants, water treatment facilities, and communication networks could be

[2] Source: https://www.fox26houston.com/news/plane-crashes-in-baytown-field-experienced-engine-failure-officials-say

impacted if an aircraft accident occurs nearby, potentially leading to service disruptions. Airports themselves are high-traffic areas where the risk of accidents is inherently higher. Additionally, densely populated areas, schools, hospitals, and industrial sites near flight corridors may face increased exposure to potential impacts.

Similarly, some individuals may also be considered vulnerable to aviation accidents due to their proximity to airports or flight paths. This includes residents living near airports and employees working in airport facilities. Although there may be no history of significant local aviation accidents, all assets and facilities remain potentially at risk of damage, which could range from minor to severe.

While incidents are exceedingly rare, the severity of impact from an aviation accident can be "Substantial," potentially resulting in multiple casualties, the complete shutdown of critical facilities for 30 days or more, and significant damage to more than 50 percent of affected properties.

CYBER ATTACK

HAZARD DESCRIPTION

A cyber-attack is any type of offensive maneuver employed by individuals or organizations that target computer information systems, infrastructures, computer networks, and personal computer devices by various malicious acts. The malicious act usually originates from an anonymous source that either steals, alters, or destroys a specified target by hacking into a susceptible system.



Cyberspace and its underlying infrastructure are vulnerable to a wide range of risk including both physical and cyber threats and hazards. Sophisticated cyber actors and nation-states exploit vulnerabilities to steal information and money and can develop capabilities to disrupt, destroy, or threaten the delivery of essential services. Various crimes are perpetrated through cyberspace including the production and distribution of child pornography and child exploitation conspiracies, banking and financial fraud, intellectual property violations, and other crimes, all of which have substantial human and economic consequences.

Cyberspace is particularly difficult to secure from cyber-attack events, due to a number of factors including the ability of malicious actors to operate from anywhere in the world, the links between cyberspace and physical systems, and the difficulty of reducing vulnerabilities and consequences in complex cyber networks. Of growing concern is the cyber threat to critical infrastructure, which is increasingly subject to sophisticated cyber intrusions that pose new risks. As information technology becomes increasingly integrated with physical infrastructure operations, there is increased risk for wide scale or high-consequence events that could cause harm or disrupt services upon which our economy and the daily lives of millions of Americans depend. In light of the risk and potential consequences of cyber events, strengthening the security and resilience of cyberspace has become an important homeland security mission.[3]

The City of Baytown takes steps to safeguard the integrity of its data and to prevent unauthorized access to information that is maintained in their computer systems. These include actions such as conducting background checks for all new employees and providing training to all system users on information security, acceptable use policies, social engineering awareness, and incident notification procedures. These measures are designed and intended to prevent corruption of data, block unauthorized access, and to ensure the integrity of information. Additionally, the city maintains a Cyber Incident Annex as part of its Emergency Operations Plan (EOP), which outlines protocols for preparing for, responding to, recovering from, and mitigating cyber threats to ensure the continuity of operations and the protection of critical systems. This section reviews the hazards to the cybersecurity assets for the City of Baytown planning area.

Types of Cyber Attacks include the following.

Denial of Service Attacks: A denial of service attack (DoS) is the attempt to make a computer or network resource unavailable to its intended users. A DoS attack may come from one or several computers, while a distributed denial of service attack (DDoS) will be launched from many, often thousands of computers. While DoS attacks may occur frequently and typically can be handled by the City's equipment, a DDoS attack can overload the City of Baytown's network or computer resources resulting in extended downtime. Often these attacks rely on lower-level network vulnerabilities.

Data Loss / Leakage: Data loss can result from a variety of reasons, both intentional and unintentional. Data loss may result from a failure to properly backup or have disaster

[3] Source: Department of Homeland Security

recovery equipment and processes, employees improperly handling sensitive data, and criminal activities such as espionage, theft, sabotage, and other malicious acts.

Infrastructure Loss / Failure: Loss of computer and network resources may result from a variety of natural and human-caused disasters including tornadoes, hurricanes, and explosions due to accidents, power loss, terrorism, and fire.

Insider Threats: Insider threats are malicious threats to the planning area that come from City of Baytown employees, contractors, and volunteers who have access to the City's computers, networks, and data. An insider can initiate a DoS attack, leak or steal data, and sabotage the infrastructure and data.

Organized Cybercrime, State-Sponsored Hackers Espionage: Organized cybercrime, which may include state-sponsored cybercrime, are attacks on City of Baytown's computers, network, and data by criminal organizations. These criminals may be motivated by money or political reasons. Often these attacks are well planned out, difficult to identify due to their more limited scope, and can result in extensive damage.

Third Party Mismanagement: Reliance on third parties for cyber services implies acceptance of the risk that the third party will properly protect the cyber resources from loss or unavailability. Hazards from the use of third parties include DoS, DDoS, data loss and leakage, infrastructure loss and failure, insider threats, and organized cybercrime.

Advance Persistent Threats: An advanced persistent threat (APT) is a stealthy and continuous attack on the City of Baytown over a long period of time. The "advanced" process signifies sophisticated techniques using malware to exploit vulnerabilities in systems. The "persistent" process suggests that an external command and control system is continuously monitoring and extracting data from a specific target. The "threat" process indicates human involvement in orchestrating the attack.

Civil Disorder: Civil disorder may impact the cybersecurity of the planning area by directly or indirectly impacting City of Baytown's ability to support its computers, networks, and data. Civil disorder can result in the planning area not having resources due to direct impact to the computers and networks, and indirectly by limiting the resources necessary to run the computers and networks.

LOCATION

Cyberwar is deceptive, invisible to most, and fought out of sight. It takes place in cyberspace, a location that cannot be seen, touched, or felt. Physical instruments, such as computers, routers, and cables can be seen; however, these instruments interact in

cyberspace, a virtual and unseen realm. Thus, the source of the hazard can extend from one part of the world to attacks on public or private sector entities in another part of the world, and the perpetrator can remain unknown in a legally provable sense. The entire City of Baytown planning area can be affected by a cyber-attack.

EXTENT

Currently an official index for measuring the extent of a cyber-attack does not exist. The extent, nature, and timing of cyber-attack events are impossible to predict. There may or may not be any warning. Some cyber-attack events take a long time (weeks, months, or years) to be discovered and identified.[4] Therefore, the City of Baytown planning area is vulnerable to all types of cyber-attack, and can occur anywhere, and at any time.

The extent of damages in the City of Baytown planning area is classified as low, medium, and high. These extents are based on historical incidents; third party information regarding the impact; and if the planning area has experienced an occurrence of the incident.

Denial of service attacks: Low

A DoS and DDoS attack could result in an extended cyber-outage in the planning area. The outage, although impacting the daily business of the planning area, would not have a substantial economic impact to the City.

Data loss / leakage: High

Data loss and leakage experienced by the planning area could result in costly remediation efforts to ensue. For example, if personally identifiable information (PII) is leaked, the City may be required to pay for credit protection services. Since the City of Baytown manages a large quantity of sensitive information, the possibility of costly remediation efforts is high.

Infrastructure loss / failure: High

Loss of a cyber-processing facility could result in very high expenses to remediate, repair, and recover from the loss.

Insider threats: Medium

Insider threats can result in substantial impacts on the organization, depending on what data the insider has accessed. The city of Baytown has remediated insider threats by

[4] Source: http://www.ready.gov/cyber-attack

using the industry standard separation of duties, and performing background checks of its employees, contractors, and volunteers.

Organized cybercrime, state-sponsored hackers' espionage: Medium

The planning area is a moderate target for organized criminals and state-sponsored hackers due to its political environment and the size of the organization. Due to the potential extent of attacks by organized criminals, the possibility and severity of resulting damages are great.

Third party mismanagement: Low

Since each vendor is isolated to the service it performs, the damages from one third party's mismanagement are fairly low.

Advanced persistent threats: High

The impact of an APT to the planning area can be severe because a large number of systems can be affected and the remediation of such an attack could be expensive to recover from.

Civil disorder: High

The impacts of civil disorder on cybersecurity could be extensive due to the typical physical nature of the attacks.

HISTORICAL OCCURRENCES

It's been reported that (in the U.S.) the electric grid is attacked every four days either physically or through cyber threats.[5] The numbers of attacks are accelerating and becoming more sophisticated. The Texas Governor announced that websites belonging to state agencies have seen an increase in attempted cyber-attacks coming out of Iran (about 10,000 per minute) in the time since Iranian general Qassem Soleimani was killed in a U.S. drone strike.[6] While the majority of attacks to gather data are not successful, the City of Baytown's technology security team remains on high alert. The Electric Reliability Council of Texas (ERCOT) reportedly has a team of professionals and a series of procedures they utilized to protect the planning area systems from cyber-attacks.

Based on available data and input from the Planning Team, no known or notable cyber-attacks have affected the City of Baytown planning area. Even though cyber-attack events

[5] Source: USA Today, March 2015, website: https://www.usatoday.com/story/news/2015/03/24/power-grid-physical-and-cyber-attacks-concern-security-experts/24892471/

[6] Statesman News Network, January 2020, Website: https://www.statesman.com/news/20200110/austin-on-guard-after-texas-hit-with-increased-cyberattacks-from-iran

are virtually impossible to predict, the City of Baytown planning area has the potential of an occurrence happening at any time.

PROBABILITY OF FUTURE EVENTS

The probability of occurrence based on historical incidents in the planning area are classified as low, medium, and high; as well as third party information regarding the likelihood of incidents if the City has not had an occurrence of the incident.

Denial of service attacks: Low

The planning area has frequent DOS attacks which are not severe enough to impact City of Baytown's service levels. The City has had no DDoS attacks over the last year which successfully impacted services. Although there have been attempts to make service disruptions through phishing emails, a fraudulent attempt to obtain sensitive information has not been successful. In the past, significant bad actors were identified by the U.S. Federal Government as Russia, Iran, and North Korea who historically attempt to disrupt or corrupt systems by damaging or gaining sensitive information through software. The City of Baytown employs vendor software, such as network monitoring software, which supports critical infrastructure.

Data loss / leakage: Low

The planning area is subject to several compliance requirements which specifically address data loss and leakage. These compliance standards include but are not limited to:

- Payment Card Industry Security Standard (PCI DSS)
- Health Insurance Portability and Accountability Act of 1996 (HIPAA)
- Criminal Justice Information Services Division (CJIS)

The City of Baytown has had no known instances of data loss over the last year which has resulted in the City having to remediate the situation.

Infrastructure loss / failure: Low

The planning area has multiple data centers which are hardened in various ways to minimize the possibility of outage. Resilience and redundancy are continuously being reviewed and addressed to reduce the risk of loss or failure. Historically, the infrastructure has had few outages that were extended. A prime example of potentially affected infrastructure would be health care systems within the planning area.

Insider threats: Low

The City of Baytown planning area require anyone who has access to government network and resources to have gone through a background check, which is regularly reviewed. There has never been evidence of insider attacks in the City of Baytown.

Organized cybercrime, state-sponsored hackers' espionage: High

Over the last five years, many organized cyberattack attempts have been made on the City of Baytown, as DDoS and malware attacks have become more and more frequent across the globe.

Third party mismanagement: Low

The City of Baytown utilizes third parties for implementing certain cybersecurity measures such as network monitoring, endpoint protection, and advanced threat protection. The City has a cooperative agreement with the Texas Department of Information Resources for Cyber Resources. Third party companies are vetted before use. There have not been any recorded instances of third-party mismanagement in the City of Baytown to date.

Advanced persistent threats (APT): Medium

APTs are defined as a highly sophisticated threat actor with the resources and knowledge needed to stage a long-term attack campaign and remain undetected for extended periods of time. APTs may use a wide variety of techniques to attack their targets, including malware and ransomware strains. The City of Baytown maintains systems which monitor symptoms of APT and utilizes services that scan and monitor both inbound and outbound communications. There have been no instances of APT's in the last five years, as reported by the Planning Team.

Civil disorder: Low

Nationally, civil disorder events have been correlated or followed by a cyber-attack to critical infrastructure, and national trends indicate a general rise in such events. However, the City of Baytown has low civil disorder in its modern history, and there have been no cyber-attacks tied into civil disturbance events within the last five years. Local, state, and federal officials monitor such events and establish lines of communication in the event that a cyber incident may unfold. The probability of following this national trend is low for the planning area.

Overall, cyber-attacks of all kinds are impossible to predict, but attack attempts have continuously risen across the country in recent years. Based on these global trends and historical evidence, the City of Baytown planning area is vulnerable to a range of cyber

threats, and the probability of future cyber-attacks is considered "Highly Likely" meaning an event is probable in the next year.

CLIMATE CHANGE CONSIDERATIONS

As a non-natural hazard, climate change has no direct impact on the future occurrences of cyber-attack incidents. However, climate change is associated with an increase in severe weather. If severe weather events occur concurrently with a cyber-attack, stress on emergency services, critical infrastructure, and the community may be compounded. Research and data regarding the impact of climate change on non-natural events is minimal and limited.

VULNERABILITY AND IMPACT



With the internet being largely open and unregulated, it leaves the planning area vulnerable to cyber-attacks and threats. The attack can be on information systems resulting in a data breach, or the spread of a virus. With the growing dependence on digital interconnectivity even a small incident may have widespread and damaging consequences.

Transportation, public safety, and utility services are all critical, and highly dependent on information technology. The motive behind such disruptions can be driven by religious, political, and other objectives.

A cyber-attack can last a few minutes to a couple of days, although large-scale events and their impacts can last much longer. Cyber-attacks differ by motive, type, vector, and perpetrator profile.

Cybersecurity involves protecting infrastructure by preventing, detecting, and responding to cyber-attack incidents. Unlike physical threats that prompt immediate action, such as "stop, drop, and roll," in the event of a fire; cyber threats are often difficult to identify and comprehend. Among these dangers are viruses erasing entire systems, intruders breaking into systems and altering files, intruders using a computer or device to attack others, and intruders stealing confidential information. The spectrum of cyber-attack risks is limitless. Threats of cyber-attack can have wide-ranging effects on the individual, community, organizational, and national level. Risks from cyber-attack include:

- Organized cybercrime, state-sponsored hackers, and cyber espionage, which can pose national security risks to our country.

- Transportation, power, and other services may be disrupted by large scale cyber incidents, and the extent of the disruption is highly uncertain as it will be determined by many unknown factors including the target and size of the incident.
- Vulnerability to data breach and loss increases if an organization's network is compromised, and therefore information about a company, its employees, and its customers can be at risk.
- Individually-owned devices such as computers, tablets, mobile phones, and gaming systems that connect to the Internet are vulnerable to intrusion, and therefore personal information may be at risk without proper security.[7]
- Cyber-attacks targeting dispatch services could prevent police, fire, and emergency personnel from being able to operate properly and dispatch to emergency situations.

Based on historical events and trends both in the planning area and globally, the potential impact of cyber-attacks for the entire City of Baytown planning area can be considered "Major" due to the critical facilities that can be indirectly impacted by an attack. While deaths, injuries or damages to the built environment are not directly caused by a cyber-attack, the secondary or cascading effects of an attack could be devastating.

DISRUPTION OF SERVICES

HAZARD DESCRIPTION

Disruption of services refers to the interruption of essential public services and infrastructure systems that support daily life, safety, and day-to-day operations. These disruptions can significantly impact residents, businesses, schools, and emergency response efforts. Types of disruptions include:

- **Power Outages:** A power outage is when the electrical power goes out unexpectedly. A power outage may disrupt communications, water, transportation, close businesses, cause spiled food and water contamination, and prevent the use of medical devices. Extended power outages may impact the whole community and the economy.
- **Water Service Interruptions:** Disruption of water supply or quality caused by damage to water treatment plants, pipelines, or distribution systems. This can lead to shortages of potable water for drinking, limited firefighting capabilities, and compromised sanitation, increasing the risk of public health issues.
- **Telecommunication Failures:** Telecommunication failure is the interruption of communication networks, including phone, internet, radio, and emergency

[7] Source: http://www.ready.gov/cyber-attack

communication systems. This can hinder emergency response coordination, disrupt business operations, and limit local residents' ability to access information.

There are several reasons why disruption of services may occur and is often referred to as a cascading impact of other disasters. Natural disasters such as hurricanes, tornadoes, floods, ice storms, and extreme heat can damage power lines, water infrastructure, and communication towers. Aging equipment, lack of maintenance, cyber-attacks, and software malfunctions may also lead to service interruptions. Even human activities, such as terrorism, can cause widespread service outages.

LOCATION

The City of Baytown's location makes it prone to many natural hazards such as hurricanes, flood, and thunderstorm wind events, as profiles in Sections 5-17. These events regularly cause disruption of services. There is no geographic boundary to a disruption of services event, therefore, the entire planning area is at risk.

EXTENT

A minor disruption may last a few hours or days, with services restored relatively quickly. Examples include power outages due to localized weather events. Major disruptions can last months, following an event such a significant natural disaster, cyberattack, or terrorist attack. These events require extensive recovery efforts to restore services, potentially causing long-term impacts. The extent of a service disruption event is determined by its cause, duration, the geographic scale of impact, and the severity of consequences. The planning area has the potential to experience the full extent of a disruption of services, ranging from minor to major.

HISTORICAL OCCURRENCES

Disruption of services occurs regularly, usually following other hazard events. Some notable events include Hurricane Harvey in 2017 which knocked out power for more than 300,000 customers in the greater Houston area. Another incident occurred in 2021 when Winter Storm Uri brought record-low temperatures, snow, and ice. The state's electric grid operator lost control of the power supply, leaving millions without access to electricity, for several days and longer. In July of 2024, Hurricane Beryl brought high winds resulting in falling trees, debris on the roadways, flooding, and power outages.

Other minor events due to maintenance or small accidents occur regularly and can still affect the planning area. For example, local news reports a water disruption event in

February of 2025 for the City of Baytown. A water line break along Bayway Drive caused an interruption in the water supply and a boiling water notice was in effect for certain areas. These types of events are often resolved quickly with minimal impacts.

PROBABILITY OF FUTURE EVENTS

Based on historical patterns and the probability of future hazard events that have previously caused disruptions of services, it is "Highly Likely" that similar events will continue to occur in the future, with at least one event in the next year. The recurrence of these events, coupled with the inherent risks posed by factors such as severe weather and infrastructure vulnerabilities, suggests that disruptions to critical services are an ongoing concern.

CLIMATE CHANGE CONSIDERATIONS

With climate change contributing to more intense storms, sea-level rise, and unpredictable weather patterns, the City of Baytown may experience an increased frequency and severity of service disruption events. Rising sea levels could exacerbate flooding risks, while extreme weather could place additional stress on power grids and water systems.

A 2015 report from the Union of Concerned Scientists said the central Gulf Coast was especially vulnerable to severe storms. The report noted the region was still slow to adapt to the risks to climate change, which includes increasingly severe storms leading to impacts on critical services, like power utilities.[8]

VULNERABILITY AND IMPACT

Power, water, and telecommunication disruptions have the ability to impact all people and structures within the planning area. The electrical grid is susceptible to damage from hazard events and outages can last for hours or days. The water system, including treatment plants and pipelines, is vulnerable to flooding, contamination, and infrastructure failure, leading to interruptions in access to clean water. Telecommunications services, including mobile networks and internet connectivity, are highly vulnerable to cyberattacks and physical damage from storms.

[8] Source: https://www.utilitydive.com/news/ercot-hurricane-harvey-knocked-out-power-to-300k-texas-customers/503680/

Power outages can lead to unsafe living conditions during extreme heat or cold events. Water disruptions may expose residents to health risks, especially if the water is contaminated or unavailable for basic sanitation.

Vulnerable and underserved populations are disproportionately impacted by disruption of service events as they may be more susceptible to health risks, especially when outages occur during extreme heat and cold events or create contaminated water supplies. People living in poverty may not have access to backup power sources or transportation and may be greater impacted by the disruption of services.

The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level and 16 percent of the population speaks English 'less than very well' (Table A-2).

Table A-2. Populations at Greater Risk

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

Other impacts from the disruption of power, water, and telecommunications services includes:

- Schools, hospitals, and emergency services may be forced to close or operate at reduced capacity, leaving residents without access to essential services.
- The City of Baytown's economy is heavily reliant on petrochemical plants and manufacturing. Service disruptions such as power outages or water interruptions can halt production, damage equipment, and lead to financial losses.
- Local retailers, restaurants, and service providers rely on power and telecommunications to operate effectively, and interruptions may cause loss of revenue.
- The loss of telephone, internet, or cellular services can leave people isolated, making it difficult to access emergency alerts.
- If telecommunications networks are down, emergency services may struggle to coordinate efforts or respond to incidents.
- There is an excess strain on emergency responders as they address widespread service outages.

- There is increased pressure on hospitals and emergency care facilities, especially if utilities like electricity and water are compromised.
- Outages lead to disruption of education as schools close or cannot function properly without utilities.
- Major events impact local government operations and services, delaying recovery efforts and public assistance.

The potential impact of disruption of services is usually considered "Limited" meaning injuries and illnesses are treatable with first aid, the shutdown of critical facilities and services for 24 hours or less, and less than 10 percent of property destroyed or with major damage.

HAZARDOUS MATERIALS (FIXED AND MOBILE)

HAZARD DESCRIPTION



Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. A hazardous material (HAZMAT) incident involves a substance outside normal safe containment in sufficient concentration to pose a threat to life, property, or the environment. These incidents can happen across various sectors, including industrial facilities, road transportation, pipeline transportation, rail transportation, maritime transportation, and aviation transportation.

Chemicals are found everywhere. They purify drinking water, increase crop production, and simplify household chores. But chemicals also can be hazardous to humans or the environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal. You and your community are at risk if a chemical is used unsafely or released in harmful amounts into the environment where you live, work, or play.

In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops.

The Toxics Release Inventory (TRI) is a publicly available database from the federal Environmental Protection Agency (EPA) which contains information on toxic chemical releases and other waste management activities that are reported annually by certain

covered industry groups federal facilities. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. Each year, facilities that meet certain activity thresholds must report their releases and other waste management activities for listed toxic chemicals to the EPA and their state or tribal entity. A facility must report if it meets the following three criteria:

- The facility falls within one of the following industrial categories: manufacturing; metal mining; coal mining; electric generating facilities that combust coal and/or oil; chemical wholesale distributors; petroleum terminals and bulk storage facilities; Resource Conservation and Recovery Act (RCRA) Subtitle C Treatment, Storage and Disposal (TSD) facilities; and solvent recovery services.
- Have ten or more full-time employee equivalents.
- Manufactures or processes more than 25,000 pounds or otherwise uses more than 10,000 pounds of any listed chemical during the calendar year. Persistent, Bio-accumulative and Toxic (PBT) chemicals are subject to different thresholds of ten pounds, 100 pounds or 0.1 grams depending on the chemical.

Submission of a Tier II form is required under Section 312 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA). Under EPCRA, all facilities which store significant quantities of hazardous chemicals must share this information with state and local emergency responders and planners. Facilities in Texas share this information by filing annual hazardous chemical inventories with the Texas Department of State Health Services (DSHS), Local Emergency Planning Committees (LEPCs), and local fire departments. The Texas Tier II Report contains facility identification information and detailed chemical data about hazardous chemicals stored at the facility.

A facility must report if it meets the following criteria:

- Any company using chemicals that could present a physical or health hazard must report them if the quantities of those chemicals exceed Tier II threshold limits.
- If an industry has an Occupational Safety and Health Administration (OSHA) deemed hazardous chemical that exceeds the appropriate threshold at a certain point in time, then the chemical must be reported. These chemicals may be on the list of 355 Extremely Hazardous Substances (EHS) or could be one of the 650,000 reportable hazardous substances (not on the EHS list). This reporting format is for a "snapshot in time." EHS chemicals must be reported if the quantity is greater than 500 pounds or the Threshold Planning Quantity (TPQ) amount, if the TPQ is less than 500 pounds. Chemicals not considered to be EHS must be reported if their quantity is 10,000 pounds or greater.

APPENDIX A: HUMAN-CAUSED HAZARDS

LOCATION

Industrial Facilities and Pipeline Transportation: The City of Baytown is home to several industrial facilities in the energy and chemical manufacturing sector and adjacent to the Houston Ship Channel and Galveston Bay. One notable facility is the ExxonMobile Baytown Complex, which is one of the largest integrated and most technologically advanced refining and petrochemical complexes in the world, at 3,400 acres. This site includes a refinery, chemical plant, and Olefins unit. Another is the Chevron Phillips Chemical Cedar Bayou facility, which is an 1,800 acre petrochemical manufacturing complex. Enterprise Products, JWS Steel, and Covestro are just a few more of the petrochemical and manufacturing facilities within the City of Baytown. These industrial facilities also use pipelines for the transportation of hazardous materials. Making areas nearest to industrial sites or hazardous material pipelines within the City of Baytown planning area most vulnerable.

Road and Rail Transportation: A hazardous material spill occurring along railroad tracks and major highways near populated areas in the City of Baytown planning area is of concern to the planning team. Trains and trucks can carry a variety of materials that would, in large quantity, threaten the health and safety of people and the natural environment in the vicinity of a spill.

All major highways, railroads, and the surrounding areas are at risk of a HAZMAT incident. In the City of Baytown planning area, there is a major railroad that is of particular concern. The rail line is part of the Union Pacific network, as it runs through the city and serves nearby industrial complexes, including refineries and chemical plants. Trains carrying hazardous materials along this track could significantly impact the planning area if a spill or derailment were to occur. This is especially true if the incident occurred in or near the more densely populated areas of the City or near critical infrastructure. Additionally, the TGS Cedar Port Railroad, which operates within the TGS Cedar Port Industrial Park, handles hazardous materials. Other transportation routes of concern include Interstate 10, which runs east-west through Baytown, and State Highway 146, which connects the city to the Houston Ship Channel and major industrial facilities.

The National Hazardous Materials Route Registry (NHMRR) lists, as reported by States and Tribal governments, all designated and restricted roads and preferred highway routes for transportation of highway route-controlled quantities of Class 7 radioactive materials and non-radioactive hazardous materials. According to NHMRR data, no routes

for the transportation of these hazardous materials are located in or near the City of Baytown planning area.[9]

Maritime Transportation: The City of Baytown is also located near several marine transportation facilities. This includes the Port of Houston, one of the country's largest and busiest ports. It is a major hub for maritime transportation and hazardous materials movement. The Houston Ship Channel, a 52-mile-long waterway, supports over 150 industrial terminals, handling a vast amount of foreign and domestic cargo, including chemicals and petroleum products. Other facilities like the Barbours Cut Container Terminal, Bayport Terminal, and the M-146 Marine Highway Connector provide the transportation of hazardous materials within the City of Baytown.

Aviation Transportation: The City of Baytown is within a short distance of some major airports, making it prone to aviation accidents that may release hazardous materials. The George Bush Intercontinental Airport (IAH) and William P. Hobby Airport (HOU) provide passenger and cargo operations. In addition, Ellington Airport (EFD) supports civilian and military aviation operations. Ellington Airport is also a spaceport, providing support for NASA and aerospace operations. These airports play a critical role in the movement of goods, including hazardous materials.

Under the Community Right-to-Know program laws upheld at the state and federal level, all facilities which store significant quantities of hazardous chemicals must share this information with state and local emergency responders and planners. Facilities in Texas share this information by filing annual hazardous chemical inventories with the state, with Local Emergency Planning Committees (LEPCs), and with local fire departments.

Based on EPA's Toxic Release Inventory (TRI), there are 33 TRI sites in the City of Baytown planning area that have reported chemicals releases in 2023. The top three TRI sites with the most chemicals released include the Chevron Phillips Chemical Plant, ExxonMobil Refinery, and ExxonMobil Chemical Plant. Figure A-2 shows the location of this TRI toxic site in the City of Baytown planning area. In addition, 500-meter and 2500-meter circle buffers are drawn around the hazardous material site to demonstrate potential areas of impact of a hazardous materials incident.

[9] Source: https://www.fmcsa.dot.gov/regulations/hazardous-materials/national-hazardous-materials-route-registry-state

APPENDIX A: HUMAN-CAUSED HAZARDS

Figure A-2. EPA 2023 Toxic Release Inventory (TRI) Facility Locations

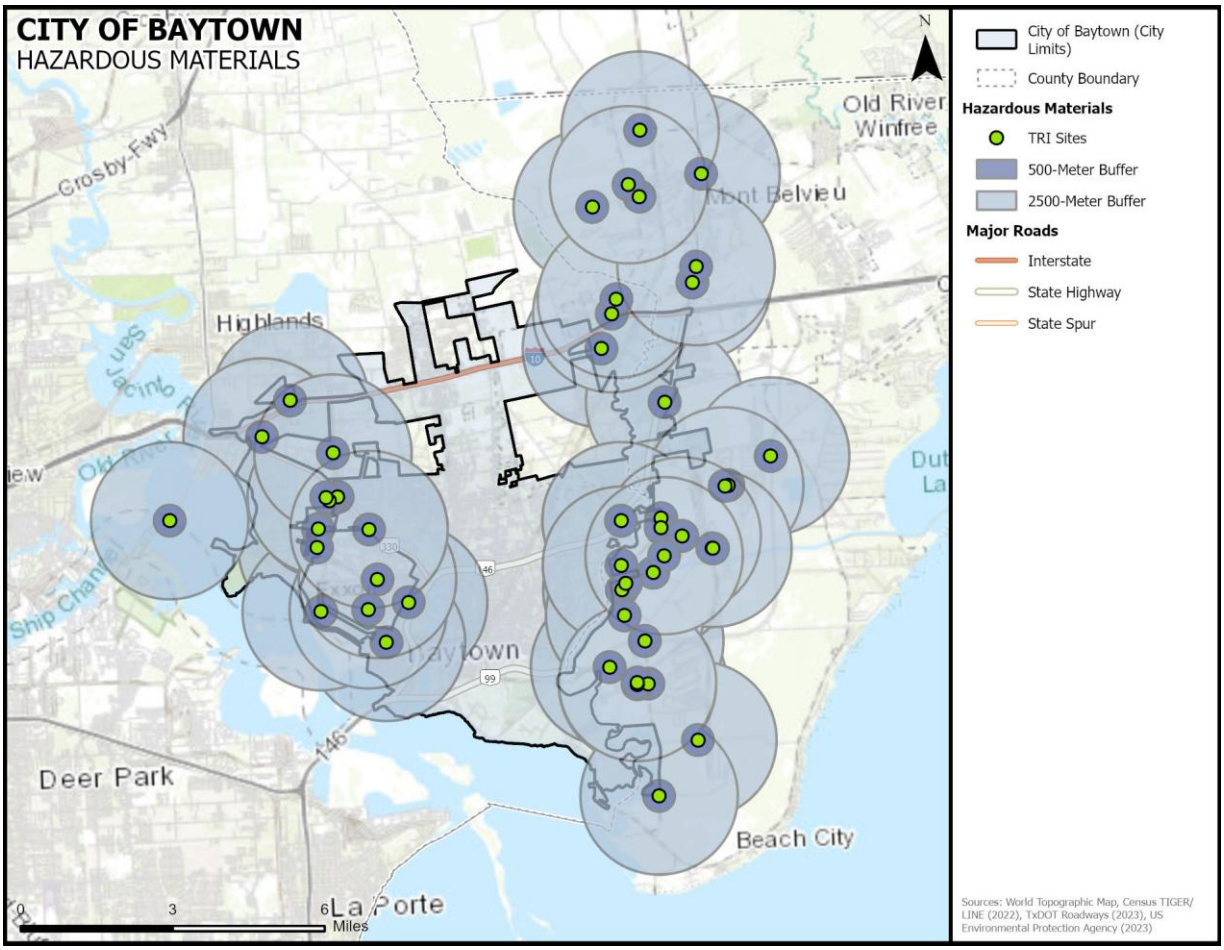


Table A-3. EPA 2023 Toxic Release Inventory (TRI) for City of Baytown[10]

TRI FACILITY NAME	RELEASES (lbs.)	ASSOCIATED CHEMICALS
Air Products Baytown 3 Facility	29,951	Ammonia; Methanol
Airgas Specialty Products	278	Ammonia
Chemicals Inc.	42	Ammonia; Hydrazine; Methanol
Chevron Phillips Chemical Co LP	1,149,692	Ammonia; Ethylene; Propylene
Clean As New Gulf Coast LLC	1,905	Chromium And Chromium Compounds; Copper And Copper Compounds; Nickel And Nickel Compounds

[10] Only TRI sites with reported chemical releases for 2023 are listed. Only top 3 chemicals released are listed. Source: https://www.epa.gov/toxics-release-inventory-tri-program.

APPENDIX A: HUMAN-CAUSED HAZARDS

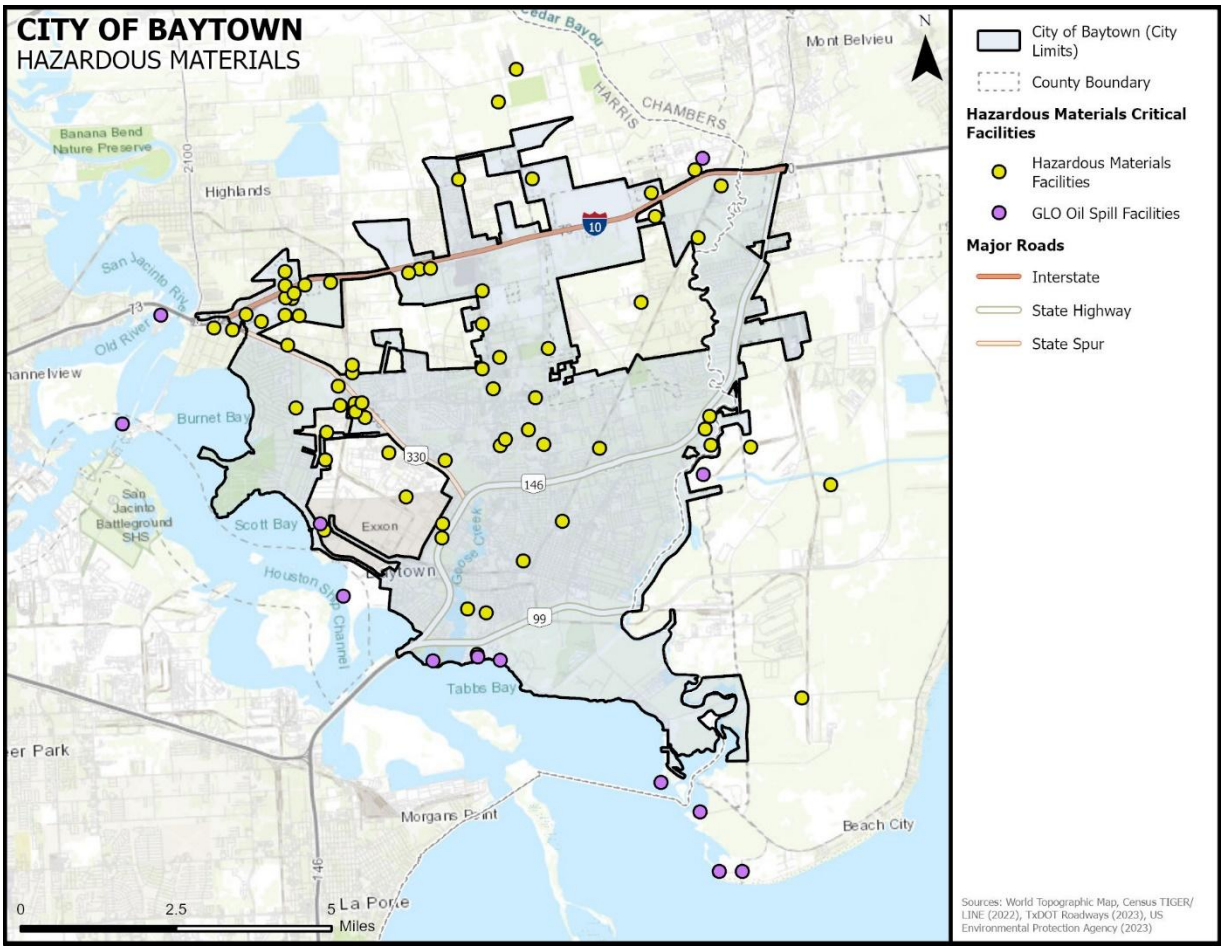
TRI FACILITY NAME	RELEASES (lbs.)	ASSOCIATED CHEMICALS
Covestro LLC	281,029	Ammonia; Chlorobenzene; Nitrate Compounds
Delta Baytown	9,595	Methyl Methacrylate; Toluene-2,4-Diisocyanate; Toluene-2,6-Diisocyanate
Duna Usa Inc.	3,404	Dichloromethane; Diisocyanates; Formic Acid
Eco Services Operations Corp.	12,908	Ammonia; Hydrogen Sulfide; Sulfuric Acid
El Dorado Nitrogen LLC	8,224	Ammonia; Chlorine; Nitric Acid
ExxonMobil Baytown Chemical Plant (Part)	1,103,894	Chloromethane; Ethylene; Propylene
ExxonMobil Chemical Co Baytown Olefins Plant (Part)	798,226	Ammonia; Ethylene; Nitrate Compounds (Water Dissociable)
ExxonMobil Mont Belvieu Plastics Plant	145,737	Ethylene; Toluene; N-Hexane
ExxonMobil Refining & Supply Baytown Refinery (Part)	2,108,015	Nitrate Compounds (Water Dissociable); Sulfuric Acid (Acid Aerosols); Toluene
Harcros Chemicals Houston	63	Certain Glycol Ethers; Nitric Acid; Nonylphenol Ethoxylates
Hexion Inc - Baytown Plant	7,751	Formaldehyde; Methanol
JSW Steel	1,635	Manganese And Manganese Compounds
Koppel Steel Corp Baytown Plant	20,966	Lead And Lead Compounds; Manganese And Manganese Compounds; Nickel And Nickel Compounds
LANXESS Corp-Baytown	383	Dibutyl Phthalate; Maleic Anhydride
LCY Elastomers LP	16,914	1,3-Butadiene; Cyclohexane; N-Hexane
MB Frac I Ii & Iii	34,602	Benzene; Cyclohexane; N-Hexane

APPENDIX A: HUMAN-CAUSED HAZARDS

TRI FACILITY NAME	RELEASES (lbs.)	ASSOCIATED CHEMICALS
MB Frac Iv & V	1	Diethanolamine; Propylene
Mont Belvieu East PHT Facility	1,101	Propylene
Mont Belvieu South Rail Terminal	6,014	Propylene
Monument Chemical Baytown LLC	14,389	Benzene; Naphthalene; Toluene
Oneok Hydrocarbon L.P. - Mont Belvieu NGL Fractionation	33,694	Ammonia; Benzene; N-Hexane
Raven Plant	12,723	Ethylene; N-Hexane
SI Group Baytown	7,067	Cyclohexane; Propylene; Styrene
Syntech Cedar Port	780	Cyclohexane; Isopropyl Alcohol; Methanol
Trifecta Trading	170	Diethanolamine; Methanol

Figure A-3 includes a location map of critical facilities identified by the City of Baytown which operates with, stores, or is otherwise related to hazardous materials.

Figure A-3. Hazardous Materials Critical Facilities



In summation, the entire City of Baytown planning area is at risk of hazardous materials. This is due to the presence of several TRI sites, the convergence of several major highways, railroads, and maritime transportation facilities. These factors, combined with a dense population and a concentration of petrochemical facilities, heighten the planning area's vulnerability to hazardous material exposure.

EXTENT

The extent of hazardous material release will depend on whether it is from a mobile or fixed site and the size of impact. The range of intensity will vary greatly depending on the circumstances. These factors and conditions include the material, toxicity, duration of the release, and environmental conditions such as the wind and precipitation.

Hazardous materials or toxic releases can have a "Substantial" impact on communities. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer

major damage. In a hazardous materials incident, solid, liquid and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions would directly affect how the hazard develops. The micro-meteorological effects on buildings and terrain can alter travel patterns and duration of agents. Shielding in the form of permanent shelter can protect people from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features can substantially increase damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

HISTORICAL OCCURRENCES

Hazardous materials are substances that if released or misused can cause death, serious injury, long-lasting health effects, and damage to infrastructure and the environment. Many products containing hazardous chemicals are used and stored in homes routinely. These products are also shipped daily on the nation's highways, railroads, waterways, and pipelines.

A total of 872 spill incidents have been reported in City of Baytown between 2002 and 2024 according to the Texas Commission on Environmental Quality (TCEQ) Emergency Response Spills database.[11] This includes chemical spills reported to and investigated by TCEQ. Many of these events were fixed site (inland) and related to refineries and chemical plants. Damages, injuries, and fatalities are not reported in this database, and a spill's inclusion in this dataset does not necessarily indicate significant damage to public health, property, or the natural environment occurred.

Historical occurrences indicate the potential for a significant hazardous materials incident to occur due to industrial accidents, as described below. In addition, the frequency of these events also indicates a significant level of risk for the planning area.

SIGNIFICANT EVENTS

July 31, 2019 – ExxonMobil Olefins Plant Fire

A fire occurred at the ExxonMobil Olefins Plant, which is part of the Baytown Complex and is one of the largest refining and petrochemical complexes in the world. It was determined that the buildup of an industrial byproduct called popcorn polymer caused a line to rupture, which led to the explosion. Local news articles state that 66 injuries were

[11] Source: https://data.texas.gov/dataset/Texas-Commission-on-Environmental-Quality-Emergenc/xagr-a3x2/about_data

a result of this event. Areas of the City of Baytown west of the facility and south of Highway 330 were subject to a shelter-in-place order that remained in effect for over three hours. Reportedly, this event released dozens of contaminants into the air, including butene, butadiene, and carbon monoxide.

December 23, 2021 – ExxonMobil Refinery Explosion

A major industrial explosion occurred at the ExxonMobil refinery which caused 4 major reported injuries. The fire happened in a unit that produces gasoline. It is possible that some amount of a chemical called naphtha was released. However, ExxonMobil, city and county officials, as well as the Texas Commission on Environmental Quality (TCEQ) monitored air quality and all readings were below detection levels.[12] According to local news, as of May 2022 residents, mostly children and elderly, filed a lawsuit against ExxonMobil due to injuries and respiratory problems allegedly caused by chemicals released during this incident.[13]

December 10, 2024 - Bluebonnet Petrochemical Solutions Chemical Spill

The Environmental Protection Agency (EPA) was notified by the National Response Center (NRC) on December 10, 2024, of a fire that released chemicals at the Bluebonnet Petrochemical Solutions facility in Baytown, Texas. According to local news reports, two chemicals (methyl palmitate and diethylene glycol monoethyl ether) leaked into a drainage area. Harris County Public Health and other local agencies responded by testing private water wells and soil, as well as monitoring air quality. Reportedly, Harris County Public Health Services advised all nearby residents that utilize well water to instead use bottled water for all activities, including drinking, washing, cooking and bathing.

PROBABILITY OF FUTURE EVENTS

Hazardous material spills are usually the result of human error and/or accidents, which cannot be predicted. However, given the concentration of industrial and petrochemical and its network of transportation, it is probable that an incident will occur in any given year. The probability of a spill threatening the health of thousands and of having widespread negative environmental consequences is, based on previous experience, low. However, a very large spill or industrial accident could lead to negative health or

[12] Source: https://abc13.com/exxon-refinery-fire-baytown-plant-chemicals-released-in-what-burned-at/11377329/

[13] Source: https://baytownsun.com/news/plaintiff-list-in-refinery-blast-case-growing/article_8bb912da-d32f-11ec-b0fa-533796258c7e.html

safety impacts and potentially cause long-term impacts on the air, soil, and groundwater, especially in the immediate area of the incident.

Based on the historic incident records and team input, the frequency of occurrence for typical hazardous material incidents would be considered Highly Likely. However, many of the previous spill incidents were minor and did not have widespread impacts. Based on the best available data, the frequency of occurrence for more significant hazardous material incidents is considered "Occasional", meaning an event is probable in the next five years for the City of Baytown planning area.

CLIMATE CHANGE CONSIDERATIONS

As a non-natural hazard, climate change has no direct impact on the future occurrences of hazardous material incidents. However, climate change is associated with an increase in severe weather. Severe weather events may cause damage to the storage of hazardous materials and can lead to an increase in chemical spills, leaks, or fires. Research and data regarding the impact of climate change on non-natural events is minimal and limited.

VULNERABILITY AND IMPACT

Due to the dense population and based on the geographic proximity of industrial and petrochemical sites and hazardous transportation routes, the entire City of Baytown planning area is vulnerable to the impacts of a HAZMAT incident. Areas closest to the Union Pacific railroad, major highways, and TRI facilities are the most vulnerable.

Public health and environmental impacts are the most common effects of a hazardous materials incident. The release of toxic chemicals can pose immediate health effects including respiratory problems, chemical burns, poisoning, and long-term illnesses such as cancer. Vulnerable populations including children and the elderly may be more susceptible to health impacts. The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent.

In extreme cases, an evacuation may be ordered to remove people from the hazardous area. Evacuating areas affected by HAZMAT incidents can be difficult, especially for people with functional needs and those who live below the poverty level and lack transportation and financial resources. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level. In addition, people who speak a language other than English

may face increased vulnerability due to language barriers that limit their access to important information such as weather-related warnings and instructions regarding safety measures. An estimated 16 percent of the planning area speak English 'less than very well'.

Table A-4. Populations at Greater Risk of HAZMAT Incidents[14]

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

According to Houston's Dirty Dozen, a report by Air Alliance Houston, most industrial facilities are located around communities with high percentages of Hispanic, African American, low-income, and elderly populations. Areas with the greatest risk of hazardous materials release and pollution are predominately low income and communities of color. These populations often have limited resources, reduced access to healthcare, and fewer evacuation options, increasing their vulnerability to hazardous materials incidents. The disproportionate exposure to hazardous materials exacerbates existing social and economic inequalities, making it more difficult for these communities to recover from disasters.[15]

Hazardous materials can have significant and long-term environmental impacts due to the release of toxic chemicals into the environment. Spills or leaks of chemicals may contaminate the soil, making it unsuitable for agriculture. Hazardous material incidents can also cause water pollution. The toxic substances can be carried by rainwater or runoff into nearby water bodies, which can harm aquatic life, disrupt ecosystems, and pose a public health risk if contamination occurs to drinking water sources. Gaseous releases can lead to air pollution, which can become widespread. HAZMAT incidents can also disrupt the local ecosystem, harming animals, and insects, leading to the displacement of native species.

While the best available data does not provide historical dollar loss amounts, hazardous material incidents can also be costly and impact the local economy. Emergency containment, clean up, and disposal may strain local resources and budgets. HAZMAT

[14] U.S. Census Bureau, American Community Survey, 2023

[15] Air Alliance Houston. Houston's Dirty Dozen: A Report on the Top Industrial Air Polluters.

incidents can also lead to property damage, most commonly to industrial facilities and transportation networks. Based on best available data, the impact of hazardous materials incidents in City of Baytown planning area is considered "Major" meaning injuries resulting in permanent disability, the complete shutdown of critical facilities between one and four weeks, and more than 25 percent of property destroyed or with major damage.

Critical facilities in the planning area are vulnerable to a range of direct and indirect impacts caused by HAZMAT incidents. Many of the impacts on critical facilities identified by the City of Baytown Planning Team are similar to the impacts listed in Sections 5 through 17. For a comprehensive list, please see Appendix F.

ASSESSMENT OF IMPACTS

HAZMAT incidents have the potential to pose a significant risk to people and can create dangerous and difficult situations for public health and safety officials. HAZMAT incidents can be frequently associated with a variety of impacts, including:

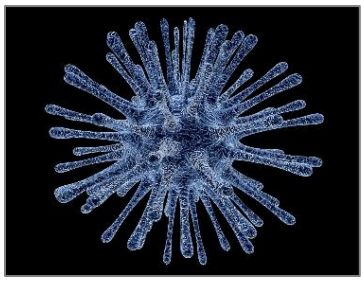
- Vulnerable populations, particularly the elderly (12 percent of total population) and children under 5 (7 percent of total population), can face serious or life-threatening health problems from exposure to toxic chemicals.
- Transportation disruptions and road closures can result in emergency response vehicles being unable to access areas of the community.
- The planning area may experience significant closures and traffic in the event of a train derailment involving hazardous materials that results in an extended cleanup time.
- First responders are exposed to toxic chemicals, hazardous materials, and generally unsafe conditions, which could result in sickness and long-term health impacts.
- Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue.
- Evacuations, shelter in place orders, or the closure of transportation routes can lead to the disruption of critical facilities, businesses, and schools.
- The environment may experience significant damage leading to air and water contamination, loss of wildfire, agriculture, and tourism.

The economic and financial impacts of hazardous material incidents on the area will depend entirely on the scale of the event, where the event occurs, and how quickly repairs to critical components of the economy can be implemented. The level of preparedness and pre-event planning done by the community, local businesses, and

citizens will also contribute to the overall economic and financial conditions in the aftermath of any HAZMAT incident.

INFECTIOUS DISEASE

HAZARD DESCRIPTION



An infectious disease is a clinically evident disease resulting from germs, such as bacteria, viruses, and fungi, that enter the body, multiply, and cause infection. Some infectious diseases are contagious or communicable, meaning they can spread from one person to another. Other infectious diseases can be spread by germs carried in air, water, food, or soil. They can also be spread by vectors, like biting insects, or by animals to humans.[16]

There are three classifications commonly used to identify disease impacts: endemic, epidemic, and pandemic. An endemic is the baseline level of disease, or the normal amount of a particular disease expected in the community. An epidemic is a sudden rise or increase in the number of reported diseases, usually above what is normally expected within a specific population or area. A pandemic is an epidemic that has spread over several countries or continents, affecting a large number of people.[17]

According to FEMA, infectious diseases are a major threat around the world, killing millions globally each year. Concerns of pandemics have risen because of the globalized economy and growing population foster large scale international travel and trade. Growing populations increase the vulnerability of all areas to disease because a denser population increases the risk of exposure to an infectious disease and advances the spread of infection.

The United States Centers for Disease Control and Prevention (CDC) monitors and reports infectious disease outbreaks across the region. These outbreaks are published on the CDC website (https://www.cdc.gov/outbreaks/index.html). The CDC also manages the Nationally Notifiable Disease List. A notifiable disease is one that, when diagnosed, requires health providers by law to report to state or local public health officials. Notifiable diseases must be reported due to their contagiousness, severity, or

[16] Source: Centers for Disease Control and Prevention (CDC), https://www.cdc.gov/ncezid/who-we-are/index.html#:~:text=Infectious%20diseases%20are%20illnesses%20caused,from%20one%20person%20to%20another.

[17] Source: Centers for Disease Control and Prevention (CDC), https://www.cdc.gov/scienceambassador/nerdacademy/glossary.html

frequency. The list is compiled through collaborative efforts among state health departments and the CDC, therefore, diseases that are considered notifiable vary from state to state. Internationally notifiable diseases (i.e., cholera, plague, and yellow fever) are also reportable in compliance with the World Health Organization's International Health Regulations. The Texas Department of State and Health Services (DSHS) manages the state's list of notifiable conditions, which includes but is not limited to, the following:

- Coronavirus
- Diphtheria
- Hepatitis A and B
- Human Immunodeficiency Virus (HIV)
- Influenza
- Measles
- Plague
- Human Rabies
- Smallpox
- Cholera
- Viral Hemorrhagic Fever (including Ebola)
- Yellow Fever

LOCATION

Pandemics cannot be predicted and only a few happen every century. The impacts from an infectious disease can affect all areas of the world, therefore all areas are vulnerable, as evidenced by the COVID-19 pandemic. Since air travel and worldwide shipping have increased, it has become increasingly difficult to contain localized outbreaks as infected or exposed people travel across the globe in a matter of hours. Third world countries have fewer resources to fight disease and may be more vulnerable than more industrialized nations. In the United States, the U.S. public health system works at the federal, state, and local level to monitor diseases, plan, and prepare for outbreaks, and prevent epidemics where possible.

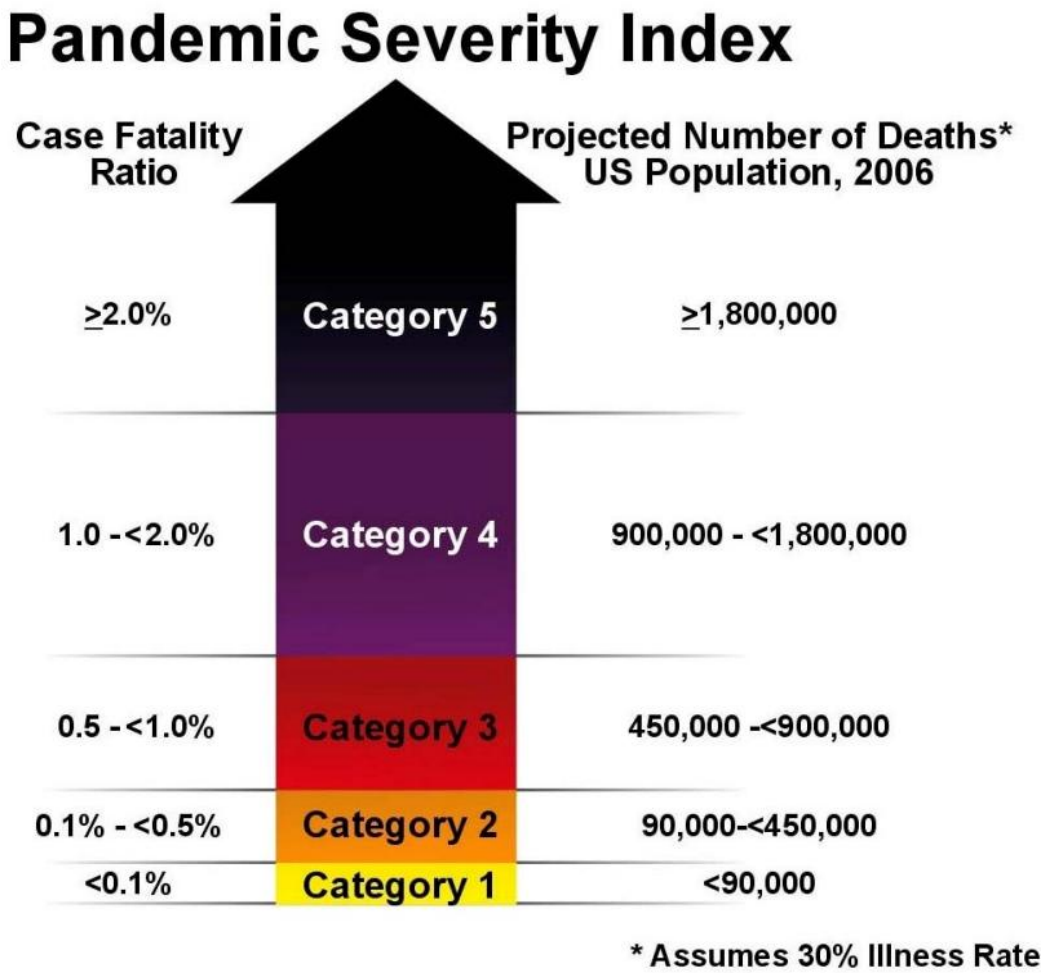
There is no distinct geographic boundary to infectious disease, therefore, it can occur throughout the entire City of Baytown planning area.

EXTENT

In terms of extent, an outbreak can range from a local endemic to a worldwide pandemic. The severity of a pandemic virus can be evaluated by using the Case Fatality Ratio (CFR) method. The CFR is the proportion of the number of deaths divided by the number of confirmed patients of a disease, which is then used to assess and compare the severity of the endemic, epidemic, or pandemic. It also can be used to evaluate the effect of new treatments, with measures decreasing as treatments improve. As depicted in Figure A-4 through A-6, the higher the CFR, the more severe the infectious disease outbreak, and

the greater the extent. The City of Baytown planning area is subject to the full range of extent in an infectious disease event.

Figure A-4. Case-Fatality Rate for Severity[18]



[18] Source: Centers for Disease Control and Prevention (CDC): https://www.cdc.gov/media/pdf/mitigationslides.pdf

Figure A-5. Pandemic Severity Index Interventions

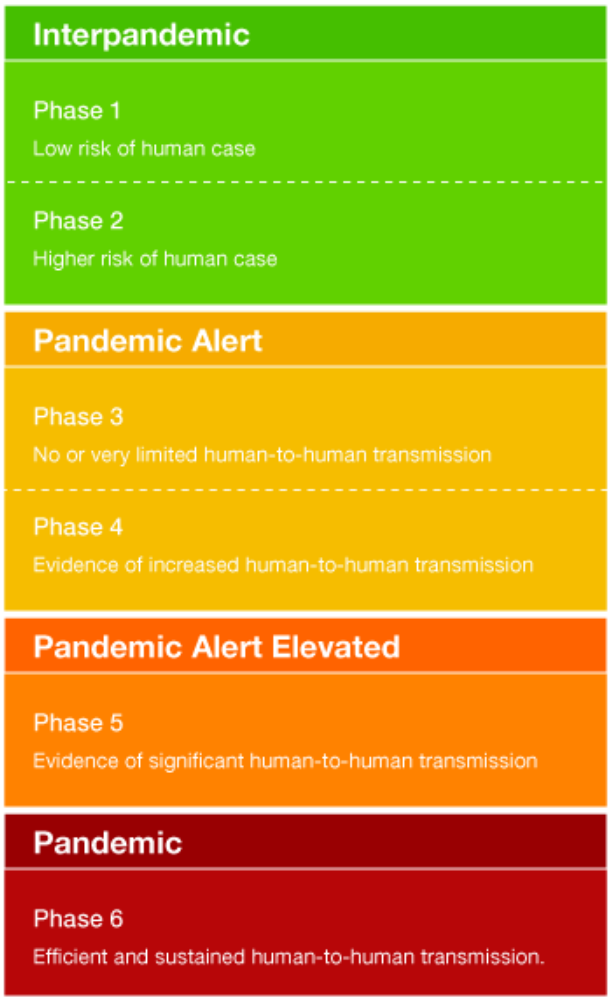
	Pandemic Severity Index		
Interventions by Setting	**1**	**2 and 3**	**4 and 5**
Home			
Voluntary isolation of ill at home (adults and children); combine with use of antiviral treatment as available and indicated	Recommend	Recommend	Recommend
Voluntary quarantine of household members in homes with ill persons (adults and children); consider combining with antiviral prophylaxis if effective, feasible, and quantities sufficient	Generally not recommended	Consider	Recommend
School			
Child social distancing –dismissal of students from schools and school-based activities, and closure of child care programs	Generally not recommended	Consider: ≤ 4 weeks	Recommend: ≤ 12 weeks
–reduce out-of-school contacts and community mixing	Generally not recommended	Consider: ≤ 4 weeks	Recommend: ≤ 12 weeks

Figure A-6. Pandemic Severity Index Interventions

	Pandemic Severity Index		
Interventions by Setting	**1**	**2 and 3**	**4 and 5**
Workplace/Community **Adult social distancing**			
–decrease number of social contacts (e.g., encourage teleconferences, alternatives to face-to-face meetings)	Generally not recommended	Consider	Recommend
–increase distance between persons (e.g., reduce density in public transit, workplace)	Generally not recommended	Consider	Recommend
–modify, postpone, or cancel selected public gatherings to promote social distance (e.g., stadium events, theater performances)	Generally not recommended	Consider	Recommend
–modify workplace schedules and practices (e.g., telework, staggered shifts)	Generally not recommended	Consider	Recommend

In addition, the World Health Organization (WHO) established various warning levels for pandemic events, as depicted in Figure A-7. During the COVID-19 pandemic, the planning area was in Phase 6.

Figure A-7. Risk levels for Pandemic (World Health Organization)



HISTORICAL OCCURRENCES

Occurrences of infectious disease events are fairly common and have the ability to affect entire regions at one time. Texas has experienced various outbreaks beginning in the early 1800s to now. The City of Baytown planning area has also been impacted by other nation-wide and global outbreaks including the epidemics and pandemics provided in the table below.

Table A-5. Historical Infectious Disease Outbreaks in Texas

YEAR	INFECTIOUS DISEASE OUTBREAK
1833	Cholera appeared in Texas causing many deaths. It appeared again in 1849.[19]
1918	An influenza (flu) pandemic occurred and caused 20 million deaths worldwide.
2009	A novel strain of H1N1, or "Swine Flu" was detected in Mexico and the United States which caused approximately 60.8 million cases, 274,304 hospitalizations and more than 12,000 deaths.[20]
2012	While the Zika virus was around much sooner, Texas suffered a severe outbreak in 2012, with 1,868 reported cases.
2020	Texas identified its first case of COVID-19 in 2020, which quickly became a pandemic, impacting millions of people worldwide. As of 2024, more than 9,000,000 cases of COVID-19 have been reported in Texas alone.[21] As of August 2020, the City of Baytown planning area reported 1,628 confirmed or probable cases of the virus, as well as 20 deaths. It is very likely this number increased throughout the remainder of the pandemic.

Some infectious diseases, such as the influenza, occur annually, like during "flu season." Other viruses such as the human immunodeficiency virus (HIV), which has impacted millions of people worldwide, are an ongoing issue. Other infectious diseases are very dangerous, and outbreaks may be localized. For example, in 2014, the first case of Ebola was diagnosed in the United States in a person who had traveled to Dallas, Texas from Liberia. Later, a nurse previously involved in direct care of the first patient was confirmed to have Ebola, and another case was reported in Ohio at the same time. The "Dallas Ebola cluster" highlighted the importance of locally planning for infectious disease outbreaks.[22]

In addition, a record of reported notifiable diseases was provided by the Chambers County Public Health department. Table A-6 below shows confirmed, probable, and suspected cases of notifiable diseases and conditions between 2019 and 2023.[23] While

[19] Source: Texas State Historical Association, https://www.tshaonline.org/handbook/entries/epidemic-diseases

[20] Carrat, F. et al. Timelines of Infection and Disease in Human Influenza: A Review of Volunteer Challenge Studies. American Journal of Epidemiology, 2008, 167: 775–785.

[21] Source: Texas Health and Human Services: https://www.dshs.texas.gov/covid-19-coronavirus-disease/texas-covid-19-surveillance

[22] Source: CDC, https://www.cdc.gov/mmwr/preview/mmwrhtml/mm63e1114a5.htm

[23] Data on disease surveillance for 2021 not reported, inaccurate, and/or incomplete

these events are tracked and reported at the county level, they provide valuable insight into public health trends that may impact the City of Baytown.

Table A-6. Historical Infectious Disease Outbreaks in Texas

YEAR	CONDITION	NUMBER OF CONFIRMED CASES	NUMBER OF PROBABLE CASES	NUMBER OF SUSPECTED CASES
2019	Cyclosporiasis	1	0	0
2019	Streptococcus, invasive	1	0	0
2019	Varicella	1	1	0
2020	Hepatitis C, acute	1	0	0
2022	Campylobacteriosis	1	0	0
2022	Carbapenem-resistant Enterobacteriaceae (CRE)	2	0	0
2022	Cryptosporidiosis	1	0	0
2022	Cyclosporiasis	1	0	0
2022	Hepatitis C, acute	1	0	0
2022	Mis-C Multisystem Inflammatory Syndrome-Children	1	0	0
2022	Salmonelloses, (Non-Paratyphi/Non-Typhi)	5	1	0
2022	Shigellosis	0	1	0
2022	Vibrio infection, including cholera	1	0	0
2022	Yersiniosis	1	0	0
2023	Cyclosporiasis	1	0	0
2023	Legionellosis	2	0	0
2023	Salmonelloses, (Non-Paratyphi/Non-Typhi)	3	3	0
2023	Shiga toxin-producing Escherichia coli	0	1	2
2023	Streptococcal disease, invasive	3	0	0

APPENDIX A: HUMAN-CAUSED HAZARDS

YEAR	CONDITION	NUMBER OF CONFIRMED CASES	NUMBER OF PROBABLE CASES	NUMBER OF SUSPECTED CASES
2023	Varicella Zoster	0	1	0
2023	Vibrio infection, including cholera	1	1	0
2023	Yersiniosis	1	0	0
TOTAL		29	9	2

PROBABILITY OF FUTURE EVENTS

Epidemics and pandemics have occurred in human and animal populations for thousands of years. As humans began to gather and congregate in urban areas, the potential for pandemics and epidemics increased. As trade routes became established and contact with other cities became more frequent, the potential for transmission of illnesses increased. In modern society, the ease of global travel has created a situation where viruses and bacteria can spread quickly from one continent to another.

Historical evidence shows that the population of the City of Baytown planning area is vulnerable to disease outbreak, and the probability of future infectious disease or pandemic events is possible, however, it is considered “Unlikely” due to the frequency of such outbreaks. Federal, state, and local public health officials maintain surveillance in hopes of identifying disease prominence and containing potential threats before they become epidemics.

CLIMATE CHANGE CONSIDERATIONS

According to the CDC and other climate change specialists, climate change does increase the risk of health threats. Mild winters, early springs, and warmer temperatures are giving mosquitoes and ticks more time to reproduce, spread diseases, and expand their habitats throughout the United States. Between 2004 and 2018, the number of reported illnesses from mosquito, tick, and flea bites more than doubled, with more than 760,000 cases reported in the United States. Nine new germs spread by mosquitoes and ticks were discovered or introduced into the United States during this period. A major concern with this shift is the potential spread of Lyme disease, the West Nile virus, and the Zika virus.

Climate change has forced some animal species into new habitats as their natural habitats disappear, and it has expanded the habitats of other animals. This movement of animals into new areas increases opportunities for contact between humans and animals and the potential spread of zoonotic diseases, for example, wildlife carrying the rabies virus are expanding to new geographic areas of the country. In addition, as global temperatures rise, deadly diseases that are a threat in other countries, like Ebola, Lassa, Rift Valley fever, and monkeypox, will increase along with the risk of them being imported into the United States.[24]

VULNERABILITY AND IMPACT

Estimated potential losses to the built environment are difficult to calculate because infectious disease causes little damage to the built environment and generally losses are experienced through public health response and medical costs, and lost wages of patients. Therefore, it is assumed that all buildings and facilities are exposed to disease but would experience negligible damage in the occurrence of an outbreak event. For example, the upkeep and maintenance of buildings and facilities would fall behind due to the high absenteeism of employees or the closing of facilities.

Critical infrastructure services, such as emergency services, utility services, water services and telecommunications can be limited by an infectious disease event. As seen during the COVID-19 pandemic, many jurisdictions executed a mandatory shutdown of non-essential businesses. The gradual re-opening of businesses and restaurants was completed in incremental stages to try and limit the spread of the infection and protect consumers while restarting the economy. Larger gatherings of people were limited to 50 and below and at times to 10 and below. In addition, local schools closed all campuses and implemented remote learning. Similar impacts are expected during future infectious disease outbreaks.

People and populations most vulnerable to infectious disease outbreaks include the elderly, children, people with disabilities, and those with pre-existing medical conditions. In addition, people living in poverty may not have the means to purchase personal protection equipment (PPE), medicine, and may have limited access to healthcare resources.

As outlined by the SouthEast Texas Health and Medical Risk Assessment new immigrants and people with limited English proficiency are more vulnerable due to

[24] Source: CDC, https://www.cdc.gov/ncezid/what-we-do/climate-change-and-infectious-diseases/index.html

language barriers and cultural differences which may hinder understanding of vaccination campaigns, quarantine protocols, and treatment availability. Unfamiliarity with local healthcare systems may delay engagement with public health interventions. Individuals reliant on caregivers or specialized services may face barriers in accessing vaccination sites, healthcare facilities, or isolation centers. Those in congregate settings, such as long-term care facilities, are at heightened risk of rapid transmission.[25]

The population over 65 in the City of Baytown planning area is estimated at 12 percent of the total population and children under the age of 5 are estimated at 7 percent. The population with a disability is estimated at 13 percent of the total population. An estimated 18 percent of the planning area population live below the poverty level and 16 percent of the population speaks English 'less than very well'.

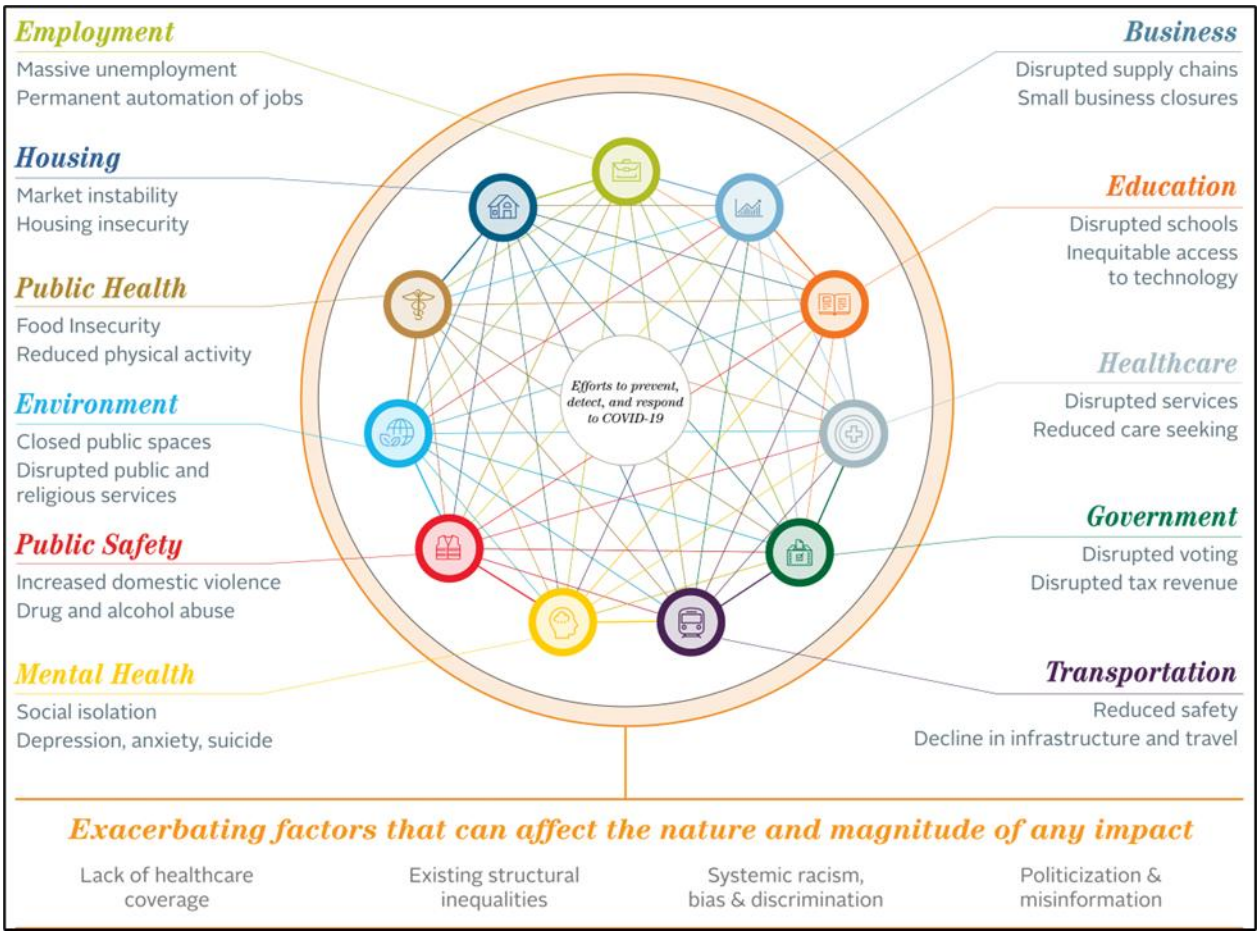
Table A-7. Populations at Greater Risk of Infectious Disease Outbreaks

JURISDICTION	POPULATION				
	65 AND OLDER	UNDER 5	WITH A DISABILITY	BELOW POVERTY LEVEL	LIMITED ENGLISH SPEAKING
City of Baytown	9,770	6,266	10,829	14,963	13,219

The recent COVID-19 pandemic demonstrated that the response costs to the public health sector for an outbreak, the economic impact, and the impact to health for the City of Baytown planning area, is "Substantial." Multiple deaths can be expected, and the City of Baytown planning area facilities could be shut down for 30 days or more. Other, unexpected, secondary impacts may also occur, as learned during the COVID-19 pandemic. Figure A-8 provides an overview of secondary impacts of COVID-19 in the United States, which can be expected in the future.

[25] SouthEast Texas Regional Advisory Council. SouthEast Texas Health and Medical Risk Assessment. December 2024.

Figure A-8. Secondary Impacts of the COVID-19 Pandemic in the United States[26]



ASSESSMENT OF IMPACTS

Disease impacts are larger than normal segments of the population, and few sectors of the population are left untouched by infectious disease. The impact of an infectious disease event will be measured by the number of fatalities, how the community is affected, and to what extent. The physical problems associated with infectious diseases may be short term or may lead to long-term physical maladies and can be frequently associated with a variety of impacts, including:

- Absenteeism in the workplace can have negative impacts on the overall functioning of society, particularly if it is prolonged.
- The risks to public health and safety include first responders and others with increased exposure to the disease. Response personnel likely to experience the

[26] Degrees, Model shows intersecting secondary impacts of COVID-19 in the US, August 6, 2020, website: https://degrees.fhi360.org/2020/08/model-shows-intersecting-secondary-impacts-of-covid-19-in-the-united-states/

greatest impact would be those with medical responsibilities, such as fire fighters, ambulance workers, and clinic and hospital personnel.

- If City staff stay home due to illness, someone in their home is ill, or because they fear becoming ill, the ability of local government to maintain operations and deliver services could be seriously limited or compromised.
- A pandemic event may result in heightened stress for responders, health care providers, public health workers, individuals, and communities.
- The public will require information on how to recognize and cope with the short- and long-term risks of sustained stress during mass vaccinations, for those debilitated by an illness, and their caregivers.
- There is the possibility of indirect damage to structures resulting from staff absenteeism and lack of routine operations and maintenance.
- Human infectious diseases do not normally pose a risk to the natural environment. Infectious diseases tend to be specific to humans and therefore pose little threat to the natural environment or non-mammalian species. However, certain exceptions exist including the avian flu, which can affect both birds and humans.
- Infectious disease outbreaks can be costly. Seasonal flu occurs annually and is estimated to cost the U.S. economy between $71 million and $167 million per year.[27] Severe pandemics have been predicted to cause more than $700 billion in economic losses, and to result in a 5.5 percent decrease in U.S. Gross Domestic Product (GDP).[28]
- If the normal movement of the epidemic within society needs to be curtailed, a process known as “social distancing,” then a greater impact to the local economy could occur.
- Depending on the situation, examples of cancellations and building closures might include cancellation of public events, such as concerts, sports events, movies, plays; and closure of recreational facilities, such as community swimming pools, youth clubs, gymnasiums.
- When clear communication with the public fails, it can result in a loss of credibility and can result in a loss of public confidence in leadership.
- Public dissatisfaction with government response will typically increase as the number of cases rises and public fear increases.
- Perceptions of inequality in medical care, particularly if those inequalities are based on socioeconomic status, ethnicity, age, gender, or seniority, can lead to increased dissatisfaction with government and leadership, and may result in a weakening of social order or hostility towards those in leadership or medical roles.

[27] Source: World Health Organization

[28] Source: Federal Reserve Bank of St. Louis

- Required rationing of supplies or vaccinations may be necessary.
- There could be significant public resistance to a decision to quarantine those who are ill or exposed, to restrict travel, or to implement social distancing.

The economic and financial impacts of infectious diseases on the community will depend on the severity of the disease, how many people are impacted, and how quickly the disease can be contained. The level of preparedness and pre-event planning done by the community, local businesses and citizens will also contribute to the overall economic and financial conditions in the aftermath of an infectious disease event.

TERRORISM

HAZARD DESCRIPTION

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States as broadly one of two types—domestic terrorism or international terrorism. Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside of the United States, or whose activities transcend their national boundaries.



A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of issue motivating the attack, and the points of weakness of the terrorist's target. In the United States, terrorist attacks have historically most often involved explosives, though active shooter events have become an increasing concern in recent years. A terrorist using a chemical or biological weapon is of particular concern to officials as special training and equipment are needed to safely manage a Weapons of Mass Destruction incident.

Terrorist incidents – as with other natural and technological disasters – involve the application of one or more modes of harmful force to the built environment. These modes include contamination (as in the case of chemical, biological radiological or nuclear hazards), energy (explosives, arson, and even electromagnetic waves), or denial of service (sabotage, infrastructure breakdown, and transportation service disruption).

The Planning Team has identified specific types and modes of terrorist attacks and have assigned them a risk level, based on the Hazard Identification and Risk Assessment

(HIRA) and Consequence Analysis (CA) in the 2023 Emergency Operations Plan. A description of each type of event along with the City's assigned risk level is provided below.

Active Shooter: An active shooter is defined as an individual actively engaged in killing or attempting to kill people in a confined and populated area. In most cases, active shooters use firearms and there is no pattern or method to their selection of victims. Recent active shooter incidents across the nation have highlighted the need for coordinated response by first responders to save lives. The planning area has deemed active shooter events a moderate risk level.

Civil Disturbance / Unrest: Civil unrest refers to any public disturbance involving acts of violence by a group, which causes immediate danger to surrounding people and properties. This can include group acts such as riots, protests, demonstrations, and assemblies. However, it is important to note that not all protests and assemblies are considered violent. The planning area has deemed civil disturbance and unrest events a moderate risk level.

Domestic Terrorism: Domestic terrorism is a broad category to describe acts of violence in the perpetrator's own country and against their fellow citizens. These acts are usually driven by social or political objectives. Incidents of domestic terrorism are on the rise in the United States. The planning area has deemed domestic terrorism events at a moderate risk level.

International Terrorism: International terrorism is a broad category meaning a foreign terrorist organization influences or directs an act of violence. The planning area has deemed international terrorism events at a low risk level.

Mass Casualty Incident: A mass casualty incident, in terms of terrorism, refers to an intentional act of violence that aims to cause widespread loss of life. It typically involves the use of weapons, explosives, biological agents, or other means to inflict harm on a large number of people. These events overwhelm local response and healthcare capabilities. The planning area has deemed mass casualty incidents a moderate risk level.

Mass Gatherings / Large Special Events: A mass gathering, in terms of terrorism, refers to the gathering of a large number of people at concerts, sporting events, political rallies, or religious gatherings. Terrorists may target these events to maximize harm and cause mass casualties. The planning area has deemed mass gatherings a moderate risk level.

Chemical, Biological, Radiological, and Nuclear (CBRN) Attack: CBRN attacks are associated with the release of a chemical (toxic gas, liquid, or solid material), biological agent (dangerous bacteria, toxins, or viruses), radiological material ("dirty bombs"), or nuclear material with the intention of causing harm. Terrorists may use these agents to contaminate food or water, as they are extremely difficult to detect. These agents can have an immediate effect (a few seconds to a few minutes) or a delayed effect (several hours to several days). The Department of Defense estimates that as many as 26 nations may possess chemical agents and/or weapons, and an additional 12 may be seeking to develop them. The Central Intelligence Agency reports that at least 10 countries are believed to possess or are currently conducting research on biological agents for weaponization. The planning area has deemed CBRN attacks a low risk level.

Explosives and Bomb Threats: Explosives and bomb threats involve the presence of or intent to detonate an explosive device. While these threats can involve acts of violence in which explosives are used, they are increasingly used as a tactic to disrupt, distract, or harass locations or organizations. The operational, financial, and psychological impacts that bomb threats can have on a community can be dangerous and costly. The planning area has deemed explosives and bomb threats a moderate risk.

LOCATION

There is no distinct geographic boundary to the threat of terrorism. An event is possible throughout the City of Baytown planning area. However, it is important to note that high-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Further, terrorists can spread fear by sending explosives or chemical and biological agents through the mail. Although there is no geographic boundary to the threat of terrorism, the City of Baytown's location near a large metropolitan area, one of the busiest seaports in the world, and major petrochemical facilities does indicate some risk to the planning area for terrorist groups or individuals seeking to disrupt energy production, transportation networks, or public safety.

EXTENT

The Homeland Security Advisory System, issued by the U. S. Department of Homeland Security, previously used a color-coded terrorism warning system that identified five threat levels. In 2011, the Department of Homeland Security (DHS) replaced the color-coded alerts of the Homeland Security Advisory System (HSAS) with the National

Terrorism Advisory System (NTAS), designed to more effectively communicate information about terrorist threats by providing timely, detailed information to the American public.

NTAS now consists of two types of advisories: Bulletins and Alerts. DHS has added Bulletins to the advisory system to be able to communicate current developments or general trends regarding threats of terrorism. As of February 2025, there has not been an active Bulletin since November 24, 2023. However, a Bulletin was active continuously from January 27, 2021, through November 24, 2023. NTAS Bulletins permit the Secretary to communicate critical terrorism information that, while not necessarily indicative of a specific threat against the United States, can reach homeland security partners or the public quickly, thereby allowing recipients to implement necessary protective measures. Because DHS may issue NTAS Bulletins in circumstances not warranting a more specific warning, NTAS Bulletins provide the Secretary with greater flexibility to provide timely information to stakeholders and members of the public.

When there is specific, credible information about a terrorist threat against the United States, DHS will share an NTAS Alert with the American public when circumstances warrant doing so. The Alert may include specific information, if available, about the nature of the threat, including the geographic region, mode of transportation, or critical infrastructure potentially affected by the threat, as well as steps that individuals and communities can take to protect themselves and help prevent, mitigate, or respond to the threat. The Alert may take one of two forms: Elevated, if there is credible threat information, but only general information about timing and target such that it is reasonable to recommend implementation of protective measures to thwart or mitigate against an attack; or Imminent, if the threat is believed credible, specific, and impending in the very near term. Terrorism Advisory System Alerts are described in Figure A-9.[29]

[29] Source: Department of Homeland Security, https://www.dhs.gov/national-terrorism-advisory-system

Figure A-9. National Terrorism Advisory



Red Cross also issues Advisory System Recommendations for individuals, families, neighborhoods, schools and businesses for each alert level. These can be found at: *www.redcross.org.*

Heightened periods for terrorism risk are based on intelligence and other information. A potential terrorist event could devastate the community physically, economically and psychologically for many years to come. Warning time for terrorism may be minimal to none.

HISTORICAL OCCURRENCES

The history of terrorism on United States soil includes the attacks of September 11, 2001, on the World Trade Center in New York and the Pentagon in Washington, D.C. and the ensuing anthrax attacks; the 1995 bombing of the Murrah Federal Building in Oklahoma

City; the bombing of the World Trade Center in 1993; and the Boston Marathon Bombings in 2013.

However, the State of Texas has experienced a significant number of domestic terrorism events as shown in Figure A-10. The United States Department of Homeland Security reported 231 domestic terrorism incidents between 2010 and 2021. These incidents occurred across the United States, but the greatest number of events occurred in states with major metropolitan areas such as California, New York, and Washington D.C.

Figure A-10. National Terrorism Advisory



Source: GAO analysis of Department of Homeland Security Counterterrorism Mission Center data. | GAO-23-104720

None of these incidents occurred within the planning area, but surrounding communities have been impacted, and some of the nation's worst attacks have occurred within the state. While complete prevention of an attack may not be attainable, the City can lessen the likelihood and/or the potential effects of an incident. The City of Baytown continues to improve its readiness to respond to a terrorist incident through participation in state and federal programs that provide training and equipment for agencies that would respond to a local terrorist incident, and in exercises that help to improve agency coordination and test local response plans.

PROBABILITY OF FUTURE EVENTS

The types, frequencies, and locations of many natural hazards are identifiable and, even in some cases, predictable, as the laws of physics and nature govern them. Malevolence, however, cannot be forecast with any accuracy. There is, therefore, some potential for most, if not all, types of intentional terrorist acts to occur anywhere and at any time. Reports also show that domestic terrorist incidents are on the rise in the United States, which indicates the slight possibility of an increased risk in the future. Based on best available data, it is "Unlikely" for a terrorist event to occur in the planning area in the next ten years.

CLIMATE CHANGE CONSIDERATIONS

As a non-natural hazard, climate change has no direct impact on the future occurrences of terrorism incidents. However, climate change is associated with an increase in severe weather. If severe weather events occur concurrently with a terrorist attack, the stress on emergency services, critical infrastructure, and the community may be compounded. Research and data regarding the impact of climate change on non-natural events is minimal and limited.

VULNERABILITY AND IMPACT

There is no defined geographic boundary for a terrorist event. All of the population, buildings, critical facilities, infrastructure and lifelines, and hazardous materials facilities within the City of Baytown planning area are considered exposed to the hazards of terrorism and could potentially be affected.

While all structures are considered exposed to the hazard of terrorism, certain facilities are vulnerable and may be targeted by terrorists to maximize harm and disruption. Critical infrastructure like power plants, water treatment facilities, and communication networks may be targeted to disrupt services, cause illness, and spread panic. Airports are high traffic areas that are historically vulnerable to acts of terrorism. Local municipal offices, military bases, federal buildings, hospitals, schools, and churches are also common targets.

Certain individuals may also be considered vulnerable to terrorist attacks due to exposure and roles in government. This includes people attending large events (concerts, festivals, and sporting events), government officials, and first responders. Extremist groups may also target individuals or communities based on religious or ethnic identities.

There are no past local events. Therefore, all assets and facilities are potentially at risk of damage that may, for the most part, be secondary.

Terrorist events can have a "Substantial" severity of impact, meaning multiple deaths, complete shutdown of facilities for 30 days or more, and more than 50 percent of affected properties destroyed or with major damage.

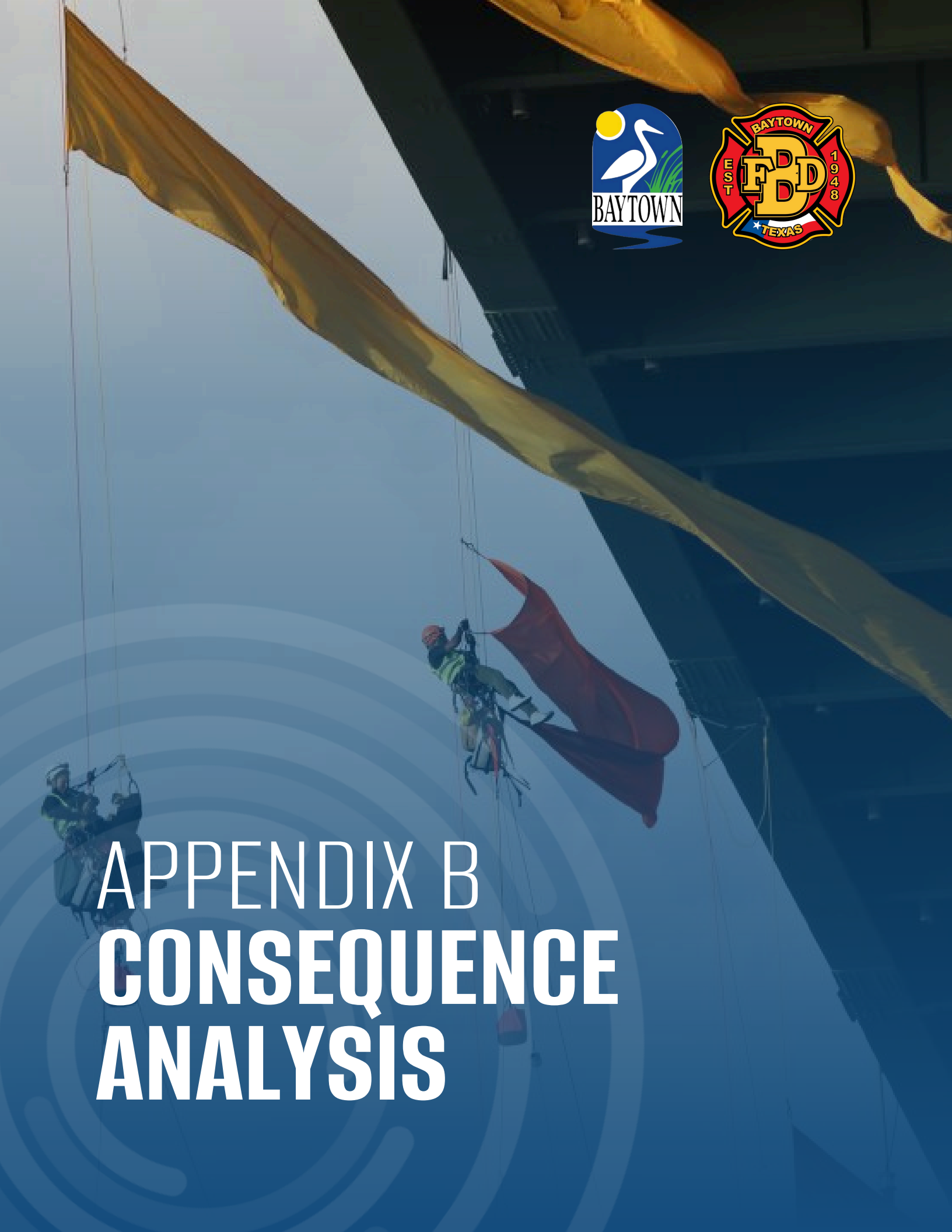
ASSESSMENT OF IMPACTS

Terrorist events have the potential to pose a significant risk to people, critical infrastructure and facilities, the economy, and built and natural environments. Due to the unforeseeable nature of terrorist attacks, as well as the broad variety of methods terrorist actors may utilize, the impacts of an event vary widely and are impossible to predict. Some of the potential impacts of a terrorist event include:

- Direct economic damage in the planning area can occur from terrorist attacks which target plants, machines, transportation systems, workers, or other smaller economic resources such as local businesses or restaurants.
- As identified in the City of Baytown Agriculture and Natural Resources Annex (ESF 11), plants, animals, and agricultural foods, feed, and other products are vulnerable to the threat of terrorism and may be targeted at any stage of the agriculture production, processing, and distribution cycle.
- A terrorist attack can lead to community-wide mental health issues and trauma such as PTSD, depression, anxiety, a sense of helplessness, and substance abuse.
- Evacuations, shelter in place orders, or the closure of transportation routes can lead to the disruption of critical facilities, businesses, and schools. Refer to the City of Baytown's Evacuation and Population Protection Support Annex for specific information regarding evacuation operations and procedures.
- In the event of chemical or biological weapons being used, the environment may experience significant damage leading to air and water contamination, loss of wildlife, agriculture, and tourism.
- As identified in the City of Baytown Utilities and Energy Annex (ESF 12), water shortages may be local or widespread and could be caused by various reasons, including terrorism, and could greatly impact the general population.
- First responders are exposed to toxic chemicals, hazardous materials, and generally unsafe conditions, which could result in sickness and long-term health impacts.
- An attack on the City of Baytown's refineries or chemical plants, which are potentially high risk targets, could lead to large-scale explosions, fires, and hazardous material releases. These attacks can endanger nearby residents,

impact public health and safety, impact air and water quality, and have devastating effects on marine life and local habitats.

- Vulnerable populations, particularly the elderly (12 percent of total population) and children under 5 (7 percent of total population), can face serious or life-threatening health problems from exposure to toxic chemicals.
- The population who speaks languages other than English (16 percent of total population) may have difficulty receiving urgent updates and safety guidance in the event of a terrorist attack.
- Terrorist attacks targeting critical facilities may result in the shutdown of essential services for extended periods of time. (See Appendix F for a comprehensive list of critical facilities in the City of Baytown planning area.)



APPENDIX B
CONSEQUENCE ANALYSIS

APPENDIX B: CONSEQUENCE ANALYSIS

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Consequence Analysis 2

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CONSEQUENCE ANALYSIS STANDARDS

An Accredited Emergency Management Program includes a Hazard Identification, Risk Assessment (HIRA), and Consequence Analysis. The 2022 *Emergency Management Standard* published by the Emergency Management Accreditation Program (EMAP)

includes Standards 4.1.1 and 4.1.2, listed below, which provide guidance on Hazard Identification, Risk Assessment (HIRA), and Consequence Analysis.

STANDARD 4.1.1

The Emergency Management Program identifies the natural and human-caused hazards that potentially impact the jurisdiction using multiple sources. The Emergency Management Program assesses the risk and vulnerability of the following:

- People
- Property
- The Environment, and
- Its own operations from these hazards.

STANDARD 4.1.2

The Emergency Management Program conducts a consequence analysis for the hazards identified in Standard 4.1.1 to consider the impact on the following:

- Public
- Responders
- Continuity of Operations, including continued delivery of services
- Property, Facilities, and Infrastructure
- Environment
- The economic condition of the jurisdiction, and
- Public confidence in the jurisdiction's governance.

CONSEQUENCE ANALYSIS

Tables B-1 through B-19 below identify impacts for each of the profiled hazards in the City of Baytown for the purposes of EMAP compliance.

APPENDIX B: CONSEQUENCE ANALYSIS

CONSEQUENCE ANALYSIS – COASTAL EROSION

Table B-1. Consequence Analysis – Coastal Erosion

COASTAL EROSION	
HAZARD / THREAT DESCRIPTION	
Coastal Erosion is the slow deterioration of land and loss of beach, shoreline, or dune material because of natural coastal processes or manmade influences. Erosion occurs when storms, flooding, wave action, sea-level rise, and human activities wear away beaches and bluffs.	
RISK AND VULNERABILITY ASSESSMENT	
People	• The possibility for fatalities or injuries directly resulting from coastal erosion is low, as it is generally a slow-evolving hazard whose effects gradually accumulate over time.
Property	• Coastal structures and infrastructure can be damaged or destroyed; extreme erosion from significant storm events may result in uninhabitable parcels where structures cannot be rebuilt.
Environment	• Coastal erosion can have significant environmental implications and cascading impacts. As the shoreline erodes, vital ecosystems deteriorate and reduce habitat availability for local wildlife.
City Operations	• Critical City infrastructure such as water treatment plants, power stations, and stormwater drainage systems may be damaged by saltwater intrusion and erosion. • Coastal erosion leading to facility inundation or damage may lead to slower emergency response times and utility outages. • Over time, coastal erosion may increase the City of Baytown's susceptibility to storm surge and high tides, leading to strains on City emergency response resources.
CONSEQUENCY ANALYSIS	
Public	• Residents of coastal areas of the City of Baytown are the most likely to experience significant impacts from coastal erosion, including damage or destruction of their homes, damaged to area roads and bridges blocking critical egress routes and making homes inaccessible, and increased flood risk. • Meaningful community spaces may be lost due to coastal retreat.

APPENDIX B: CONSEQUENCE ANALYSIS

COASTAL EROSION	
	• Coastal residents may require immediate shelter and long-term displacement assistance in extreme erosion occurrences. Some residents may be forced to move inland to less affected areas or leave the City entirely due to safety concerns.
Responders	• The greatest impacts on responders are the cascading effects of coastal erosion exacerbating conditions and straining response capabilities during other hazard events. • Damaged roads and bridges could prevent or delay emergency response. • Coastal erosion may dramatically hinder rebuilding and recovery efforts from flood, hurricane, and other storm events. • Increases in number of rescues needed as areas become more vulnerable to storm surges or high tides due to erosion.
Continuity of Operations	• Coastal erosion could impact operations and service delivery in the event that power lines, utility facilities, or infrastructure are damaged due to erosion or subsequent inundation. • Damage to roadways and bridges may result in delayed response times to get services back online. • Erosion can damage water treatment and sewage systems, leading to contamination and health hazards.
Property, Facilities, and Infrastructure	• Any coastal portions of the built environment, including roads, bridges, structures, facilities, and infrastructure, may be damaged or destroyed by erosion; though these impacts are likely to be gradual. • Parcels of land may become uninhabitable and impossible to rebuild upon. • Inland structures in the planning area are unlikely to experience direct impacts from coastal erosion.
Environment	• The Baytown Nature Center provides habitat to 317 species of birds as well as aquatic species such as shrimp, crab, and fish. Shoreline retreat could lead to ecosystem deterioration in Nature Center and other coastal areas of the planning area. • Loss of protective natural barriers, such as wetlands and dunes, increases vulnerability to future flooding and storm surge.

COASTAL EROSION	
	• Loss of natural vegetation can diminish the natural flood absorption capacity, increasing flood risk.
City Economic Conditions	• Beaches may be less desirable, reducing tourism and negatively impacting the economy. • Economic disruption reduces community programs and services due to short- and long-term revenue loss. • Some businesses not directly damaged by coastal erosion could suffer financial losses while roads or beachfront properties undergo repairs. • Increased insurance costs and reduced property values may make it difficult for homeowners and businesses to recover financially. • Disrupted breeding grounds for fish and shellfish could lead to long-term declines in commercial and recreational fishing industries.
Public Confidence in Governance	• Generally, coastal erosion's biggest impacts on public confidence stem from its potential to increase the difficulty of responding to or recovering from more acute hazard events such as hurricanes or floods. • Loss of valued tourist destinations, landmarks, wildlife ecosystems, or community spaces due to coastal erosion may decrease confidence in City leadership.

CONSEQUENCE ANALYSIS – DROUGHT

Table B-2. Consequence Analysis – Drought

DROUGHT	
HAZARD / THREAT DESCRIPTION	
Drought is a period of time without substantial rainfall that can result in water and crop shortages, increased risk of wildfire, and other impacts. Drought is the consequence of anticipated natural precipitation reduction over an extended period, usually a season or more in length.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Extended drought periods may lead to increases in illness and disease. • Injuries or fatalities may result from wildfires or extreme heat waves that are caused or exacerbated by drought.

APPENDIX B: CONSEQUENCE ANALYSIS

DROUGHT	
	• Water and food shortages may lead to health impacts across the planning area.
Property	• Effects on property directly caused by drought are generally minimal, though damage or destruction of structures may result from wildfires caused by drought.
Environment	• Habitat damage is a vulnerability of the environment during periods of drought for both fish and terrestrial wildlife. • Severe erosion and land degradation may result from prolonged or extreme drought.
City Operations	• City operations are not considered significantly vulnerable to drought, though resources may be strained in the event that water restrictions or rationing must be implemented. • Drought's secondary impacts, such as wildfire, may result in more severe disruptions in the City's operations.
CONSEQUENCE ANALYSIS	
Public	• Drought can impact the public locally, regionally, and at the state level. • Drought periods would likely impact all of the public in the City of Baytown planning area similarly. • Prolonged drought periods can become major news events and concerns for the public.
Responders	• Firefighters may have limited water resources for firefighting activities. • Increased law enforcement activities may be required to enforce water restrictions. • Drought-related wildfires may significantly increase in frequency and intensity.
Continuity of Operations	• The City of Baytown may need to increase operational costs to enforce water restrictions or rationing. • Planning mechanisms are needed to ensure essential functions such as water utilities continue to perform during drought events.
Property, Facilities, and Infrastructure	• Water and Wastewater treatment plants may be overloaded. • Low water levels at water treatment facilities can lead to increased concentrations of pollutants, making treatment more difficult.

DROUGHT	
	• Drought conditions can damage structures and infrastructure due to ground subsidence.
Environment	• Drought's most severe environmental impact is increasing the potential for wildfires. • Wildlife and natural ecosystems may be disrupted by decreases in natural resources and vegetation. • Disease in fish and wildlife will increase during times of drought.
City Economic Conditions	• Long-term drought may negatively impact future economic development. • The agriculture industry may be significantly impacted during drought, reducing crop yields and increasing prices. • Drought-related decreases in production may lead to an increase in unemployment.
Public Confidence in Governance	• Local government response must be immediate and effective to maintain public confidence. • Political conflicts may increase due to disagreements between residents and the City over water use and water rights.

CONSEQUENCE ANALYSIS – EARTHQUAKE

Table B-3. Consequence Analysis – Earthquake

EARTHQUAKE	
HAZARD / THREAT DESCRIPTION	
An earthquake is the sudden movement of the Earth's surface caused by the release of stress accumulated within or along the edge of the Earth's tectonic plates, volcanic eruption, or by a manmade explosion. Hazards associated with earthquakes include surface faulting, ground motion (shaking), landslide, and tsunami.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Historically, there have been no significant impacts on residents in the City of Baytown. No damaging earthquakes are known to have impacted the planning area.

APPENDIX B: CONSEQUENCE ANALYSIS

EARTHQUAKE	
Property	• The strongest earthquake activity reported in the City of Baytown was mild-intensity, non-damaging ground shaking. It is unlikely that an earthquake event will cause structural damage in the planning area.
Environment	• It is unlikely that earthquakes will significantly affect the environment of the City of Baytown planning area.
City Operations	• City operations are unlikely to be disrupted by earthquake events, as significant events in the planning area, and the entire State of Texas, are considered exceedingly rare.
CONSEQUENCE ANALYSIS	
Public	• Earthquakes affect those in the event area as well as surrounding areas, depending on the event's size and strength. • Due to the rarity of damaging earthquakes in the State of Texas, a severe event would become a major news event and concern for the public.
Responders	• In the event of a severe earthquake, responders may be significantly impacted by power outages, damaged facilities, loss of communications, or the inability to access impacted areas.
Continuity of Operations	• Planning and communication between local, state, and federal departments would be required to ensure operation of essential functions during and after a severe earthquake. • No earthquake event has ever impacted the City of Baytown's ability to operate and deliver City services. In the event of a severe earthquake, damages to structures and infrastructure, loss of communication, and transportation delays would significantly impact the City's ability to operate.
Property, Facilities, and Infrastructure	• No earthquake within the State of Texas has been of high enough magnitude to impact structures within the City of Baytown. In the event of a severe earthquake, the damage to property could be potentially devastating causing damage to buildings, lifelines (water, gas, and sewer lines), transportation networks, and critical facilities, leading to disruptions and economic losses
Environment	• Earthquake's primary impact on the environment involves the potential for cascading impacts such as landslides, mudslides, dam

EARTHQUAKE	
	failures, and tsunamis which can damage ecosystems, contaminate water sources, and release hazardous materials.
City Economic Conditions	• Historically, no earthquakes have impacted the local economy. • A damaging earthquake would severely drain state, county, and city resources. This severity of earthquake event could cause significant impacts on the local economy due to damaged or destroyed structures, loss of housing, and power outages.
Public Confidence in Governance	• Only minor, non-damaging earthquakes have been recorded within 100-miles of the City of Baytown. It is unlikely that an earthquake will present severe enough conditions to impact public confidence in local governance and leadership.

CONSEQUENCE ANALYSIS – EXTREME HEAT

Table B-4. Consequence Analysis – Extreme Heat

EXTREME HEAT	
HAZARD / THREAT DESCRIPTION	
Extreme heat is a prolonged period of excessively high temperatures and humidity. Extreme heat during the summer months is a common occurrence in the City of Baytown.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Heat-related illness and fatalities are the most significant impact of extreme heat on the planning area. Since 1996, over 130 heat-related deaths have been reported within Chambers and Harris Counties. • Vulnerable populations such as the elderly, children under 5, and those below the poverty level who may not be able to run air-conditioning are considered the most at-risk during extreme heat events.
Property	• Existing and future buildings, infrastructure, and critical facilities are not considered vulnerable to significant damage caused by extreme heat events. No monetary property damages due to extreme heat have been reported for Harris or Chambers Counties.

APPENDIX B: CONSEQUENCE ANALYSIS

EXTREME HEAT	
Environment	• Extreme high temperatures can have significant cascading impacts, leading to droughts, water shortages, fires, and excessive demands for energy.
City Operations	• Typically, more than 12 hours of warning time would be given before an extreme heat event. • It is possible that excessive energy use could lead to temporary power outages and shut down of critical facilities during extreme heat waves.
CONSEQUENCE ANALYSIS	
Public	• The greatest risk from extreme heat is to public health and safety. Heat exposure, even indoors, can cause life-threatening health problems. • Human health concerns associated with hot temperatures include hyperthermia, heat cramps, heat exhaustion, and heat stroke. • Hot weather and crime are positively correlated, particularly violent crime.
Responders	• Response personnel are subject to the same risk and impacts as the general public. This would include utility workers, public works personnel, and any other City departments in which individuals are required to work outside. • Response personnel may be more affected by the impacts of extreme heat than the general population, as their exposure would be greater.
Continuity of Operations	• Energy utilities are the most likely services to be impacted by extreme heat. Rolling blackouts, sagging transmission lines, and potential power grid failure may result from extreme heat and the resulting high energy demand. • Heat can be linked to drought, which can create challenges for hydropower and thermal plants that rely on water for temperature control.
Property, Facilities, and Infrastructure	• Highways, roads, airport runways, and railway lines are damaged by excessive heat causing asphalt to soften and melt. • Concrete roads have been known to “explode” during extreme heat. • Train travel may become dangerous as metal railroads expand and bend in the heat.

EXTREME HEAT	
	• Heat stress is also placed on automobile cooling systems, ultimately leading to mechanical failure.
Environment	• If combined with drought, extreme heat can lead to habitat damage and the reduction or even extinction of local species, especially those species which are already distressed from other factors. • Extreme heat increases ground-level ozone "smog," an air pollutant which has a direct impact on respiratory illness.
City Economic Conditions	• Extreme heat can result in decreased or interrupted tourism, though this effect is likely to be short-lived • Costs associated with food, water, and energy are likely to increase during prolonged extreme heat. • Agriculture and fisheries may experience economic hardship due to extreme heat.
Public Confidence in Governance	• Public dissatisfaction with government may result from higher energy utility bills, water scarcity, and other economic impacts resulting from the reduction of services by local government during extreme heat. • Perceptions of inequality in relief could lead to decreased confidence in local government and leadership.

CONSEQUENCE ANALYSIS – FLOOD

Table B-5. Consequence Analysis – Flood

FLOOD	
HAZARD / THREAT DESCRIPTION	
Floods generally result from excessive precipitation causing the overflow of large amounts of water beyond its normal confines. The primary types of general flooding are inland and coastal flooding, both of which can impact the City of Baytown planning area.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Flooding is the deadliest natural disaster across the U.S. and poses a constant and significant threat to the health and safety of the people in the City of Baytown. • The majority of deaths attributed to flooding occur in vehicles.

APPENDIX B: CONSEQUENCE ANALYSIS

FLOOD	
	• Texas has the most flood-related fatalities of any state from 1958-2008; Harris County has reported over 150 fatalities due to flood during that time.
Property	• A property's vulnerability to a flood depends on its location and proximity to the floodplain. Structures along banks of a waterway or the coast are the most vulnerable and are often repetitive loss structures. • Historically, floods have had devastating impacts on the City of Baytown and surrounding areas; billions of dollars in property damages have been reported in Harris and Chambers Counties since 1900.
Environment	• Flooding is a natural occurrence and can be beneficial for the environment by nourishing the soil and maintaining the water table. • Floodwaters collect human artifacts, such as household chemical and toxins or untreated sewage. In the long term, contaminated floodwaters can create negative consequences for the natural environment. • Major flood events can scour stream or riverbanks, damage overwhelmed flood control structures, and lead to the loss of native plants and animals.
City Operations	• Although the City of Baytown has encouraged development outside of the floodplain, impact from major flood events can impact huge portions of the planning area. • Critical facilities may be shut down for up to a week.
CONSEQUENCE ANALYSIS	
Public	• Flooding can pose health risks and threats to people after the floodwater has receded. These include contaminated food and water, mold spores proliferating, and electric power being interrupted. • Evacuations may be necessary in inundated areas, leading to the displacement of residents due to flood damage. • The psycho-social effects on flood victims and their families can traumatize them for long periods of time, creating long term increases in needed medical treatment and services.

APPENDIX B: CONSEQUENCE ANALYSIS

FLOOD	
Responders	• Response personnel are exposed to greater risks and impacts than the general public in flood events, as they are exposed to high and swift water rescues and potentially hazardous or contaminated flood waters. • City departments may be flooded, delaying response and recovery efforts for the entire community.
Continuity of Operations	• Loss of communication, power outages, damaged infrastructure and roads, and damaged or destroyed facilities may significantly impact the City's operations following a flood. • Roadway obstructions may prevent City personnel from leaving their homes or travelling to perform essential duties. • Essential City data and equipment such as filing systems and computers may be damaged or destroyed from flood events. • Private sector entities the City relies on may also be unable to deliver their goods and services during and after a major flood.
Property, Facilities, and Infrastructure	• Large flood events may result in extensive damages or destruction to structures in the floodplain. • Roads and other essential infrastructure may be inundated, damaged, or inaccessible during and immediately after flood events.
Environment	• Coastal flooding may result in increases in coastal erosion. • Flooding can potentially impact the environment positively by nourishing soil and maintaining the water table. • Loss of livestock and wildlife may result from large floods. • Flood poses a potential catastrophic risk to crop production and overall crop quality. • Contaminated floodwaters may lead to long-term negative consequences to the natural environment and ecosystem.
City Economic Conditions	• Destroyed residential structures which are uninsured or underinsured may never be rebuilt, reducing the tax base for the community. • Businesses that are uninsured or underinsured may have difficulty reopening, which results in a net loss of jobs for the community and a potential increase in the unemployment rate. • Damage to infrastructure may slow economic recovery since repairs may be extensive and lengthy.

FLOOD	
Public Confidence in Governance	• Public confidence in local government may be impacted by how the response and recovery efforts resulting from the flood event are handled. • If the perception developed, correctly or incorrectly, that the response was slow, that needs or complaints of residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence will decline.

CONSEQUENCE ANALYSIS – HAIL

Table B-6. Consequence Analysis – Hail

HAIL	
HAZARD / THREAT DESCRIPTION	
A severe weather event where thunderstorms produce ice pellets (hail) that can cause damage to property and potentially injure people. Hailstorms are characterized by strong updrafts of air within thunderstorms, which carry water droplets high into the atmosphere where they freeze and grow into hailstones.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Large hail has the potential to cause significant injuries, or even fatalities, to those exposed during a hailstorm. • No injuries or fatalities have been reported in the City of Baytown or elsewhere in Harris or Chambers Counties.
Property	• Structures built before 1980, before the use of more stringent construction standards, and manufactured or mobile homes are at the greatest risk to hail damage. • Large hail events can cause significant roof, siding, and window damage in buildings and automobiles.
Environment	• Hail can shred plants and crops to ribbons. • Hail damage to chemical facilities or other structures containing hazardous materials could lead to spills and long-lasting impacts on the surrounding environment.
City Operations	• Hail is unlikely to cause significant or long-term disruptions in the City of Baytown's operations and services.

APPENDIX B: CONSEQUENCE ANALYSIS

HAIL	
	• Temporary power outages or unsafe travel conditions can occur during hail events.
CONSEQUENCE ANALYSIS	
Public	• Individuals caught outside during hail events are exposed to significant risk of being struck by hail, falling branches, or other debris. • Hail events resulting in power outages could place the public in jeopardy, particularly those who rely on power for health and life safety, such as those on life support systems.
Responders	• Downed power lines, damaged structures, hazardous spills, and debris caused by hail pose a risk to responders and impede response personnels ability to operate. • Large debris, such as downed trees, may prevent the City's response vehicles from responding to call or performing essential functions.
Continuity of Operations	• Hail and road obstructions caused by hail may make City personnel unable to travel or perform essential functions. • Interruptions in utility services and power outages may result from hail damage to infrastructure or staff members being unable to perform their duties.
Property, Facilities, and Infrastructure	• Hail typically causes damage to the infrastructure of a community, including buildings, facilities, and power lines. • It can take a significant amount of time to fully repair damaged facilities and infrastructure, depending on the nature of the damage and the resources available that can be dedicated to the project.
Environment	• Hail is unlikely to cause severe damage to the natural environment, though shredded crops and foliage or damaged and downed trees may result from large hail.
City Economic Conditions	• Hail damage can force businesses to temporarily close, even if they were not directly impacted due to critical service disruptions. • Damage to infrastructure will generally slow down the economic recovery of the City. • Businesses that are uninsured or underinsured may have difficulty reopening.

HAIL	
Public Confidence in Governance	• Public confidence in local government may be impacted by the perception of the response to the event and how the recovery from the event is handled. If residents perceive the City was unprepared, slow to respond, or did not meet residents' needs, public confidence will decline.

CONSEQUENCE ANALYSIS – HURRICANE / TROPICAL STORM

Table B-7. Consequence Analysis – Hurricane / Tropical Storm

HURRICANE / TROPICAL STORM	
HAZARD / THREAT DESCRIPTION	
A hurricane is an intense tropical weather system of strong thunderstorms with well-defined surface circulation and maximum sustained winds of 74 mph or higher. Tropical storms are characterized as having maximum sustained winds between 39 and 73 mph.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Based on the planning area's location and history of hurricane events, all residents of the City of Baytown are at high risk to hurricanes and tropical storms. • Fatalities, injuries, and long-term displacements can all result from hurricane events.
Property	• Catastrophic property damage can result from hurricanes along the Texas coast. In Harris and Chambers Counties, over $200 billion dollars (2024 dollars) has been reported since 1900 due to hurricanes.
Environment	• Coastal erosion is the major environmental impact from hurricanes and tropical storms.
City Operations	• Depending on the strength of the storm and where damages occur, City operations may be disrupted in numerous ways including impeded travel; critical facilities being damaged, destroyed, or inaccessible; utility failure or service interruptions; loss of communications; and direct impacts on critical staff.

APPENDIX B: CONSEQUENCE ANALYSIS

HURRICANE / TROPICAL STORM	
CONSEQUENCE ANALYSIS	
Public	• Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees. Damage to structures may result in harm to the building's occupants. • Flooding and wind-blown debris obstructing roadways may leave residents stranded and in need of rescue. • Evacuations may be required as tropical storms or hurricanes near the City of Baytown.
Responders	• Floodwater, downed powerlines, or windblown debris may make travel unsafe or impossible for responders. • Heavy hurricane winds may prevent responses to calls. • Response personnel are subject to the health and safety concerns that impact the general public, but face greater risk as they have higher exposure.
Continuity of Operations	• City operations are significantly threatened, with potential impacts including damaged, destroyed, or inaccessible files (hard or electronic); stressing of City resources; and interruptions in City services. • Needed repairs to get City services back online may be impossible to perform during a hurricane event. • Road and bridge closures, as well as transit service disruptions, to protect public safety may be a consequence.
Property, Facilities, and Infrastructure	• Structures can be damaged or crushed by falling trees and flying debris. • Older structures built to less stringent building codes may suffer greater hurricane damage. • Hurricanes can cause major damage to large areas, meaning all existing and future buildings, facilities, and infrastructure in the City of Baytown are at risk to these storms.
Environment	• Hurricanes and tropical storms are known to pose risks to the environment, though they are unlikely to result in catastrophic or prolonged damage to the natural environment.

HURRICANE / TROPICAL STORM	
	• Hazardous chemical spills resulting from hurricane impacts may lead to long-term degradation of soil, vegetation, or water quality. • Strong hurricanes or tropical storms may lead to increases in coastal erosion.
City Economic Conditions	• Damage to infrastructure and roads may halt the standard delivery of goods and services. • Emergency evacuations could lead to temporary declines in the local economy. • Businesses that are more reliant on utility infrastructure than others may suffer greater damage without a backup power source. • Large scale hurricanes can have significant economic impact on the affected area, as it must now fund expenses such as infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, as well as normal day-to-day operating expenses.
Public Confidence in Governance	• Public confidence in local government may be impacted by the perception of the response to the event and how the recovery from the event is handled. If residents perceive the City was unprepared, slow to respond, or did not meet residents' needs, public confidence will decline.

CONSEQUENCE ANALYSIS – LAND SUBSIDENCE

Table B-8. Consequence Analysis – Land Subsidence

LAND SUBSIDENCE	
HAZARD / THREAT DESCRIPTION	
Land subsidence is often described as the gradual or sudden sinking of the Earth's surface. Land subsidence typically happens slowly and goes unnoticed unless it reaches extreme levels, as seen in rare catastrophic sinkhole events.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Land subsidence typically poses limited risk to people, impacts to people largely stem from the potential need for evacuation or relocation following a severe subsidence event.

APPENDIX B: CONSEQUENCE ANALYSIS

LAND SUBSIDENCE	
Property	• All existing and future structures are considered vulnerable to land subsidence events, due to their random nature. • In severe subsidence events which result in large sinkholes, damages to structures, automobiles, or other property sitting on top of that land will occur.
Environment	• Land subsidence typically poses limited risk to the environment. • If a land subsidence event results in ruptured pipes or other infrastructure containing hazardous materials could lead to long-term impacts on the natural environment.
City Operations	• Land subsidence is not likely to significantly impact the City of Baytown's operations. • Sinkholes occurring on roadways could impede travel until repairs are made.
CONSEQUENCE ANALYSIS	
Public	• Land subsidence typically poses little risk for the health and safety of individuals. The greatest risk to the public would be forced relocation or evacuation in the event a severe land subsidence event damaged or destroyed their home.
Responders	• Emergency response and service operations may be impacted by limitations on access and mobility if roadways are closed, or obstructed. • Significant subsidence can result in emergency response vehicles being unable to access areas of the community. • Responders may be put in dangerous situations, such as exposure to downed power lines or ruptured gas lines, while responding to severe land subsidence events.
Continuity of Operations	• Power and water outages are possible throughout the planning area due to damaged power lines, underground water pipes, and other damaged utility infrastructure. • Depending on the severity and scale of damage caused by ground movement, damage to critical infrastructure can require weeks to repair.

LAND SUBSIDENCE	
Property, Facilities, and Infrastructure	• All property, critical facilities, and infrastructure in the planning area could potentially be damaged in a subsidence event. • Older structures built to less stringent building codes may suffer greater damage as they are typically more vulnerable to impacts of subsidence.
Environment	• If a subsidence event resulted in hazardous materials spills, long-term negative effects may be seen in the nearby natural environment. • Subsidence/sinkhole events can alter the topography, potentially displacing wildlife and damaging habitats.
City Economic Conditions	• Land subsidence is unlikely to significantly impact the local economy; economic impacts would likely be localized to the subsidence site and temporary. • Some businesses not directly damaged by subsidence may be negatively impacted while roads are restored, further slowing economic recovery.
Public Confidence in Governance	• Land subsidence has the potential to negatively impact public confidence in local government if there are perceptions that sinkholes or other subsidence hazards are not being addressed and repaired quickly and acceptably.

CONSEQUENCE ANALYSIS – LIGHTNING

Table B-9. Consequence Analysis – Lightning

LIGHTNING	
HAZARD / THREAT DESCRIPTION	
Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground.	
RISK AND VULNERABILITY ASSESSMENT	
People	• All people within the City of Baytown planning area are considered at risk to lightning.

APPENDIX B: CONSEQUENCE ANALYSIS

LIGHTNING	
	• Those caught outdoors during lightning activity are at much greater risk than those located inside. • Lightning has resulted in 15 fatalities and 56 injuries in Chambers and Harris Counties since 1996.
Property	• The entire general building stock and all infrastructure of the City of Baytown planning area are considered exposed to the lightning hazard. • Lightning can damage buildings, cause electrical, forest, and/or wildfires, and impair infrastructure such as power transmission lines and communication towers.
Environment	• The primary impact of lightning on the environment is its potential to ignite wildfires. When lightning is paired with drought or high winds, a wildfire can ignite and become very difficult to contain.
City Operations	• The impact on the City of Baytown's due to lightning is considered limited, meaning critical facilities being shutdown for 24 hours or less and less than 10 percent of property destroyed.
CONSEQUENCE ANALYSIS	
Public	• Lightning events can pose a significant risk to people and create dangerous and demanding situations for public health and safety officials. • Individuals exposed to the storm can be directly struck, posing significant health risks and potential death. • Structures can be damaged or crushed by falling trees damaged by lightning, which can result in physical harm to the occupants. • Lightning can also result in power outages, putting those who rely on power for health and safety at risk.
Responders	• Responders can be exposed to greater risk than the general public, as they are often required to travel outdoors during lightning events. • Lightning strikes can be associated with structure fires and wildfires, creating additional risk to residents and first responders.
Continuity of Operations	• Power outages can lead to service disruptions for city operations at agencies and departments that are not equipped with emergency power generators.

LIGHTNING	
	• Potential damage to infrastructure, equipment, and systems, can lead to operational disruptions for all government functions.
Property, Facilities, and Infrastructure	• Homes, critical facilities, or infrastructure struck by lightning may suffer significant damage to electrical components causing system failures, data loss, and equipment overload. • Lightning strikes often cause structure fires, damaging or destroying critical structures and infrastructure.
Environment	• Lightning strikes directly to trees may damage or kill them. • The most significant environmental impact is the potential for lightning-ignited wildfires.
City Economic Conditions	• Significant, long-term economic impacts due to lightning are unlikely. • Power outages resulting from lightning may negatively impact the local economy. • Some businesses not directly damaged by lightning events may be negatively impacted while utilities are being restored, further slowing economic recovery.
Public Confidence in Governance	• Public confidence in local government will be impacted by how the response to a lightning event is perceived and will be maintained by how the recovery from the event is handled. • If the perception develops that the response was slow, needs or complaints of residents are ignored, or the City failed to anticipate the magnitude of the event, then public confidence will decline.

CONSEQUENCE ANALYSIS – SEVERE WINTER STORM

Table B-10. Consequence Analysis – Severe Winter Storm

SEVERE WINTER STORM
HAZARD / THREAT DESCRIPTION
A severe winter storm event is identified as a storm with snow, ice, or freezing rain. Winter storms are associated with freezing or frozen precipitation such as freezing rain, sleet, snow, and the combined effects of winter precipitation and strong winds. Wind chill is a function of temperature and wind. Low wind chill is a product of high winds and freezing temperatures.

APPENDIX B: CONSEQUENCE ANALYSIS

SEVERE WINTER STORM	
RISK AND VULNERABILITY ASSESSMENT	
People	• Winter storm conditions (e.g., extreme cold, freezing rain, snow, sleet, ice, and high wind) can have direct impacts on members of the community. • Certain populations, such as those experiencing homelessness, older adults, young children, and those with preexisting medical conditions are more vulnerable to the impacts of winter storms. • Extreme cold exposure can cause hypothermia or frostbite, with the potential to be fatal.
Property	• All populations, buildings, critical facilities, and infrastructure in the City of Baytown planning area are vulnerable to severe winter events. Common impacts include power outages, burst pipes, and damage caused by falling tree limbs.
Environment	• There are potential impacts to wildlife, plants, and crops that are unaccustomed to living in colder temperatures. However, risks to wildlife would be mild because winter storm events tend to be of a short duration in the area.
City Operations	• The most significant impacts of winter storm on the City of Baytown's operations are likely to be related to unsafe travel conditions and power outages. As seen during Winter Storm Uri in 2021, prolonged power outages during winter storms are a potential risk in the State of Texas.
CONSEQUENCE ANALYSIS	
Public	• The greatest risk from a winter storm hazard is to public health and safety. Exposure to cold temperatures can cause severe or life-threatening health problems particularly for infants and the elderly, who are less able to regulate body temperature than healthy adults. Human health concerns associated with cold temperatures include hypothermia and frostbite. • Loss of electric power, sources of heat, or both can increase potential for health risks associated with fire injuries or hazardous gas inhalation because residents burn candles for light or use fires or generators to stay warm.

APPENDIX B: CONSEQUENCE ANALYSIS

SEVERE WINTER STORM	
Responders	• Response personnel are subject to the same impacts and risks as the general public. This includes utility workers, public works personnel, debris removal staff, tow truck operators, and any other group responding to the effects of the severe winter storm. • Response personnel exposure to winter storm event hazards would be greater than the general population, as they may be required to work outside in extreme cold and travel in unsafe conditions.
Continuity of Operations	• Buildings, such as facilities, government buildings, and cultural and historic resources, can incur roof or structural damage from downed trees, damage to paved areas, and broken pipes due to a winter storm event. • Road and bridge closures, as well as transit service disruptions, to protect public safety may be a consequence. • Severe winter storms, such as Winter Storm Uri in 2021, have the potential to delay services or shut down City operations for extended periods.
Property, Facilities, and Infrastructure	• Winter storms have the capacity to directly impact roads, railroads, bridges, and other transportation infrastructure. Depending on the extent of the winter storm event, infrastructure may be impacted for an extended period or may require time to repair. • Water infrastructure may be directly damaged during winter storms by frozen and cracked pipes. Service disruptions and outages that far outlast the extent of the storm may occur. • Extended power outages may occur and damages to powerlines and other energy infrastructure may take longer than the duration of the storm to repair.
Environment	• Natural resources may be impacted by extended exposure to cold air from winter storms, including agricultural crops and plants and trees in local parks and on personal property. • Fish and wildlife unaccustomed to living in colder temperatures could perish or access to food and water may be limited. • Winter storm events could lead to tree, shrub, and plant damage or death.

SEVERE WINTER STORM	
City Economic Conditions	• Increased consumption and limited production of resources may result in higher prices and limited availability for products. • Ice and snow on roadways may cause supply chain disruptions, further limiting access to resources, and may limit workers' ability to get to work, creating lost wages. • Cleanup and repair costs may impact local government and the private sector. • While cleanup and repair costs would likely be addressed with insurance coverage, available state and federal assistance, or operating reserves, the extent of damage can still result in significant costs.
Public Confidence in Governance	• A response to winter storm events that is perceived as insufficient can impact the public's confidence in its government and leaders. • Perceptions of slow response to power outages, the clearing of roads, and responses to emergency calls may significantly impact public confidence. • If necessary, rationing of electricity needs to be conscientiously implemented to avoid the appearance of bias or impropriety.

CONSEQUENCE ANALYSIS – THUNDERSTORM WIND

Table B-11. Consequence Analysis – Thunderstorm Wind

THUNDERSTORM WIND	
HAZARD / THREAT DESCRIPTION	
Thunderstorms create extreme wind events which includes straight-line winds. Wind is the horizontal motion of the air past a given point, beginning with differences in air pressures. Straight-line winds are responsible for most thunderstorm wind damages. One type of straight-line wind, the downburst, is a small area of rapidly descending air beneath a thunderstorm.	
RISK AND VULNERABILITY ASSESSMENT	
People	• While all citizens are at risk to the impacts of thunderstorm wind, forced relocation and disaster recovery drastically impact low-income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes.

APPENDIX B: CONSEQUENCE ANALYSIS

THUNDERSTORM WIND	
	• Warning time for these events is typically enough for individuals to seek shelter, some populations such as young children, the elderly, or those with disabilities may have trouble taking shelter due to mobility issues or lack of awareness.
Property	• Due to the randomness of these events, all existing and future structures and facilities in the City of Baytown could potentially be impacted and remain vulnerable to possible damage or property loss from strong thunderstorm winds. • Trees, power lines and poles, signage, manufactured housing, radio towers, concrete block walls, storage barns, windows, garbage receptacles, brick facades, and vehicles – unless reinforced – are vulnerable to thunderstorm wind events.
Environment	• Thunderstorm winds are a natural phenomenon and are unlikely to result in catastrophic or prolonged natural or environmental damages directly. • Thunderstorm wind impacts to the built environment may result in significant secondary impacts to the natural environment, such as damage and disruption to ecosystems in the event of a wind-caused chemical spill.
City Operations	• An extreme wind event can also result in traffic disruptions, injuries, and in rare cases, fatalities. • Power outages due to downed power lines or energy infrastructure are possible. • Widespread or prolonged interruptions to City operations due to thunderstorm winds are unlikely.
CONSEQUENCE ANALYSIS	
Public	• Thunderstorm wind events have the potential to pose a significant risk to people and create dangerous and difficult situations for public health and safety officials. • Individuals exposed to the storm can be struck by flying debris, falling limbs, or downed trees. • Residential structures can be damaged or crushed by falling trees, resulting in physical harm to the home's occupants.

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THUNDERSTORM WIND	
Responders	• Large amounts of debris, such as downed trees, can result in emergency response vehicles unable to access areas of the City planning area. • Downed power lines may result in roadways being unsafe for use, preventing first responders from responding to calls for assistance. • During heavy wind events, first responders may be prevented from responding to calls, as the winds may reach a speed at which their vehicles and equipment are unsafe to operate.
Continuity of Operations	• Critical facilities may not be accessible to staff unable to leave their neighborhood due to roadway debris or other obstructions. In that case, those staff members would be limited to performing work with available resources from their remote location. • If files (hard or electronic) are damaged, destroyed, or otherwise inaccessible, a City department may be unable to perform its assigned tasks and deliver its designated services.
Property, Facilities, and Infrastructure	• If debris downed by thunderstorm winds results in the closure of roadways over a large area, this would lead to a temporary halt to any repair of damaged infrastructure, impede emergency response activities, and interrupt the standard delivery of goods and services. • Damaged electrical substations, downed power lines, and roadway obstructions are all common occurrences during thunderstorm wind events, and all will impact a community's normal operations and service delivery.
Environment	• Thunderstorm wind is known to pose a risk to the environment, though it is unlikely to result in catastrophic or prolonged natural or environmental damage. • Thunderstorm wind impacts to the built environment may result in significant secondary impacts to the natural environment, such as damage and disruption to ecosystems in the event of a wind-caused chemical spill.
City Economic Conditions	• Large-scale wind events can cause significant property damage to homes, businesses, industrial properties, and government buildings. This can have a significant economic impact on the affected area.

THUNDERSTORM WIND	
	• Damage to infrastructure, which is common from severe thunderstorm winds, will generally slow down the community's economic recovery, as it often slows the re-opening of businesses and can limit the clean-up effort. • The economic and financial impacts of thunderstorm wind on the area will depend entirely on the scale of the event, what is damaged, and how quickly repairs to critical components of the economy can be implemented.
Public Confidence in Governance	• Public confidence in local government may be impacted by the perception of the City's response to a thunderstorm wind event, depending on how the event was handled. • A response that demonstrates to residents that the City and its leaders/officials were prepared for the event, anticipated the magnitude, and responded appropriately, will promote goodwill among its citizens. • Public confidence will decline if residents' perception is that the City was not prepared, response was slow, and needs of residents were ignored.

CONSEQUENCE ANALYSIS – TORNADO

Table B-12. Consequence Analysis – Tornado

TORNADO	
HAZARD / THREAT DESCRIPTION	
A tornado is a rapidly rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornadoes are among the most violent storms on the planet, with the most violent tornadoes being capable of tremendous destruction and windspeeds of 250 miles per hour or more.	
RISK AND VULNERABILITY ASSESSMENT	
People	• All populations in the City of Baytown are considered to be exposed to tornadoes and could potentially be impacted. • Those below the poverty line may be most affected by a tornado, as forced relocation and disaster recovery drastically impacts low-

TORNADO	
	income residents who lack the financial means to travel, afford a long-term stay away from home, and to rebuild or repair their homes. • The vulnerability of humans and property is difficult to evaluate since tornadoes form at different strengths, in random locations, and create relatively narrow paths of destruction.
Property	• Although tornadoes strike at random—making all buildings vulnerable – three types of structures are most likely to suffer damage: manufactured or mobile homes; homes on crawlspaces (more susceptible to lift); and buildings with large spans, such as shopping malls, gymnasiums, and factories.
Environment	• Tornadoes are a natural phenomenon and are unlikely to result in catastrophic or prolonged natural or environmental damage. • The greatest risks to the natural environment from a tornado are the cascading impacts from tornado damage to the built environment, such as spills of hazardous chemicals into the local ecosystem.
City Operations	• Tornadoes have the potential to greatly disrupt City operations, as strong tornadoes can completely devastate structures and infrastructure along their paths. Significant interruptions or delays in City services and operations may occur depending on what critical facilities, infrastructure, or other structures are damaged by a tornado's winds or flying debris.
CONSEQUENCE ANALYSIS	
Public	• Tornadoes have the potential to pose a significant risk to the population and can create dangerous situations during which providing and preserving public health and safety is difficult. • Individuals who are exposed to the storm can be struck by flying debris, falling limbs, or downed trees. • Residential structures can be damaged or crushed by falling trees, which can result in physical harm to the occupants. • Power outages and delays in emergency responses resulting from tornadoes may also place the public in unsafe situations.
Responders	• In addition to the potential impacts faced by the general public, response personnel must enter the damage area shortly after the

TORNADO	
	tornado passes to begin rescue operations and to organize cleanup and assessment efforts. • During these efforts, response personnel are exposed to downed power lines, unstable and unusual debris, hazardous materials, and generally unsafe conditions.
Continuity of Operations	• Tornadoes are a threat to operations and service delivery in the City of Baytown and have the potential to significantly impact the continuity of operations. • Critical facilities may not be accessible to all staff, as they may be unable to leave their neighborhood due to roadway debris or other obstructions. • If files (hard or electronic) are damaged, destroyed, or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services. • Private sector entities that the City and its residents rely on, such as utility providers, financial institutions, and medical care providers, may be similarly impacted by a tornado event and should have specific preparedness plans that are routinely exercised.
Property, Facilities, and Infrastructure	• Tornadoes typically damage the infrastructure of a community, including buildings, facilities, roads, bridges, power lines, and power plants. It can take a significant amount of time to fully repair these facilities and infrastructure, depending on the nature of the damage and the availability of resources dedicated to the project. • Some businesses rely more heavily on utility infrastructure than others. For example, grocery stores are typically reliant upon electricity to maintain the safety of their food supply. Some larger chain stores may have emergency power generators and fuel on hand, but smaller, independent stores often do not.
Environment	• Tornadoes are known to pose a risk to the environment, though they are unlikely to result in catastrophic or prolonged natural or environmental damage. • Tornado impacts to the built environment may result in significant secondary impacts to the natural environment, such as damage and disruption to ecosystems in the event of a wind-caused chemical spill.

APPENDIX B: CONSEQUENCE ANALYSIS

TORNADO	
City Economic Conditions	• The potential financial and economic risks associated with tornadoes may be significant for the City. A major tornado, where many structures are damaged or destroyed, can have serious economic and financial consequences for a community. • A community affected by significant property damage would need to fund infrastructure repair and restoration, temporary services and facilities, overtime pay for responders, and normal day-to-day operating expenses. • Large or intense tornadoes can also result in dramatic population fluctuations, as people are unable to return to their homes or jobs and must seek shelter and/or work outside of the affected area. They may require temporary relocation assistance, and some of them may choose not to return to the community. • In addition to property damage and revenue interruptions, tornadoes often result in additional unexpected costs to the local government. Debris removal, staff overtime, additional personnel, services, and repairs to damaged structures will result in unexpected costs.
Public Confidence in Governance	• Public confidence in local government may be impacted by how response and recovery efforts resulting from a tornado event are handled. • A response demonstrating that the City, its leaders, and officials were prepared for the event, anticipated the magnitude, and understood what could happen, will boost the City's reputation and standing with residents. • If the perception developed that the response was slow, needs or complaints of City residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence will decline.

APPENDIX B: CONSEQUENCE ANALYSIS

CONSEQUENCE ANALYSIS – WILDFIRE

Table B-13. Consequence Analysis – Wildfire

WILDFIRE	
HAZARD / THREAT DESCRIPTION	
Wildfire is an unplanned fire burning in natural or wildland areas such as forests, shrub lands, grasslands, or prairies. Wildfires have the potential to spread quickly given the right environmental conditions, particularly within the wildland urban interface and intermix. Most ignition sources for wildfires are a result of human activities, such as an electrical line sparking dry grasses, an improperly discarded cigarette, burning debris, or arson.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Areas along railroads and people residing in woodland settings have an increased risk of being affected by wildfire. • Populations within the Wildland-Urban Interface (WUI) are considered at the greatest risk to wildfires. In the City of Baytown planning area, 26 percent of the total population live within the WUI. • As population and population density increases in the City of Baytown, risk to wildfire impacts on residents would increase. • The most heavily populated areas of the planning area are not highly likely to experience large, sweeping fires.
Property	• Structures and infrastructure within the WUI are subject to the greater risk to wildfires, though all of the City of Baytown planning area is at some risk. • Unoccupied buildings and open spaces that have not been maintained have the greatest vulnerability to wildfire.
Environment	• Diminished air quality can result from a wildfire event and pose a potential health risk. • The smoke plumes from wildfires can contain potentially inhalable carcinogenic matter. Fine particles of invisible soot and ash that are too microscopic for the respiratory system to filter can cause immediate and possibly long-term health effects. • Large wildfires can devastate forests, parks, undeveloped land, and other features of the natural environment. • Climatic conditions such as severe freezes and drought can significantly increase the intensity of wildfires since these conditions

WILDFIRE	
	kill vegetation, creating a prime fuel source for wildfires. The intensity and rate at which wildfires spread are directly related to wind speed, temperature, and relative humidity.
City Operations	• Wildfires which impact the City's critical facilities could substantially impact City operations. Critical facilities and infrastructure located within the WUI would be considered most vulnerable to wildfire.
CONSEQUENCE ANALYSIS	
Public	• A wildfire event poses a potentially significant risk to public health and safety, particularly if the wildfire is initially unnoticed and spreads quickly. • Persons in the area at the time of the fire are at risk for injury or death from the variety of threats present during a wildfire event. Burns to the human body and smoke inhalation are the foremost threats.
Responders	• Response personnel face the same potential impacts as the public, but face an increased risk of physical injury because the nature of their responsibilities may bring them closer to the hazard. • Response personnel can experience more long-term impacts resulting from prolonged exposure to smoke, chemicals, and heat. Heart disease, respiratory problems, and related illnesses can develop in response personnel after repeated and concentrated exposure.
Continuity of Operations	• Depending on the characteristics and location of the wildfire event, operations and service delivery could be impacted by a wildfire. • If hard or electronic files are damaged, destroyed or otherwise inaccessible, a City department may be unable to perform its assigned tasks and deliver its designated services. This interruption could have significant impacts throughout the City and could negatively impact its ability to respond to and recover from the wildfire event.
Property, Facilities, and Infrastructure	• Damage from a wildfire can impact utility infrastructure, resulting in a temporary loss of function for businesses in the planning area that rely on utilities for operation, even if those businesses were not directly impacted by the fire. • Firefighters may need to close a roadway if a wildfire grows outs of control or shifts unexpectedly.

WILDFIRE	
	• Most property, facilities, and infrastructure within the planning area are at some risk from damage or destruction from a wildfire event, including residential and commercial structures and their supporting utilities, vehicles and transportation infrastructure, and community buildings, such as hospitals, police stations, and schools. • Roadways in or near the WUI could also be impacted by wildfire because of damage or closure resulting from smoke and limited visibility.
Environment	• Wildfires are often a natural phenomenon and part of the normal cycle of the natural environment. • Wildfires can result in significant deforestation, wildlife death, and cause water and air pollution. Environmental damage caused by a wildfire event may take decades, or longer, to become fully restored. • Wildfire also performs a variety of environmentally beneficial functions to the burned area. Fire returns nutrients to the soil, encourages growth of more fire-resistant fauna and trees, and promotes the establishment of seedlings. Many wildlife species thrive in the aftermath of wildfire.
City Economic Conditions	• The financial and economic impacts associated with a wildfire event may be significant. A major fire, where many structures are damaged or destroyed, can have serious economic and financial consequences for a community. • The economic and financial impacts of a wildfire event on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented.
Public Confidence in Governance	• Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. • A wildfire that is responded to and handled with little damage to structures or infrastructure can enhance public perception. Visual images of the firefighting and suppression effort can be a powerful tool to aid in the public trust and confidence regarding firefighting and public safety.

WILDFIRE	
	• If the perception develops, correctly or incorrectly, that the response was slow, needs or complaints of its residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence may decline.

CONSEQUENCE ANALYSIS – AVIATION ACCIDENT

Table B-14. Consequence Analysis – Aviation Accident

AVIATION ACCIDENT	
HAZARD / THREAT DESCRIPTION	
An aviation accident is defined as an occurrence associated with the operation of an aircraft that takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which: • A person is fatally or seriously injured; • The aircraft sustains damage or structural failure; • The aircraft is missing or is completely inaccessible.	
RISK AND VULNERABILITY ASSESSMENT	
People	• There is no geographic boundary to aviation accidents; the entire population of the City of Baytown planning area is vulnerable to one of these events.
Property	• There is no geographic boundary to aviation accidents; all structures, critical facilities, and infrastructure in the City of Baytown planning area are vulnerable to one of these events. • Certain facilities may be more vulnerable due to their proximity to the airports and areas with high air traffic.
Environment	• Aviation accidents are unlikely to significantly impact the natural environment, however accidents involving fires or spilled fuel may result in impacts such as water contamination, soil degradation, or wildfires.
City Operations	• Aviation accidents are typically isolated events with narrow event areas, meaning widespread disruptions in City operations are unlikely. City personnel and facilities which are in close proximity to airports,

AVIATION ACCIDENT	
	areas of high air traffic, and flight corridors are at higher risk of their normal operations being disrupted.
CONSEQUENCE ANALYSIS	
Public	• Aviation accidents can result in injury or death for both those on board the involved aircraft(s) and those within close proximity at the time of the incident. • An aircraft incident within the planning area could lead to long-term psychological impacts on the public, even for those who were not directly impacted.
Responders	• Responders face the same potential impacts as the general public but may be put at greater risk as they perform essential duties at the incident site. • During these efforts, response personnel may be exposed to downed power lines, unstable and unusual debris, spilled fuel or other hazardous materials, and generally unsafe conditions.
Continuity of Operations	• Aviation accidents have the potential to disrupt operations and services, depending on the location and nature of the incident. • Air traffic may face delays or further complications following an aviation accident. • City resources and personnel may be strained during response to significant aviation accidents • Wide-spread or long-term disruptions in City operations and services are unlikely to be caused by an aviation incident.
Property, Facilities, and Infrastructure	• All property, facilities, and infrastructure in the planning area has the potential to be damaged or destroyed from an aviation accident, though this damage would typically be confined to a small area. • Airports, aircrafts, and other aviation infrastructure is most likely to be damaged or destroyed in an incident, potentially leading to costly and long-term impacts on flying in and around the planning area.
Environment	• Aviation accidents are unlikely to significantly impact the natural environment. However, secondary impacts like resulting fires or fuel spills may damage the surrounding natural environment following an incident.

AVIATION ACCIDENT	
City Economic Conditions	• Depending on the nature of the incident, aviation accidents could have long-term impacts on the appeal of air-travel and tourism in the area, negatively impacting the local economy. • Significant aviation accidents may require significant resources and the City may incur substantial losses in response and recovery to the event.
Public Confidence in Governance	• Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. • If the perception develops, correctly or incorrectly, that the response was slow, needs or complaints of its residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence may decline.

CONSEQUENCE ANALYSIS – CYBER ATTACK

Table B-15. Consequence Analysis – Cyber Attack

CYBER ATTACK	
HAZARD / THREAT DESCRIPTION	
A cyber-attack is any type of offensive maneuver employed by individuals or organizations that target computer information systems, infrastructures, computer networks, and personal computer devices by various malicious acts. The malicious act usually originates from an anonymous source that either steals, alters, or destroys a specified target by hacking into a susceptible system.	
RISK AND VULNERABILITY ASSESSMENT	
People	• With the internet being largely open and unregulated, it leaves the planning area vulnerable to cyberattacks and threats. The attack can be on information systems resulting in a data breach, or the spread of a virus. With the growing dependence on digital interconnectivity, even a small incident may have widespread and damaging consequences.
Property	• Transportation, public safety, and utility services are all critical and highly dependent on information technology. The motive behind such disruptions can be driven by religious, political, or other objectives.

APPENDIX B: CONSEQUENCE ANALYSIS

CYBER ATTACK	
Environment	• Cybercrime can result in loss of control of critical equipment and warning systems and has the potential to cause damage to human health and the environment from catastrophic spills, waste discharges, and air emissions. • These events can cause fires, explosions, and hazardous material releases that result in bodily injury, property damage, environmental remediation expense, and significant legal liability claims. • Pipelines can be very vulnerable to cyberattack based on their extensive use of Supervisory Control and Data Acquisition (SCADA) systems to remotely operate the pipeline, control inputs and outputs, and perform critical leak detection.
City Operations	• Threats of cyberattack can have wide-ranging effects on the individual, community, organizational, and national level. • Among cyberattack dangers are viruses erasing entire systems, intruders breaking into systems and altering files, intruders using a computer or device to attack others, and intruders stealing confidential information. The spectrum of cyberattack risks is limitless. • Transportation, power, and other services may be disrupted by large-scale cyber incidents, and the extent of the disruption is highly uncertain as it will be determined by many unknown factors, including the target and size of the incident.
CONSEQUENCE ANALYSIS	
Public	• Cyberattacks can have severe consequences for the public. • Attacks can lead to the release of confidential data that can damage financial security, result in detrimental identity theft, and expose private or compromising information. • The psychological impact of being a victim of cybercrime can lead to a sense of vulnerability and mistrust in digital interactions. • Cyberattacks can also damage critical infrastructure utilized by the public, such as communications, transportation, financial institutions and access to vital public services such as health, education, and social services.

APPENDIX B: CONSEQUENCE ANALYSIS

CYBER ATTACK	
Responders	• There are various agencies that may respond to a cyberattack depending on the nature and victim of the crime. • Cyberattacks on a larger scale would likely require intervention from government agencies such as the FBI, Department of Homeland Security, or the Department of Justice. While some of these agencies possess the explicit purpose of responding to cyberattacks, others may feel a strain on time and personnel resources when faced with the need to respond to unexpected, often unprecedented, and highly sensitive security breaches.
Continuity of Operations	• Transportation, power, communication and other services may be disrupted by large-scale cyber incidents, and the extent of the disruption is highly uncertain as it will be determined by many unknown factors such as the target and size of the attack. • A shutdown of transportation networks may prevent people from attending work, school, reaching essential medical services, or attending to others who depend on their care. • Disruption to networks that provide social services can have dire and stressful impacts on those who rely on these resources.
Property, Facilities, and Infrastructure	• Given the wealth of personal information they hold, real estate and construction companies are particularly attractive targets for cyberattacks and should take steps to safeguard their data. • While threats to property through cyberattacks are considered mostly secondary, the potential impacts to the real estate market and moreover the health of the economy are substantial. • Cyber threats to data and operations systems can take a facility offline, leading to disruption of care due to software outages. In addition, the loss of access to health records may limit a provider's ability to administer appropriate care, shelter, and medicine in times of need. • Infrastructure systems are often interconnected and rely on digital technologies, making them more susceptible to cyberattacks. Attacks on critical infrastructure can have severe consequences, including loss of life, economic damage, national security threats, and social unrest.

APPENDIX B: CONSEQUENCE ANALYSIS

CYBER ATTACK	
Environment	• The loss of control of critical equipment and warning systems due to a cyberattack has the potential to cause damage to human health and the environment. A lapse in control of these systems can result in catastrophic spills, dam failure, waste discharges, and harmful air emissions. • Pipelines are particularly vulnerable to cyberthreats due to their extensive use of computer systems for operations such as remotely operating pipelines, controlling input and outputs, and performing critical failure detections.
City Economic Conditions	• Cybercrime's most significant impacts include financial and economic hardship, loss of critical intellectual property and sensitive data, and loss of revenue from diminished international trade. • A significant consequence of a cyberattack is a sudden decline in sales as wary clients seek services elsewhere to avoid the risk of cybercrime. • Companies can potentially lose money due to hackers attempting to extort money from their victims. Additionally, consumers may knowingly or unknowingly inherit the costs and consequences of businesses and companies who fall victim to cyberattacks.
Public Confidence in Governance	• Public confidence will almost certainly be impacted by a cyberattack. The public's perception of the emergency response to an attack will be determined by the process of recovery and repair as a result of the event. • If the perception developed that the response was slow, that needs or complaints of its residents were ignored, or that the leadership fails to anticipate the magnitude of the event, then public confidence can decline. • A cyberattack that is responded to and handled with little damage to public trust or services will enhance public perception.

APPENDIX B: CONSEQUENCE ANALYSIS

CONSEQUENCE ANALYSIS – DISRUPTION OF SERVICES

Table B-16. Consequence Analysis – Disruption of Services

DISRUPTION OF SERVICES	
HAZARD / THREAT DESCRIPTION	
Disruption of services refers to the interruption of essential public services and infrastructure systems that support daily life, safety, and day-to-day operations. These disruptions can significantly impact residents, businesses, schools, and emergency response efforts. Types of disruptions include power outages, water service interruptions, and telecommunication failure.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Disruption of services can result from a wide range of events including natural hazards, human activity, or mechanical or technological malfunctions. The entire planning area population is at risk, as there is no geographic boundary to a disruption of service event. • Vulnerable populations such as those below the poverty line, those with disabilities, or those with limited English speaking may be disproportionately affected by a disruption of services.
Property	• Power, water, and telecommunication disruptions have the ability to impact all structures within the planning area. • The electrical grid is susceptible to damage from hazard events and outages can last for hours or days.
Environment	• Disruptions in critical infrastructure or utilities which support or maintain the natural environment could place the local ecosystem at risk.
City Operations	• City operations may be greatly impacted by disruptions of services. Those that rely on water, electricity, telecommunications, or any other disrupted services would be unable to function normally for the duration of the event.
CONSEQUENCE ANALYSIS	
Public	• Significant health and safety impacts may be felt by the public during disruption of service events, including inability to access potable water; inability to access emergency alerts; and the loss of power.

APPENDIX B: CONSEQUENCE ANALYSIS

DISRUPTION OF SERVICES	
	• Those that rely on electricity for health and safety will be placed in dangerous circumstances during loss of power. • Schools, hospitals, and emergency services may be forced to close or operate at reduced capacity, leaving residents without access to essential services.
Responders	• If telecommunications networks are down, emergency services may struggle to coordinate efforts or respond to incidents. • There is an excess strain on emergency responders as they address widespread service outages. • There is increased pressure on hospitals and emergency care facilities, especially if utilities like electricity and water are compromised.
Continuity of Operations	• Major events impact local government operations and services, delaying recovery efforts and public assistance. • Loss of telecommunications services will prevent City personnel from coordinating emergency response and relief efforts as well as essential functions. • Loss of power and water utilities may make normal operations impossible for the duration of the event.
Property, Facilities, and Infrastructure	• Hydropower and thermal plants that rely on water for temperature control may be damaged or inoperable during water service disruptions. • Prolonged disruptions in services may lead to damages to infrastructure and facilities which may require additional time to repair.
Environment	• Disruption of service events are unlikely to cause catastrophic or long-lasting impacts on the natural environment. However, losses of communication, water, and power may impact personnel and equipment used to maintain or support the natural environment and ecosystems.
City Economic Conditions	• The City of Baytown's economy is heavily reliant on petrochemical plants and manufacturing. Service disruptions such as power outages or water interruptions can halt production, damage equipment, and lead to financial losses.

DISRUPTION OF SERVICES	
	• Local retailers, restaurants, and service providers rely on power and telecommunications to operate effectively, and interruptions may cause loss of revenue.
Public Confidence in Governance	• Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. • If the perception develops, correctly or incorrectly, that the response was slow, needs or complaints of its residents were ignored, or the City failed to anticipate the magnitude of the event, then public confidence may decline.

CONSEQUENCE ANALYSIS – HAZARDOUS MATERIALS

Table B-17. Consequence Analysis – Hazardous Materials

HAZARDOUS MATERIALS (Fixed and Mobile)	
HAZARD / THREAT DESCRIPTION	
Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. A hazardous material (HAZMAT) incident involves a substance outside normal safe containment in sufficient concentration to pose a threat to life, property, or the environment. These incidents can happen across various sectors, including industrial facilities, road transportation, pipeline transportation, rail transportation, maritime transportation, and aviation transportation.	
RISK AND VULNERABILITY ASSESSMENT	
People	• Populations nearest to locations where hazardous materials are stored, transported, or manufactured are at the greatest risk to hazardous materials incident. These would include facilities such as the ExxonMobile Baytown Complex and transportation routes such as the Union Pacific Railroad which may carry hazardous materials.
Property	• Property, facilities, and infrastructure are all subject to significant impacts from hazardous materials. Hazardous materials incidents often involve fire or explosions that can impact property and facilities, including roadways and bridges.

HAZARDOUS MATERIALS (Fixed and Mobile)	
	• If the event is significant enough, utilities in the area may need to be temporarily suspended or disconnected, which would impact multiple facilities and properties.
Environment	• The environment is often vulnerable in, and can be heavily damaged by, a hazardous materials incident.
City Operations	• Hazardous materials incidents have the potential to significantly impact City operations, depending on the nature and severity of the event. Resulting emergency situations, utility disruptions, and environmental impacts from hazardous materials incidents may disrupt or stress normal City operations.
CONSEQUENCE ANALYSIS	
Public	• Hazardous materials incident can result in severe injuries and fatalities. • It is likely that inhaled hazardous gasses may result in respiratory problems, including burning sensations in the lungs, nose, and throat. • Releases that involve solids or liquids can be absorbed through the skin and may cause burns on contact. • In some instances, the threat to health and safety may not be evident for an extended period of time.
Responders	• Response personnel are at greater risk from more concentrated or prolonged exposure to the agent involved in the hazardous materials incident. • Through response efforts, response personnel can encounter hazardous materials before the nature of the hazard is determined. • Response personnel have a greater likelihood of being impacted by secondary explosions or leaks. • Roadway damage resulting in unstable foundations or bridge and overpass instability may create an impact and more dangerous situations in which response personnel must work.
Continuity of Operations	• Generally, hazardous materials incidents will interrupt operations and services within a limited area. The incident may result in the closure of multiple facilities and transportation infrastructure until the area can be remediated and made safe and habitable.

HAZARDOUS MATERIALS (Fixed and Mobile)	
	• The nature of an operational and service interruption will depend on the facilities in the impacted area. • Damage to roadways, railways, and physical infrastructure resulting from transportation of hazardous materials can impair normal operations and delivery of services.
Property, Facilities, and Infrastructure	• Property, facilities, and infrastructure are all subject to significant impacts from hazardous materials. Hazardous materials incidents often involve fire or explosions that can impact property and facilities, including roadways and bridges. • Gas lines, water lines, sewer lines, and communication lines can be interrupted or destroyed, depending on the nature of the event. • If the event is significant enough, utilities in the area may need to be temporarily suspended or disconnected, which would impact multiple facilities and properties.
Environment	• Environmental risks from hazardous materials incidents can range from nonexistent to catastrophic, depending on the nature of the release. • In a hazardous materials transportation incident, specialized containment, mitigation, and cleanup capabilities and procedures may be required to reduce environmental impacts. • Very little environmental testing or monitoring is completed after hazardous materials incidents, especially incidents in which there may be no impacts to monitor, because testing and monitoring can be expensive in terms of financial investments and staff resources. • The environment may experience significant damage leading to air and water contamination, loss of wildfire, agriculture, and tourism.
City Economic Conditions	• The risks to economic and financial sectors can be deeply felt and long-lasting. • Industries which handle, produce, or store hazardous materials make up a significant portion of the City of Baytown's economy; in 2023, 33 sites in the planning area reported hazardous chemical releases per the EPA's Toxic Release Inventory. Incidents which led to a temporary or prolonged shutdown of these facilities could lead to significant negative economic impacts.

HAZARDOUS MATERIALS (Fixed and Mobile)	
	• Economic disruption negatively impacts the programs and services provided by the community due to short- and long-term loss in revenue. • Cleanup costs, loss of access to facilities, and lost business or customers are all possible impacts after a hazardous materials incident.
Public Confidence in Governance	• For minor hazardous materials incidents, there is generally no impact to public confidence because most people are either not impacted or unaware that the incident has even occurred. • For larger incidents, the threat to public confidence is determined by how the public perceives the event is handled. Public perception will impact the public's behavior during the next incident. • Misunderstood, confusing, and/or conflicting messages from emergency management officials, or delivery mechanisms that are ineffective, could have negative impacts to public confidence in emergency management staff and leadership.

CONSEQUENCE ANALYSIS – INFECTIOUS DISEASE

Table B-18. Consequence Analysis – Infectious Disease

INFECTIOUS DISEASE	
HAZARD / THREAT DESCRIPTION	
An infectious disease is a clinically evident disease resulting from germs, such as bacteria, viruses, and fungi, that enter the body, multiply, and cause infection. Some infectious diseases are contagious or communicable, meaning they can spread from one person to another. Other infectious diseases can be spread by germs carried in air, water, food, or soil. They can also be spread by vectors, like biting insects, or by animals to humans.	
RISK AND VULNERABILITY ASSESSMENT	
People	• The entire population of the planning area would be at risk to a pandemic-level infectious disease event, though certain vulnerable populations including the elderly, young children, and those with preexisting medical conditions would be at greater risk for severe health impacts.

APPENDIX B: CONSEQUENCE ANALYSIS

INFECTIOUS DISEASE	
Property	• Estimated potential losses to the built environment are difficult to calculate because infectious disease causes little damage to the built environment and generally losses are experienced through public health response and medical costs, and lost wages of patients. • It is assumed that all buildings and facilities are exposed to disease but would experience negligible damage in the occurrence of an outbreak event.
Environment	• Human infectious diseases do not normally pose a risk to the natural environment. • Certain exceptions exist, including the avian flu, which can affect both birds and humans. It is possible that other pathogens may affect more than one species, but those pathogens would likely be limited to specific species.
City Operations	• The recent COVID-19 pandemic demonstrated that the response costs to the public health sector for an outbreak, the economic impact, and the impact to health as a whole for the City of Baytown planning area, is "Substantial." • As in the case of COVID-19, outbreaks can result in mandatory shutdowns of non-essential businesses and overall severe impacts on normal City operations.
CONSEQUENCE ANALYSIS	
Public	• Pandemics impact larger than normal segments of the population and few sectors of the population are left untouched by infectious disease, as evidenced by the COVID-19 pandemic. • The impact of an infectious disease event will be measured by the number of fatalities, how the community is affected, and to what extent. • If many people get sick simultaneously, major social consequences will occur. • Absenteeism in the workplace can have negative impacts on the overall functioning of society, particularly if it is prolonged.
Responders	• The risks to public health and safety include first responders and others with increased exposure to the disease.

INFECTIOUS DISEASE	
	• Response personnel likely to experience the greatest impact would be those with medical responsibilities, such as fire fighters, ambulance workers, and clinic and hospital personnel. • Response personnel could be in frequent contact with those who are either sick or infected and are prone to suffer proportionally higher impacts as a result.
Continuity of Operations	• Depending on the severity of the infectious disease event, there could be serious problems with continuity of operations and delivery of services. • If City staff stay home due to illness, someone in their home is ill, or because they fear becoming ill, the ability of local government to maintain operations and deliver services could be severely limited or compromised. • A vital part of pandemic planning is the development of strategies and tactics to address these potential problems. This includes psychological health resources, identifying at-risk populations, and protocols for disbursing vital health information to the public.
Property, Facilities, and Infrastructure	• An infectious disease hazard affects living beings, therefore the vulnerability of property to an infectious disease event is minimal. • there is the possibility of indirect damage resulting from staff absenteeism and lack of routine operations and maintenance.
Environment	• The primary consequence of infectious diseases on the environment can be attributed to potentially significant impacts on wildlife populations. “Zoonotic” diseases which can spread between humans and animals could lead to the decline or extinction of specific species in the planning area and result in overall ecosystem destabilization.
City Economic Conditions	• Major infectious disease events and pandemics can be expected to have larger and deeper impacts to the local and national economy. • If the disease is slow progressing, particularly long-lasting, or has long-term residual effects, the impact to the economy could be extended. • Negative economic impacts will result from mandatory shutdown of non-essential businesses and cancellation of public events, as seen in the recent COVID-19 pandemic.

INFECTIOUS DISEASE	
Public Confidence in Governance	• Infectious disease events can undermine the public's confidence in its government and leaders. Public dissatisfaction with the governments response will typically increase as the number of cases rises and public fear increases. • Perceptions of inequality in medical care, particularly if those inequalities are based on socioeconomic status, ethnicity, age, gender, or seniority, can lead to increased dissatisfaction with government and leadership, and may result in a weakening of social order or hostility towards those in leadership or medical roles. • There could be significant public resistance to a decision to quarantine those who are ill or exposed, to restrict travel, or to implement social distancing. Any decision to restrict individual movement must be accompanied by a major public relations campaign to assure the public that these actions are necessary.

CONSEQUENCE ANALYSIS – TERRORISM

Table B-19. Consequence Analysis – Terrorism

TERRORISM	
HAZARD / THREAT DESCRIPTION	
A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of issue motivating the attack, and the points of weakness of the terrorist's target. Types of terrorist attacks include: active shooter; civil disturbance / unrest; domestic terrorism; international terrorism; mass casualty events; mass gatherings / large special events; chemical, biological, radiological and nuclear (CBRN) attacks; and explosives or bomb threats.	
RISK AND VULNERABILITY ASSESSMENT	
People	• There is no defined geographic boundary for a terrorist event, therefore the entire population is considered at risk. Several vulnerable populations such as the elderly, young children, and those with disabilities may be more susceptible to the impacts of an event, depending on the type of attack.

APPENDIX B: CONSEQUENCE ANALYSIS

TERRORISM	
Property	• There is no defined geographic boundary for a terrorist event, therefore all buildings, critical facilities, and infrastructure are considered at risk. • However, it is important to note that high-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks.
Environment	• When a terrorist attack occurs, there are many potential environmental impacts due to the varied ways an event can occur. These include air pollution, soil contamination, water pollution and hydrologic impacts, and radiological contamination.
City Operations	• Terrorist events can have a catastrophic impact on City operations, depending on the nature and scale of the attack. Potential impacts are wide ranging.
CONSEQUENCE ANALYSIS	
Public	• Terrorism poses a potentially significant risk to public health and safety. Persons in the area at the time of a terrorist attack are at risk for injury or death from a variety of threats. • The chance for death, injury, and financial loss increases as population density increases. Therefore, locations in the City of Baytown planning area with high population density should be considered most at risk.
Responders	• Response personnel face potential impacts similar to the general public. Response personnel can be at increased risk of physical injury because the nature of their responsibilities may bring them closer to the hazard and secondary incendiary devices are often directed at response personnel. • Response personnel can be subjected to more long-term impacts resulting from prolonged exposure to chemicals or biological weapons.
Continuity of Operations	• Depending on the characteristics and location of the event, it is possible that operations and service delivery could be impacted by a terrorist attack.

TERRORISM	
	• Critical facilities may be inaccessible in the event of a terrorist attack, limiting staff members to performing work with the resources available to them from remote locations. • If hard or electronic files are damaged, destroyed or otherwise inaccessible, a department may be unable to perform its assigned tasks and deliver its designated services.
Property, Facilities, and Infrastructure	• Damage from a terrorist event can impact utility infrastructure, either directly or indirectly, resulting in loss of function and service. • Most property, facilities, and infrastructure within the planning area are at risk from damage or destruction from a terrorism event, including residential and commercial structures and their supporting utilities, vehicles and transportation infrastructure, and community buildings, such as hospitals, police stations, and schools. • Roadways in or near the terrorist event could be impacted because of damage or closure due to response or investigative operations.
Environment	• The environmental consequences of a terrorist attack are difficult to quantify due to the unpredictable nature and severity of this type of event. • Intentional release of hazardous materials into soil, water, or air that leads to environmental contamination which may be difficult to contain and treat, posing potential long-term effects on the environment in a multitude of ways. • In the event of arson or fire-bomb attacks, fire affected regions sustain losses to forest areas, watersheds, and agricultural resources impacting wildlife habitat and essential resources to human health and safety.
City Economic Conditions	• The financial and economic impacts associated with a terrorist event may be significant. • A major attack, where many structures are damaged or destroyed, can have serious economic and financial consequences for a community. These consequences will depend on what is damaged, the extent of the damage, and the services the damaged structures provided to the community.

TERRORISM	
	• The economic and financial impacts of a terrorist event on local government will depend on the scale of the event, what is damaged, costs of repair or replacement, lost business days in impacted areas, and how quickly repairs to critical components of the economy can be implemented.
Public Confidence in Governance	• Public confidence in local government may be impacted by how response and recovery efforts resulting from the event are handled. • A terrorist attack that is responded to and handled with little damage to structures or infrastructure will enhance public perception. Visual images of the first responders can be a powerful tool to aid in the public trust and confidence regarding public safety. • If the perception developed, correctly or incorrectly, that the response was slow, that needs or complaints of its residents were ignored, or that the leadership failed to anticipate the magnitude of the event, then public confidence can decline.



APPENDIX C
CRS REQUIREMENTS

APPENDIX C: CRS REQUIREMENTS

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APPENDIX C: CRS REQUIREMENTS

OVERVIEW

The City of Baytown is an active participant in the Community Rating System (CRS). CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. Approximately 1,500 communities participate in the CRS, which is less than 10 percent of current NFIP participating communities nationwide. Lower class ratings mean lower flood insurance premiums for residents. Out of a 10-point rating system (where 1 is the best), the City of Baytown currently has a class rating of 5. This qualifies the community for a 25 percent insurance discount for the residents of the City of Baytown. Approximately 200 participating CRS communities currently have a rating of 5 or lower. The City of Baytown continues to exceed minimum national standards to increase the community's flood resiliency through comprehensive floodplain management and construction standards and to provide financial relief to homeowners in terms of flood insurance discounts.

FLOOD ZONE DESCRIPTIONS

A floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without increasing the water surface elevation more than a designated height.

The 100-year flood, also referred to as the base flood or Special Flood Hazard Area (SFHA), is the area that will convey water during a 1-percent annual chance flood and constitutes a threat to the planning area. Structures built in the SFHA are subject to damage by rising water and floating debris. Moving flood water exerts pressure on everything in its path and causes erosion of soil and solid objects. If not elevated above Base Flood Elevation, utility systems, such as heating, ventilation, air conditioning, fuel, electrical systems, sewage maintenance systems and water systems, may be damaged.

Zone VE is located within the special flood hazard area. This zone is designated as a coastal high hazard area (V1-30, VE and/or V). These areas are associated with high velocity waters from tidal surges and hurricane wave wash.

The 500-year flood is the area that will convey water during a 0.2-percent annual chance flood. Structures built in the 500-year flood are subject to damage by rising waters and floating debris during a 0.2-percent annual chance flood.

Areas of minimal flood hazard are areas that are unlikely to flood, and are usually designated as FEMA flood zones C or X. These areas lie outside of the regulatory floodway, SFHA, and the 0.2-percent annual flood level.

REPETITIVE LOSS PROPERTIES

The Severe Repetitive Loss (SRL) Grant Program under FEMA provides federal funding to assist states and communities in implementing mitigation measures to reduce or eliminate the long-term risk of flood damage to severe repetitive loss residential structures insured under the NFIP. The Texas Water Development Board (TWDB) administers the SRL grant program for the State of Texas. One of the goals of the Flood Mitigation Assistance (FMA) program is to reduce the burden of repetitive loss and severe repetitive loss properties on the NFIP through mitigation activities that significantly reduce or eliminate the threat of future flood damage.

Repetitive Loss properties are defined as structures that are:

- Any insurable building for which 2 or more claims of more than $1,000 each, paid by the National Flood Insurance Program (NFIP) within any 10-year period, since 1978;
- May or may not be currently insured under the NFIP.

Severe Repetitive Loss properties are defined as residential properties that are:

- Covered under the NFIP and have at least four flood related damage claim payments (building and contents) over $5,000 each, and the cumulative amount of such claims payments exceed $20,000; or
- At least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

In either scenario, at least two of the referenced claims must have occurred within any ten-year period and must be greater than 10 days apart.[1]

Table C-1 shows repetitive loss and severe repetitive loss properties for the City of Baytown planning area by type. Please see Appendix (X) for a comprehensive list of repetitive and severe repetitive loss properties as well as a complete list of structures with previous flood insurance claims.

[1] Source: Texas Water Development Board

APPENDIX C: CRS REQUIREMENTS

Table C-1. Repetitive Loss and Severe Repetitive Loss Properties

JURISDICTION	STRUCTURE TYPE	NUMBER OF STRUCTURES	NUMBER OF LOSSES	HISTORICAL FLOOD CLAIMS
City of Baytown	Single Family	123	307	$14,793,273.06
	Non Residence	15	31	$2,304,797.68
	Business	13	26	$3,294,303.43

PREVENTATIVE ACTIVITIES

COMPREHENSIVE OR LAND USE PLAN

A Comprehensive or Land Use Plan may guide future decisions regarding the growth of the City. These plans, actions, and goals may meaningfully shape the way in which the City spends local funds, sustains infrastructure, protects resources, and much more. The City of Baytown has a comprehensive plan that was adopted on May 26, 2022. The most recent comprehensive plan runs through 2040.

The plan is comprised of an Existing City Report, which examines the historical and current conditions of the City, and a Future City Report, which imagines the future of growth and development in the City of Baytown. The purpose of the Future City Plan is to build upon the research from the Existing City Report to identify goals and priority actions to meet the City's future needs. Each Focus Area addresses these goals and priorities, then an Implementation section ties everything together by assigning the priority actions. This plan outlines the future vision for the City and recommendations on specific Focus Areas including Land Use and Development, Transportation, Housing and Neighborhoods, Growth Capacity, Economic Development, and Recreation and Amenities.

The Comprehensive Plan specifically identifies actions to reduce future flood losses and recognizes how significant an issue flooding is in the City of Baytown. Some actions include developing drainage studies to identify flood prone areas, continuing engaging in the Cedar Bayou Initiative, evaluating the potential for stormwater detention facilities, and coordinating watershed projects to develop regional flood protection. The City's Comprehensive Plan was created with sustainable development as a key component, aligning with the goals and strategies outlined in the mitigation plan and revisions are not considered necessary at this time.

APPENDIX C: CRS REQUIREMENTS

For this activity and all activities herein, please refer to Section 20: Mitigation Actions, for a complete listing of all recommended mitigation measures by hazard and priority, and Appendix H for the City of Baytown Capability Assessment.

BUILDING CODES

Building codes are imperative to reduce future flood losses. The City of Baytown building regulations establish minimum standards for the construction, alteration, maintenance, repair, and demolition of buildings and other structures to protect the safety of the public. The Building Services Division is responsible for administering the codes and ordinances that prescribe minimum construction standards to safeguard the public's health, safety and general welfare. This includes plan review and permits issuance for all construction related activity, whether it is new construction, renovations or repairs. Subsequent field inspections are conducted to ensure that the project adheres to the adopted codes. The City of Baytown adopted the 2015 International Building Code effective November 1, 2020.

These development regulations and building codes are consistent with the goals and strategies of this plan and have considerably reduced flood damage. For example, construction of projects located within an area of special or moderate flood hazard shall have the lowest floor and all facility systems elevated to at least the 500-year floodplain elevation or 24 inches above the base flood elevation, whichever is higher. Slab on grade construction is not permitted for the new construction of residential dwellings. In addition, facilities located in coastal high hazard areas (zone V1-30, VE and/or V) shall be located out of high tide and elevated on pilings and columns.

The City of Baytown will continue to evaluate and enhance its building codes to mitigate flood risks. However, the City can consider upgrading to newer building codes, such as the IBC 2021 or IBC 2024, which include improved flood resilience standards. The City may also explore the opportunity to integrate codes and regulations for green infrastructure, such as, including permeable surfaces in new developments to mitigate flooding.

FLOODPLAIN MANAGEMENT REGULATIONS

Floodplain management regulations establish minimum standards for the construction, alteration, maintenance, repair, and demolition of buildings and other structures inside of floodplains. The City's Flood Damage Prevention Ordinance is codified in Chapter 110, Subpart B, Land Development Code, of the City of Baytown Code of Ordinances. The

City's regulations address regulatory systems for permits and plats, standards for flood hazard reduction, manufactured homes, and enforcement.

Floodplain management regulations are developed for the purpose of mitigating flood losses and are therefore consistent with the goals and strategies of this plan. Flood damage prevention measures have been continually reviewed and updated as needed. The City of Baytown recognizes that the minimum NFIP standards do not adequately provide long-term flood risk reduction, and that climate change is playing a larger role in increased flood risk. The City has adopted standards well in excess of FEMA's minimum standards, such as 2' freeboard above the Base Flood Elevation (BFE), that have considerably reduced flood damage. Higher regulatory standards are continually evaluated for effectiveness as well as identifying additional potential measures to reduce flood risk.

Flooding can happen anywhere in the City of Baytown, and all citizens live in a flood zone even if they are not located in a SFHA, or high-risk flood zone. However, regulations are typically limited to the mapped FEMA Special Flood Hazard Area (SFHA). A significant portion of flooding in the City of Baytown occurs outside the floodplains, due to local ponding and backups in ditches and storm sewers. Many of the affected homes and businesses are in areas outside the mapped SHFA where flood regulations do not currently apply. The City should adopt requirements to expand floodplain regulations to include locally identified flood hazard areas.

Harris County Flood Control District (HCFCD), counties and cities have adopted regulations that are intended to require that new upstream development not worsen downstream flooding by increasing impervious land and runoff, overloading the channels. The regulatory framework, though, is not uniform across watersheds, enforcement powers are limited, and there are instances when developers have found ways to work around the system. Climate changes, including increased rainfall amounts and frequencies, indicate that the "100-year storm" events are now underestimated. While the City has continually evaluated the best available science to guide changes in floodplain management regulations, increases in current standards are likely to be necessary in the future for continued success in achieving the mitigation goals identified in this plan.

SUBDIVISION ORDINANCE

Subdivision ordinances may define requirements such that developments are constructed with clear designs meant to reduce future flood losses. The Planning

Division regulates land development in the City of Baytown. The Department reviews and processes all zoning and subdivision requests in accordance with development standards and land codes. This also includes long-range planning, which envisions the City of Baytown's continued growth, development, and economic strength.

Subdivision development requirements are included in the City's newly adopted 2025 Unified Land Development Code (ULDC). This document serves as the official zoning and subdivision regulation document that ensures proper, safe, efficient, and desired development throughout the city in accordance with the adopted Comprehensive Plan for the City of Baytown.

The ULDC aligns with the goals and strategies identified in this plan. While no revisions are identified at this time, increased subdivision development requirements may be necessary as new or updated information becomes available on climate changes in the planning area as well as downstream impact studies.

STORMWATER MANAGEMENT REGULATIONS

Stormwater management regulations provide the criteria required of storm drainage improvements made within the City's jurisdiction. The City's stormwater management regulations are codified in Chapter 98 of the City of Baytown Code of Ordinances. The City's stormwater management regulations establish methods for controlling pollutants in the municipal storm sewer system, regulate construction and development, and establish minimum stormwater management requirements and controls.

Stormwater management regulations are developed for the purpose of managing stormwater in a manner that reduces the probability of inundation, avoiding or significantly reducing flood losses and are therefore consistent with the goals and strategies of this plan. The City's regulations exceed the National Flood Insurance Program (NFIP) standards.

The SFHA deals with existing conditions and does not take the impacts of future urbanization into account in its modeling or floodplain map delineations. Therefore, buildings that are permitted and built in accordance with the National Flood Insurance Program's (NFIP) minimum standards may flood in the future as the basins develop. This is why the City of Baytown regulates to a higher standard, requiring that no insurable structure will be built that has its first finished floor less than the 500-year flood elevation or 2 feet above the BFE, whichever is higher. The City of Baytown established a water and sewer impact fee to help offset the costs of water and wastewater capital improvements

necessitated by and attributable to new development, as well as to offset the costs of higher development standards.

The City of Baytown also established a Municipal Drainage Utility System (MDUS) fee for using its drainage system. This fee funds drainage maintenance and improvement projects, detention pond maintenance, and the City's construction of new drainage projects.

PRESERVATION OF OPEN SPACE

The City of Baytown maintains more than 1,000 acres of open space, more than 15 miles of trails, and more than 50 parks. The park system includes the Baytown Nature Center, the Eddie V. Gray Wetlands Center, Pirates Bay Waterpark, Calypso Cove Waterpark, six spray pads, numerous playgrounds and sports fields, the Town Square, the Bayland waterfront, and parks with historic interest such as Bicentennial Park. The City's parkland and open space inventory continues to grow.

The City of Baytown is the home of the nationally famous Baytown Nature Center (BNC), which is a 500-acre peninsula surrounded by Burnet Bay, Crystal Bay, and Scott's Bay. It consists of hardwood uplands, high quality tidal marsh, and freshwater wetlands. This unique site is listed on the Great Texas Coastal Birding Trail, providing habitat for 317 species of resident and neo-tropical migrant birds. The American Bird Conservancy designated BNC as a nationally important bird area. In addition, it's an important nursery area for a variety of aquatic species, including shrimp, crab and fish. This area was formally a residential subdivision, known as Brownwood, and was converted into an open space area as part of a buy out program.

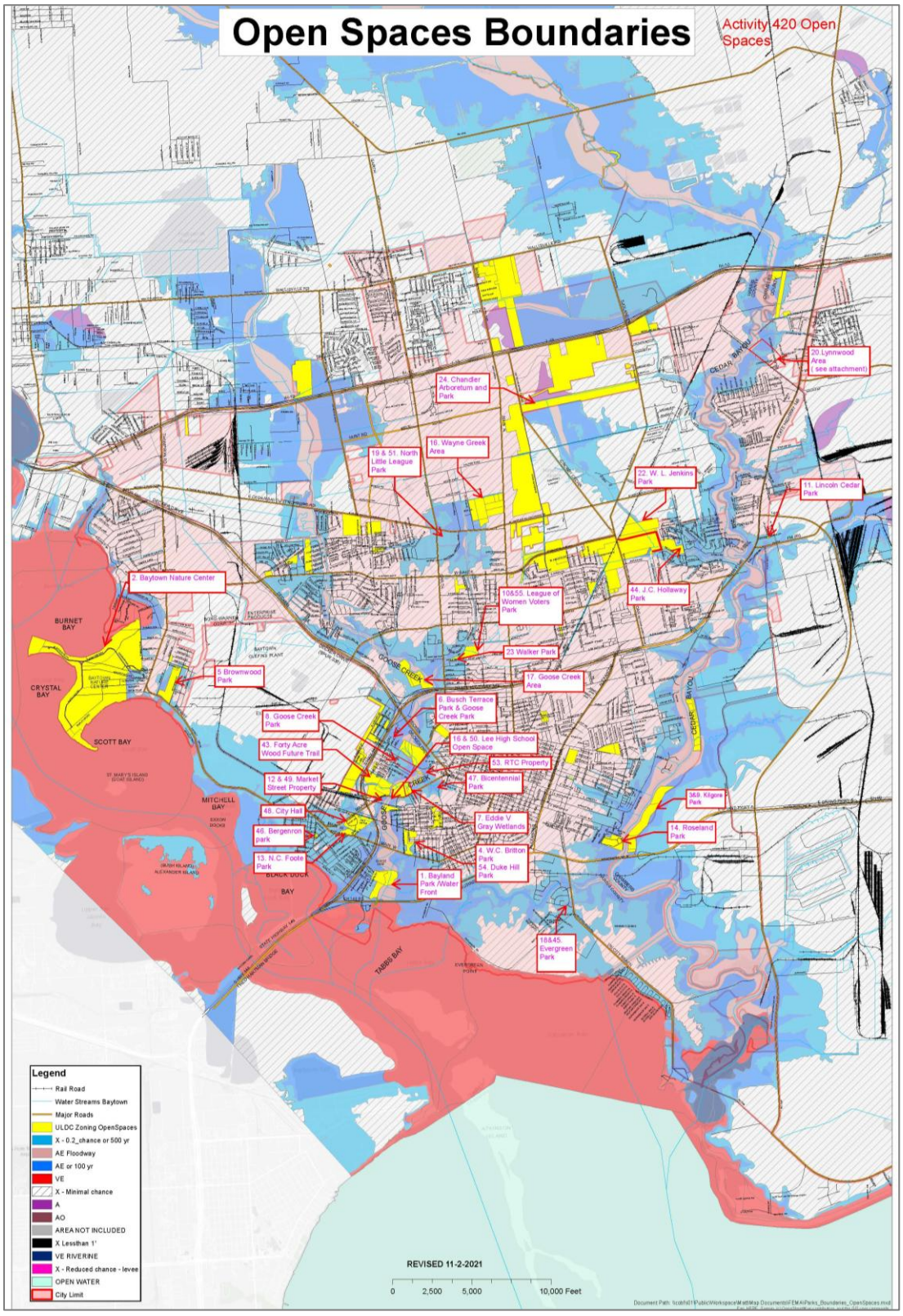
Additionally, in terms of shoreline preservation, the City of Baytown recently initiated the Baytown Nature Center Crystal Bay Shoreline Stabilization project. This project aimed to preserve a coastal natural resource area by sprigging a Spartina alterniflora salt marsh between a breakwater and the shoreline to prevent erosion.

Significant portions of the floodplain are dedicated open space (Figure C-1), and the City has an active repetitive loss acquisition program, as mentioned above. A significant portion of dedicated open space is reserved for natural and beneficial floodplain function and aligns with the goals and strategies identified in this plan. Open space preservation helps to keep damage-prone development out of hazardous or sensitive areas. Preserving floodplains, wetlands, and natural water storage areas maintains the existing stormwater storage capacities of an area. These sites can also serve as recreational areas, greenway corridors and provide habitat for local flora and fauna. In addition to

being preserved in its natural landscape, open space may also be maintained as a park, golf course, or in agricultural use. The City should continue its program to identify and acquire land for open space uses.

APPENDIX C: CRS REQUIREMENTS

Figure C-1. Open Space Areas in Floodplain



APPENDIX C: CRS REQUIREMENTS

ACQUISITION / RELOCATION

Although the City of Baytown withdrew from the FEMA Repetitive Flood Property Buyout Program in 2009, the City continues to purchase properties in flood-zone areas. The City of Baytown will, through the Community Development group, demolish and reconstruct homes as a continuing effort with the help of CBDG assistance. The City of Baytown continues to purchase properties in flood prone areas, with two homes relocated in 2024 and three new homes beginning in January of 2025.

Acquisition and relocation programs in the City of Baytown have been broadly viewed as successful. Buyouts of flood prone structures remain a priority for the community. Future buyouts may consider the following modifications to increase success and participation:[2]

- Voluntary buyout programs could be more effective if they are done with extensive public outreach and coupled with active case management and generous relocation assistance.
- Flexibility in funding from non-federal sources would allow more properties to be included in buyout programs and encourage more property owners to participate in buyouts, aiding in avoiding the "checkerboard effect."
- Create a coordinated housing plan that creates new housing concurrently with buyouts. Buyout programs could significantly reduce the supply of affordable housing in the region, and more people will agree to buyouts if viable relocation options are made possible by an affordable housing plan.

BUILDING ELEVATION

When a house is properly elevated, the living area will be above all but the most severe floods (such as the 500-year flood). Several elevation techniques are available. In general, they involve (1) lifting the house and building a new, or extending the existing, foundation below it or (2) leaving the house in place and either building an elevated floor within the house or adding a new upper story.

The City regularly seeks grant funds to elevate structures that do not currently meet the City's minimum standards of 24 inches above the 500-year flood elevation. When grants are awarded, homes are brought into compliance by lifting the structure to meet the minimum standard, with a new foundation being built to support the home. The City regularly works to identify residents that may qualify for assistance to elevate flood prone structures.

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[2]Greater Houston Flood Mitigation Consortium, April 2018, *Greater Houston Strategies for Flood Mitigation, Edition 1*: https://www.houstonconsortium.com/graphics/StrategiesReport_pages.pdf

The City of Baytown regularly seeks grant funding to elevate high risk structures. For example, the City was recently granted Flood Mitigation Assistance (FMA) funds to mitigate the risk of flooding for two severe repetitive loss homes. The project aims to raise each home above the minimum Base Flood Elevation (BFE) to help protect lives and property from future flooding events.[3]

Elevating homes in high risk areas is an action prioritized by the City that decreases flood risk and reduces disruptions and economic consequences of flooding and increasing resiliency. Minimizing flooding in neighborhoods through elevation of structures is considered an appropriate use of available funds as it will protect housing and make neighborhoods safer and more desirable places to live.

RETROFITTING

The City of Baytown has initiated numerous property protection measures to reduce flood risk in the community. Other than elevation (listed above) retrofitting measures have included:

- Constructing barriers out of compacted soil or concrete between the building and flood waters.
- "Dry floodproofing" to make the building walls and floor watertight.
- "Wet floodproofing" to protect a building by allowing floodwaters to enter uninhabited areas of the property such as parking and storage areas.
- Preventing basement flooding from sewer backup or sump pump failure.

Similar to elevation of structures, the City of Baytown utilizes funding, when appropriate, to retrofit structures to minimize the impacts of flooding and increase resiliency. Minimizing flood impacts on structures may not provide full protection but may prevent substantial damage to buildings that cannot otherwise be protected. The City of Baytown considers flood proofing to be an appropriate mitigation measure for buildings where more comprehensive mitigation measures (such as elevation) are not feasible.

INSURANCE

Flood insurance is a policy that can cover buildings, the contents in a building, or both. Flooding is the most common, and most expensive, natural disaster in the United States. Just 1 inch of water pooled in a single-story, 1,000 square-foot home can cause close to $11,000 worth of damage; 1 foot of water in a 2,500 square-foot single-story home can

[3] FEMA. City of Baytown Climate Resilient Flood Mitigation Home Elevation Project. https://www.fema.gov/case-study/texas-city-baytown-climate-resilient-flood-mitigation-home-elevation-project.

cause more than $29,000 in damage. Having this coverage helps property owners, renters, and businesses recover faster when floodwaters recede. Flood insurance is available to anyone living in one of the 23,000 participating NFIP communities. Homes and businesses in high-risk flood areas with mortgages from government-backed lenders are required to have flood insurance.

There are more than 84,000 residents living in the City of Baytown. Given the City of Baytown's flat terrain, proximity to the coast, and historical flooding record, all residents need to be protected by federal flood insurance. With 315 flood policies in force in the City of Baytown, the entire community is considered "needs improvement" to increase flood coverage in the high-risk flood zone, areas outside the SFHA in high-need areas, areas with low policy count, and community-wide.

As part of the City's CRS program, a 'Coverage Improvement' (CP) Plan was developed as a key outreach program to improve and increase the flood insurance policy count city-wide. CP efforts are tracked annually, and adjustments made as needed based on number of policies, city-wide and in targeted areas. Relative to its location, and growing population, the City of Baytown officials recognize the need to promote flood insurance in an effort to increase the policy count, protect property, and save lives and continue to implement CP efforts, which is a priority for the community.

WETLANDS PROTECTION

Restoring and protecting wetlands can improve water quality and reduce flooding. Healthy wetlands filter, absorb, and slow runoff. Wetlands also sustain healthy ecosystems by recharging groundwater and providing habitats for fish and wildlife.

The City of Baytown has a long history of wetland protection, starting with the Brownwood Subdivision Acquisition and Relocation (Buyout) Project involving FEMA and the US Army Corps of Engineers. Following the 1979 Texas Coast Hurricane Study, which recommended the permanent evacuation of 750 acres and 450 residences to reduce flood damages, Congress authorized the buyout. Phase One, completed in 1985, included 177 properties, converting the area into a wetland and bird sanctuary that is now part of the Baytown Nature Center. A consortium of 200 companies, along with Baytown, Exxon, ARCO, FEMA, and the SBA, supported the Brownwood Marsh Restoration Project, helping expand the Baytown Nature Center to over 400 acres of nature preserve.

The Eddie V. Gray Wetlands Education and Recreation Center is a 14,000 square foot facility located on the banks of Goose Creek. The Wetlands Center offers a variety of

educational and recreational programs including a computer lab, science lab, and numerous exhibits and aquariums. It is an official stop on the Great Gulf Coast Birding Trail. The Eddie V. Gray Wetlands Education and Recreation Center is dedicated to increasing awareness, appreciation and understanding of wetlands, the environment, and cultural history through environmental education and environmental recreation.

The Wetlands Mitigation Bank is a project administered through the HCFCD. The project focuses on mitigation banking, a concept that provides sustainable ecological benefits and wetlands restoration activities to an area that would otherwise be susceptible to adverse impacts from human activity. Mitigation credits are offered to developers such that the builders can pay a one-time fee to meet the wetlands mitigation requirement. The Crosby Eastgate Wetlands Mitigation Bank is in development and will directly benefit the City of Baytown, particularly along the Cedar Bayou Watershed.

This program of wetlands mitigation streamlines the construction of important flood damage reduction and other projects, by allowing the Harris County Flood Control District and others to obtain necessary U.S. Army Corps of Engineers permits more efficiently. The HCFCD focuses on wetlands mitigation that maximizes wetlands functions and values. Mitigation banking on large tracts of land allows for greater floodplain storage (among other things) and supports the goals and objectives of this plan as well as supporting the mission of the HCFCD.

EROSION CONTROL

Erosion is the process of the gradual wearing down of land masses. Erosion can occur along coasts, rivers, and streams. As erosion occurs, sediment may build up in waterways and hinder their ability to convey water during flood events. This may cause the impacts of flooding to worsen over time. This may be mitigated by clearing waterways of sediment deposited over time and employing erosion control methods along susceptible sections of waterways.

The City of Baytown and Harris County Flood Control District (HCFCD) address erosion that occurs on streams and drainage ways in the City. Due to the general flat stream gradients in the City and surrounding areas, riverine erosion is not considered to be a major problem. The shoreline within the community, however, is eroding.

A mixture of commercial, industrial and residential development lies along the coastal areas within the City of Baytown. Waterfront areas along Galveston Bay, located in Zone VE, are subject to coastal surge flooding and erosion. Coastal areas along Galveston Bay

and the San Jacinto River (Houston Ship Channel) are subject to damage from tides during coastal storms.

Floods increase coastal erosion by intensifying the force of water against the shoreline, which can wash away sediment and vegetation that naturally protect coasts and shorelines. During floods, strong waves and storm surges erode beaches, dunes, and cliffs, while excess runoff from heavy rainfall can destabilize coastal land. The removal of sediment and natural barriers weakens the coastline's resilience to future storms and accelerates long-term erosion.

The City's Stormwater Pollution Prevention Ordinance (Erosion and Sediment Control Section) requires all construction site operators to implement erosion and sediment control best management practices at sites with construction activity that are 1 acre or larger, including sites that are part of a larger common plan of development and defines sanctions for non-compliance. Construction site operators must comply with TPDES Construction General Permit TXR150000 before local construction permit will be issued.

The City's Stormwater Pollution Prevention ordinance requires a number of prevention structures during development to reduce erosion and control sediment in channelized and non-channelized flow areas. The drainage system throughout the City of Baytown includes detention ponds, stream channels, swales, ditches, and culverts. Drainage system maintenance is an ongoing program to clean out blockages caused by an accumulation of sediment or overgrowth of weedy, non-native vegetation or debris, and remediation of stream bank erosion sites. These measures are considered appropriate and align with the mitigation goals identified in this plan by maintaining drainage capacity and reducing erosion, which can exacerbate flooding.

NATURAL AREA PRESERVATION AND/OR RESTORATION

Natural floodplains provide flood risk reduction benefits by slowing runoff and storing flood water. They also provide other benefits of considerable economic, social, and environmental value that are often overlooked when local land-use decisions are made. Floodplains frequently contain wetlands and other important ecological areas which directly affect the quality of the local environment. The City of Baytown maintains more than 265 acres of open space throughout the floodplain.

The City realizes the importance of open space preservation and in an attempt to offset the amount of impervious cover and restore the City's open areas. The HCFCD administers the Vegetation Management Program. This project restores natural

landscapes around the City and offers stormwater drainage while also protecting the environment.

Vacant tracts adjacent to existing streams, channels, and bayous are not permitted to develop within the proposed ultimate right of way of the stream, channel, or bayou. HCFCD reviews plans for development adjacent to HCFCD-maintained drainage facilities as part of the City of Baytown building permit process. During this review, HCFCD ensures that open space is maintained adjacent to their facilities.

HAZARD THREAT RECOGNITION AND WARNING

HCFCD maintains a Flood Warning System (FWS) that measures rainfall amounts and monitors water levels in bayous and major streams on a real-time basis (data may be delayed up to five minutes) to inform citizens of dangerous weather conditions. The system relies on 188 gage stations strategically placed throughout Harris County bayous and their tributaries. The stations contain sensors that transmit valuable data during times of heavy rainfall and during tropical storms and hurricanes. Some gages also measure wind speed and direction, barometric pressure, air temperature, road temperature and humidity. The FWS is used by HCFCD and by Harris County's Office of Homeland Security and Emergency Management to inform citizens of imminent and current flooding conditions along bayous. It also is used by the National Weather Service to assist in the issuing of flood watches and warnings. Accurate rainfall and bayou / stream level data assists the public and emergency management officials to make critical decisions that ultimately can reduce the risk of property damage, injuries, and loss of life. The rainfall and stream gauges in the City of Baytown include:

- Site 1720: 1720 Cedar Bayou at SH 146
- Site 1540: 1540 Goose Creek at Baker Road
- Site 1520: 1520 Goose Creek at SH 99
- Site 1550: Goose Creek at IH 10
- Site 1710: Cedar Bayou at SH 99

The City of Baytown offers a secure, web-based mass notification system called Baytown Alert. This system enables the delivery of a rapid voice, text, email, and social media messages that warns and directs residents to further information in the event of an emergency. Residents are encouraged to register with Baytown Alert to receive emergency notifications from Baytown officials for floods and other severe weather emergencies, all-hazards incidents, major fire and hazmat incidents, and utility and water outages.

The Baytown Office of Emergency Management maintains an AM Radio Station (AM 1610) to provide emergency alerts. The NOAA radio weather forecast is looped on the system when not in use. The strategically located radio towers located in the City of Baytown are equipped to transmit and receive NOAA Weather Radio signals for warnings and alerts. The city can also send specific incident messages by broadcasting live or sending pre-loaded messages based upon incident types, such as traffic incidents, chemical emergencies, evacuation messages, and other emergency advisory messages.

City Buildings and Goose Creek CISD Schools are outfitted with ALERTUS beacons to provide building occupants warnings about severe weather, shelter in place orders, and other types of emergencies. The ALERTUS system is sponsored by the Greater Baytown Area Local Emergency Planning Committee.

HAZARD RESPONSE OPERATIONS

The goal of hazard response operations is to save and sustain lives, minimize suffering, and protect property in a timely and effective manner in communities that become overwhelmed by natural disasters. Proper coordination ensures efficient and effective delivery of immediate emergency assistance to individuals and communities impacted and overwhelmed by disasters.

The primary plan that guides the City during any major emergency, including a flood, is the Emergency Operations Plan (EOP). Texas state law requires that the City maintain an EOP to direct the organizational response during emergency situations. City departments with field response roles typically have developed Standard Operating Procedures (SOPs) to be implemented during emergency situations. During an emergency, departments may need to activate their own procedures to manage their field resources and coordinate with the City's Emergency Operation Center (EOC). In addition, the City maintains a current Continuity of Operations Plan, Emergency Management Action Plan, Hazard Mitigation Plan, Stormwater Management Plan, and many others.

The mayor, as the emergency management director for the City, has statutory powers and duties during an emergency (Texas Government Code § 418.1015). The mayor has the same powers, on a local level, as the governor under Chapter 418 of the Government Code. The mayor's authority/responsibilities under this code include:

- Declaring a state of disaster or requesting that the governor declare a state of emergency.

- If local resources are exhausted and assistance is needed outside a mutual aid agreement, the mayor must request it from other political subdivisions or the state.
- Has the authority to order and enforce evacuation and other restrictions on movement during an emergency.
- Authority to designate an emergency management coordinator to be an assistant for emergency management purposes.
- Must notify the Division of Emergency Management of the City's plan for emergency management.
- Enforce mandatory evacuation orders against individuals who refuse to leave.

The City of Baytown follows the requirements of state statutes regarding the EOP, which aligns with the first goal of this plan, to protect public health and safety.

CRITICAL FACILITIES PROTECTION

A critical facility is a structure that, if impacted by an event, would present an immediate threat to life, public health, and safety. Critical facilities include hospitals, emergency operations centers, fire department services, and nursing homes. The City of Baytown maintains a list and map of all critical facilities. This list identifies vulnerabilities and estimates risks of all hazards that have a defined area of vulnerability. This list is updated on an ongoing basis and maintained by the City of Baytown Office of Emergency Management

Protecting critical facilities during a disaster is the responsibility of the facility owner or operator. However, if they are not prepared for an emergency, the rest of the community could be impacted. If a critical facility is damaged, workers and resources may be unnecessarily drawn away from other disaster response efforts. If the owner or operator adequately prepares such a facility, it will be better able to support the community's emergency response efforts.

Most critical facilities have full-time professional managers or staff who are responsible for the facility during a disaster. These people often have their own emergency response plans. Many facilities would benefit from early disaster warning, disaster response planning, and coordination with community disaster response efforts.

Schools are critical facilities not only because of the special population they accommodate, but because they are often identified as shelter sites for a community. Processes and procedures can be developed to determine mitigation priorities incorporated into capital improvement plans that will ensure these buildings function after an event.

APPENDIX C: CRS REQUIREMENTS

POST DISASTER MITIGATION ACTIONS

Post disaster mitigation actions are mitigation actions taken after a disaster occurs to increase resilience for disasters to come. Following disasters, it is important to look for opportunities to properly plan for and mitigate hazards. Rebuilding with future hazards in mind increases the resiliency of a community and reduces future flood losses. In addition to projects and structural improvements, higher codes and standards, prearranged agreements, and local collaboration are important tools that can be used for hazard mitigation.

Immediately following a disaster, the City initiates activities to protect public health and safety, facilitate recovery, and ensure compliant reconstruction in the impacted area. These activities include actions such as damage assessments, critical infrastructure coordination and restoration, information collection, analysis, and dissemination, private sector coordination, and inspections and permitting, in addition to a number of other post disaster recovery activities.

Requiring permits, conducting inspections, and enforcing the NFIP substantial improvement/ substantial damage regulations can be difficult for local, understaffed, overworked offices after a disaster. If these activities are not conducted properly, not only does the City miss an opportunity to mitigate during redevelopment or clear out a hazardous area, but it may also be violating its obligations under the NFIP. Mitigation actions that the City initiates in the early stages of disaster recovery includes:

- Pushing out public information regarding building inspections, permitting, substantial damage determinations, and mitigation measures during reconstruction.
- Identifying feasible, cost-effective, long-term mitigation measures for public facilities and critical infrastructure that can be implemented during reconstruction.
- Identifying repetitive loss properties for potential acquisition.
- Coordination across multiple divisions to apply for mitigation grant funding and identify priority projects.

REVIEW STRUCTURAL PROJECTS

Structural projects are usually designed by engineers or architects, constructed by the public sector, and maintained and managed by governmental entities. Structural projects traditionally include stormwater detention/retention ponds, reservoirs, levees and floodwalls, channel modifications, diversions, drainage and storm drain improvements.

APPENDIX C: CRS REQUIREMENTS

Existing structural projects in the City of Baytown are reviewed regularly to identify sound mitigation opportunities both before and after a disaster. Following a flood disaster, inadequate, undersized, or otherwise deficient existing infrastructure can be advanced for mitigation opportunities including 406 Public Assistance mitigation funding during reconstruction. Ideally, mitigation should occur before a disaster ever occurs. The City of Baytown is very proactive in identifying mitigation opportunities throughout the year. Projects in the City's CIP are interwoven with mitigation solutions and techniques due to the unique flood risks the City faces. A few examples include the Baytown Central Stormwater Detention Basin Improvements project, San Jacinto Regional Detention project, and the installation of generators at critical facilities to mitigate the impacts of flooding and severe weather events. The City of Baytown is a leader in integrating mitigation into a variety of City plans and capital improvements, aligning with the goals and strategies of this plan as well as others.

MAP INFORMATION

A Flood Insurance Rate Map (FIRM or floodplain map) is a map produced by the Federal Emergency Management Agency (FEMA) and adopted by a city or by a county. It is used to determine flood insurance rates and to assist in floodplain management and the regulation of land development. Its purpose is to identify areas at risk for flooding from a bayou, creek or other waterway overflowing during 1 percent (100-year) and 0.2 percent (500-year) floods, and from coastal flooding related to storm surge from a tropical storm or hurricane.

The City of Baytown is located in both Harris and Chambers Counties. The majority of the Baytown planning area (95%) is located in Harris County, with a small portion (5%) in Chambers County. Harris County FIRM's have an effective date of January 6, 2017, while the current Chambers County FIRM's have an effective date of January 19, 2018.

While a FIRM is a good indicator of flooding risks from a bayou or creek overflowing during certain floods, it does not identify all flooding risks for the planning area, which receives an average of 48 inches (4 feet) of rain each year. A FIRM does not identify risks from street flooding caused by roadside ditches and storm sewers exceeding their capacity or from sheet flow, which is water traveling over land to reach a bayou. Half or more of the flooding that occurs in Harris and Chambers Counties falls into these two categories. A FIRM also does not show flooding risks from events greater than the magnitude of a 0.2 percent (500-year) flood, such as Tropical Storm Allison, which dropped unprecedented amounts of rain and far exceeded a 0.2 percent (500-year) flood

in some parts of Harris County in 2001. In fact, 65 percent of the area that flooded during Allison was not in a mapped floodplain.

The City of Baytown provides several mapping resources for residents on the city's website. This includes the Harris County Flood Warning System. This site is maintained by Harris County and provides residents with real time rainfall amounts and flood levels for Goose Creek and Cedar Bayou. Residents can even sign up for texts and emails to know when these streams are getting full.

The City of Baytown also promotes the use of the NOAA Coastal Flood Exposure Mapper. This site is maintained by the National Oceanic and Atmospheric Administration and can help residents understand what happens when different types of flood events happen. City of Baytown residents can map and view FEMA flood zones, as well as high tide, tsunami, storm surge, and sea level rise areas.

In addition, HCFCD has developed an interactive mapping tool to assist residents and business owners in identifying and understanding their flood risk and provides information about their drainage channels, bayous and tributaries. The purpose of the Flood Education Mapping Tool is to provide information about the boundaries of mapped floodplains in Harris County and the City of Baytown relative to residences, businesses, and other structures. Floodplains are officially delineated on the Federal Emergency Management Agency's Flood Insurance Rate Map (FIRM or floodplain map) for the City of Baytown and Harris County. While the floodplains shown on the Flood Education Mapping Tool are the floodplains delineated on the FIRM, the Flood Education Mapping Tool is not the effective FIRM. The Flood Education Mapping Tool includes regularly updated floodplain information from the FIRM for Harris County, interactive legend options, a simple map display and easy map navigation.

FEMA provides floodplain and FIRM information as a mitigation service. The City of Baytown can help residents submit requests for map amendments and revisions when these are needed to show that a building is outside the mapped floodplain. Although FEMA maps are accurate, users and inquirers must remember that maps are not perfect. They display only the larger flood-prone areas that have been studied. In some areas, watershed developments make even recent maps outdated. Those inquiring about flood maps must be reminded that being outside the mapped floodplain is no guarantee that a property will never flood. As noted above, many properties that flood are not located in a designated floodplain.

Finally, the City of Baytown's Floodplain Administrator is a member of the Community Advisory Group for Harris County's Modeling, Assessment, and Awareness Project (MAAPNext) and has been advocating for the City of Baytown's interests. MAAPNext is compiling the latest data, technology, and methodologies to analyze current land use and flood data to develop updated floodplain maps for Harris County. MAAPnext will improve the understanding of the flood risk in Harris County so that the public, local communities, and emergency managers can make informed decisions to protect life and property.

Additional hazard data that can be shown on maps includes wildland urban interface or wildfire risks, earthquake zones, wetlands, hazardous material sites, and areas of subsidence. Much of this data has been developed by U.S. Geological Survey, U.S. Army Corps of Engineers, Texas A&M Forest Service, and the U.S. Fish and Wildlife Service, and are available for incorporation into local GIS mapping.

OUTREACH PROJECTS

City of Baytown residents can obtain information concerning past historical flooding, Flood Insurance Rate Maps (FIRMs), flood depths, floodways and flood zone determinations from the Baytown Public Works & Engineering department. Elevation certificates, which have been collected for properties in the Special Flood Hazard Area are on file at the Baytown Public Works & Engineering department and can be requested through an open records request. The Public Works and Engineering Department is also actively working to communicate floodplain regulations to the public through public meetings and by creating a page on the Public Works and Engineering (PWE) website. Please visit this website for more information: https://baytown.org/1321/Floodplain-Protection.

The City of Baytown will continue to support public awareness efforts to inform citizens of the protection that can only be provided by purchasing flood insurance coverage for structures and their contents. The city coordinates and hosts annual workshops aimed at increasing awareness about the importance of flood insurance. These sessions aim to educate homeowners, lenders, and insurance agents about flood risks and the benefits of obtaining appropriate coverage. It is the responsibility of the City of Baytown Chief Building Official to coordinate and host Flood Insurance Workshops.

Community workshops are often held with the Harris County Flood Control District (HCFCD) in which City of Baytown residents are encouraged to attend. The Flood Control District will conduct public meetings in a primary project watershed area to solicit public comments about the project being implemented. In addition, the HCFCD has several

community service programs, like the Open Space Program, and volunteer opportunities for residents to become involved in local flood resiliency projects.

The city has implemented procedures to share crucial information with residents before, during, and after flood events. Regular communications provide flood safety and preparedness guidance. The city's website offers resources on emergency preparedness, how to obtain flood insurance, and links to mapping tools and flood risk information specific to residents' areas.

REAL ESTATE DISCLOSURE

Several Texas laws require sellers to disclose information about their property prior to or at the time a sales contract is executed. Not only are seller's disclosures required by law, but they also give buyers important information, reduce risks for sellers, and lower chances of complaints or lawsuits. The Texas Real Estate Commission (TREC) Seller's Disclosure Notice only contains the minimum information required by statute. The Texas REALTORS® notice (TXR 1406) has added provisions that provide more information for buyers and is designed to serve as a risk-reduction tool for sellers. If sellers fail to disclose or misrepresent material information about a property, sellers and their agents may face liability for fraud and deceptive practices. License holders may also be found in violation of TREC rules. REALTORS® may also be found in violation of the Code of Ethics.

Sellers must disclose if a home is located in the 100-year floodplain, or if it previously flooded. In addition, as of September 2019, sellers must disclose if it is wholly or partially in the 500-year floodplain, a reservoir or a flood pool. Renters are also provided a measure of protection in Texas as landlords must include in every residential lease, including renewals, a flood risk disclosure form or addendum that tells potential renters two things: if the unit is in a 100-year floodplain, and if the owner is aware of any flooding in the past five years.

LIBRARY

The City of Baytown's Sterling Municipal Library is a place for residents to seek information on hazards, hazard protection, and protecting natural resources. Historically, libraries have been the first place people turn to when they want to research a topic. Interested property owners can read or check out handbooks or other publications that cover their situation. The libraries also have their own public information campaigns with displays, lectures, and other projects, which can augment the activities of the local government.

The library is home to a multitude of flood damage reduction resources including FEMA publications on floodproofing and retrofitting, as well as the effective FIRMs and FIS documents. In addition, the City's library system maintains flood related documents required under the NFIP and CRS. The documents are available to the public in the library.

Although visits to U.S. libraries have dropped by 21 percent since 2009, there are actually more people borrowing books than ever before. Specifically, over 174 million people in the country are registered at a local library. That's nearly 54 percent of the population. The City of Baytown should continue to utilize the library system in place to continue outreach efforts on flood and other natural hazard risks.

However, to reach the broadest audience, the City also relies on a variety of outreach activities in addition to the utilization of the local library, including the Better Baytown App where residents can send and receive information regarding permits, storm water issues, and more. The city also has flood information such as flyers, trifolds, and disaster guides at the following locations:

- PWE Administration Building
- City Hall
- Baytown OEM (Available Upon Request)
- Baytown Wetlands Center

Please see other opportunities for outreach efforts at:
https://www.baytown.org/1424/Engage-With-Us.

ENVIRONMENTAL EDUCATION

The floodplain management committee continues to meet well after each plan is adopted in order to evaluate progress and recommend changes to mitigation goals, objectives and actions. Plans developed for the purposes of hazard identification and risk reduction are updated on a recurring schedule. Mitigation actions and risk reduction programs and policies are regularly evaluated during each planning cycle to determine the effectiveness of implemented projects, programs and policies, to determine if improvements can be made and to reflect changes in priorities.

The Hazard Mitigation Action Plan risk and vulnerability assessment remain aligned with the community's mitigation goals and the mitigation strategy reflects similar goals and objectives. The process of evaluation currently in place provides the necessary information to identify mitigation successes, evaluate ongoing mitigation actions and identify new mitigation ideas to be incorporated into the next mitigation planning cycle.

APPENDIX C: CRS REQUIREMENTS

FUNDING

Financial capabilities are the resources that the City has access to or is eligible to use to fund mitigation actions. The costs associated with implementing mitigation activities vary. Some mitigation actions such as building assessment or outreach efforts require little to no costs other than staff time and existing operating budgets. Other actions, such as the acquisition of flood-prone properties, could require a substantial monetary commitment from local, State, and Federal funding sources.

While the City primarily relies on state and federal mitigation funding programs such as HMGP, FMA, and CDBG-MIT to fund mitigation activities, the City of Baytown has access to recurring sources of revenue, such as water and sewer impact fees, Capital Improvement Project (CIP) funds and revenue bonds. The City continues to identify and seek funding opportunities for flood mitigation. The City needs to identify and secure additional ongoing sources of funding for hazard mitigation projects outside of stormwater projects.

Table C-2. Financial Capabilities

FUNDING	APPLICATIONS
Capital Improvement Project	Stormwater mitigation activities
Utility fees	Maintain and expand utility services
Impact fees for new development	Fee meant to offset the financial impact a new development places on public infrastructure
Municipal Drainage Utility System (MDUS) fee	Maintain and expand the stormwater drainage system
General Obligation or special tax bonds	Fund specifically identified projects
Community Development Block Grant-Disaster Recovery	Housing, infrastructure, and economic revitalization assistance to impacted area
Community Development Block Grant-Mitigation	Mitigation funding to increase resilience to disasters in impacted areas
Hazard Mitigation Grant Program	Long term, cost effective mitigation projects
Building Resilient Infrastructure and Communities	Long term, cost effective mitigation projects
Flood Mitigation Assistance	Mitigate repetitive flood damage to buildings insured under the NFIP

APPENDIX C: CRS REQUIREMENTS

FUNDING	APPLICATIONS
Federal Highway Administration Funding	Eligible transportation projects
High Hazard Potential Dams	Rehabilitation of eligible high hazard potential dams including technical, planning, design, and construction assistance



APPENDIX D
PLANNING TEAM

APPENDIX D: PLANNING TEAM

Planning Team Members 1
Stakeholders 3

PLANNING TEAM MEMBERS

The City of Baytown Hazard Mitigation Action Plan Update 2025 was organized using a direct representative model. An Executive Planning Team from the city, shown in Table D-1, was formed to coordinate planning efforts and request input and participation in the planning process. Table D-2 reflects the Advisory Planning Team, consisting of additional city departments that participated throughout the planning process. Table D-3 reflects the Emergency Management Planning Committee, consisting of various city and community representatives that participated throughout the planning process to aid in meeting CRS requirements. Table D-4 is comprised of stakeholders who were invited to provide Plan input. Public outreach efforts and meeting documentation is provided in Appendix G.

Table D-1. Executive Planning Team

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Emergency Management	Emergency Management Coordinator
City of Baytown – Emergency Management	Deputy Emergency Management Coordinator

Table D-2. Advisory Planning Team

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Fire	Public Information & Education Coordinator
City of Baytown – Government	Council Member District 1
City of Baytown – Government	Council Member District 2
City of Baytown – Government	Council Member District 3
City of Baytown – Government	Council Member District 4
City of Baytown – Government	Council Member District 5
City of Baytown – Government	Council Member District 6
City of Baytown – Government	Mayor
City of Baytown – Government	Precinct 2 – Community Engagement

APPENDIX D: PLANNING TEAM

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Government	Precinct 3 – Community Engagement
City of Baytown – Human Resources	Risk Manager
City of Baytown – Parks & Recreation	Director
City of Baytown – Parks & Recreation	Planning & Construction Superintendent
City of Baytown – Planning & Development Services	Assistant Director - Building Services
City of Baytown – Planning & Development Services	Assistant Director - Planning and Community Development
City of Baytown – Planning & Development Services	Chief Building Official
City of Baytown – Planning & Development Services	Economic Development Manager
City of Baytown – Public Works & Engineering	Assistant Director - Capital Projects
City of Baytown – Public Works & Engineering	Assistant Director / City Engineer / Floodplain Manager
City of Baytown – Public Works & Engineering	CRS Coordinator
City of Baytown – Public Works & Engineering	Operations Superintendent
City of Baytown – Public Works & Engineering	Project Coordinator

Table D-3. Emergency Management Planning Committee

ORGANIZATION / DEPARTMENT	TITLE
City of Baytown – Administration	City Manager
City of Baytown – Fire	Division Chief - Training
City of Baytown – Fire	Fire Chief
City of Baytown – Health	Director
City of Baytown – Police	Assistant Chief of Police
City of Baytown – Police	Chief of Police
City of Baytown – Public Works & Engineering	Director

APPENDIX D: PLANNING TEAM

ORGANIZATION / DEPARTMENT	TITLE
CenterPoint Energy	Service Area Manager
ExxonMobil	Emergency Coordinator / Industry Representative
General Public	Former Council Member / Public Representative
Goose Creek Consolidated ISD	Director of Safe & Secure Schools
Goose Creek Consolidated ISD	Director of Safe & Secure Schools / Education Representative
Houston Methodist – Baytown Hospital	Director of Pharmacy / Hospital Safety Officer
United Way of Greater Baytown Area & Chambers County (UWGBACC)	CEO / Non-Profit Representative

STAKEHOLDERS

The following groups listed in Table D-4 represent a list of organizations invited to stakeholder meetings, public meetings, and workshops throughout the planning process and include: members of community groups, non-profit organizations, private businesses, utility providers, neighboring counties, school and universities, and state and federal agencies. The public were also invited to participate via e-mail throughout the planning process. Many of the invited organizations and stakeholders participated and were integral to providing comments and data for the Plan. For a list of attendees at meetings, please see Appendix G[1].

Table D-4. Stakeholders

AGENCY	TITLE	STAKEHOLDER TYPE
ADL Assisted Living Inc.	Administrator	Residential Facilities / Vulnerable Populations
ADL Assisted Living Inc. #2	Administrator	Residential Facilities / Vulnerable Populations
American Red Cross	Gulf Coast Region Representative	Regional / Community Organization

[1] Information contained in Appendix G is exempt from public release under the Freedom of Information Act (FOIA).

APPENDIX D: PLANNING TEAM

AGENCY	TITLE	STAKEHOLDER TYPE
Babies in Baytown	Community Systems Senior Manager	Community Organization
Bay Area Homeless Services	Executive Director	Community Organization
Bayou City Water	Waterkeeper	Utility Provider
Baytown Area Water Authority (BAWA)	Administrative Assistant	Utility Provider
Baytown Arts, Culture, and Entertainment District (ACE)	President	Community Organization
Baytown Chambers of Commerce	President	Community Organization
Baytown Municipal Development District (MDD)	Finance Director	Utility Provider
Baytown-West Chambers Economic Development Foundation	President / CEO	Community Organization
Baytown Sun	Reporter	Community Organization
Burning Tree Living Center	Area Administrator	Residential Facilities / Vulnerable Populations
Center Point Energy	Engineer	Utility Provider
Chambers County	Emergency Management Coordinator	Neighboring Community
Deer Park, City of	Emergency Services Director	Neighboring Community
Environmental Protection Agency (EPA)	Deputy Regional Administrator	Federal Agency
Environmental Protection Agency (EPA)	Director of Superfund an Emergency Management Division	Federal Agency
Environmental Protection Agency (EPA)	Regional Administrator	Federal Agency
Faith Family Church	Homeless Outreach Team	Community / Religious Organization
Focused Care at Allenbrook	Chief Operating Officer	Residential Facilities / Vulnerable Populations
Focused Care at Burnet Bay	Chief Operating Officer	Residential Facilities / Vulnerable Populations

APPENDIX D: PLANNING TEAM

AGENCY	TITLE	STAKEHOLDER TYPE
Focused Care at Cedar Bayou	Chief Operating Officer	Residential Facilities / Vulnerable Populations
Galveston Bay Foundation	President	Community Organization
Gold Star Living	Founder	Residential Facilities / Vulnerable Populations
Goose Creek Consolidated ISD	Assistant Superintendent of Operations	Academia
Goose Creek Consolidated ISD	Superintendent	Academia
Gulf Coast Protection District	Director / Chambers County Representative	Community Organization
Gulf Coast Protection District	President / Harris County Representative	Community Organization
Harris County	Emergency Management Coordinator	Neighboring Community
Harris County ESD #75	Board President	Community Organization
Harris County Flood Control District	Director of Planning	Utility Provider
Harris County Flood Control District	Flood Warning System Manager	Utility Provider
Harris County Flood Control District	Risk Mitigation Manager	Utility Provider
Harris County Municipal Development District (MDD) #213	Customer Service Representative	Utility Provider
Harris County Municipal Development District (MDD) #459	Office Supervisor	Utility Provider
Hearts and Hands of Baytown	Executive Director	Community Organization
Houston-Galveston Area Council (H-GAC) Initiative for Cedar Bayou Initiative	Emergency Preparedness Program Representative	Regional Organization
La Porte, City of	Emergency Management Coordinator	Neighboring Community
Lee College	President	Academia

APPENDIX D: PLANNING TEAM

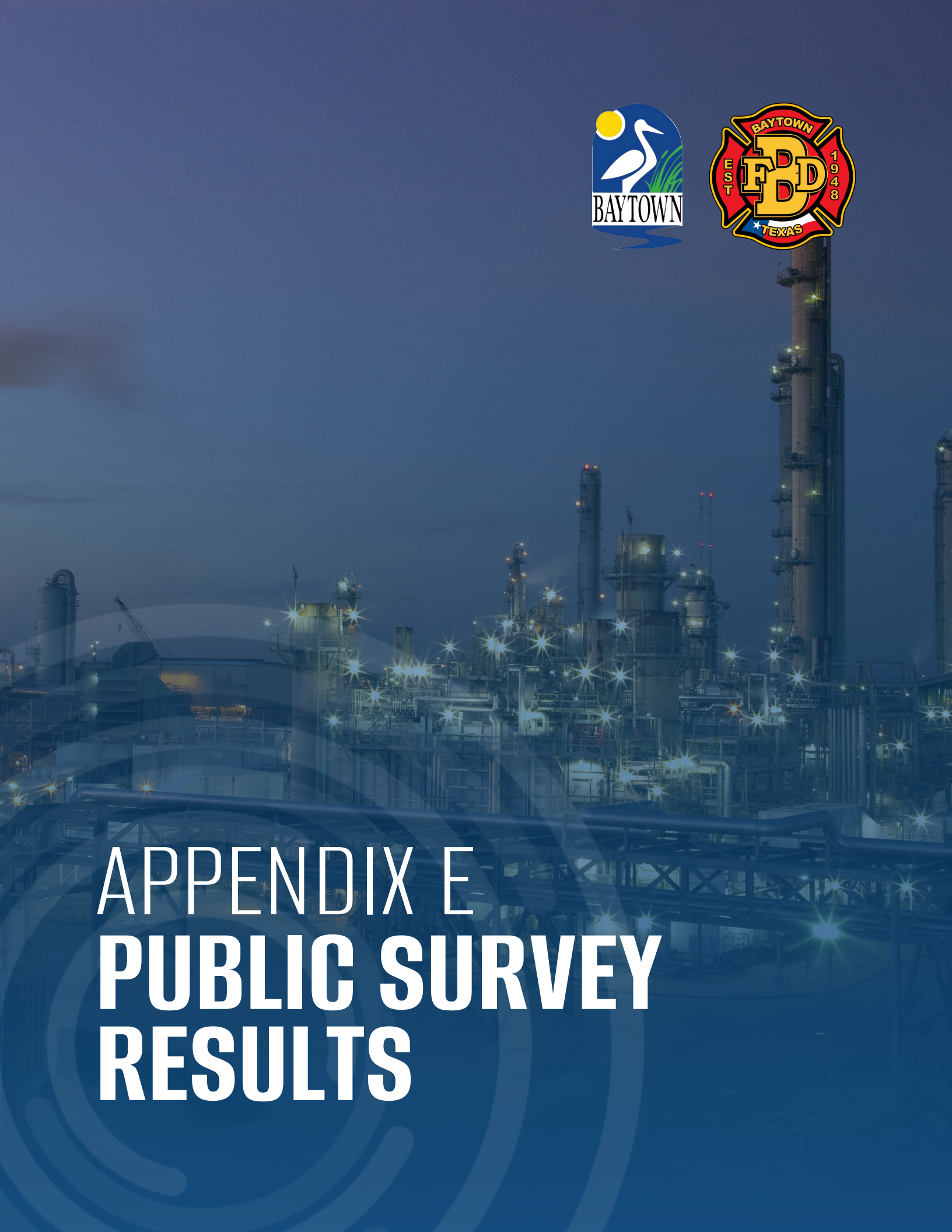
AGENCY	TITLE	STAKEHOLDER TYPE
Lee College	Emergency and Safety Manager	Academia
The Lodge at Pine Creek	General Facility Representative	Residential Facilities / Vulnerable Populations
Maplewood Living Center	Area Administrator	Residential Facilities / Vulnerable Populations
Memorial Baptist Church	Senior Pastor	Community / Religious Organization
Mont Belvieu, City of	Fire Chief / Emergency Management Coordinator	Neighboring Community
National Weather Service (NWS)	Houston / Galveston Regional Representative	Federal Agency
NOAA	Chief of Policy, Planning & Communications	Federal Agency
Olive Living Center	Area Administrator	Residential Facilities / Vulnerable Populations
Pasadena, City of	Emergency Management Coordinator	Neighboring Community
Rollingbrook Rehabilitation and Healthcare Center	Administrator	Residential Facilities / Vulnerable Populations
San Jacinto River Authority (SJRA)	Water Resources and Flood Management Division Manager	Utility Provider
Second Baytown	Administrative Pastor	Community / Religious Organization
Spring Meadows Municipal Development District (MDD)	Customer Service Representative	Utility Provider
St. James House of Baytown	Administrator	Residential Facilities / Vulnerable Populations
St. John Catholic Church	Disaster Preparedness Committee Chair	Community / Religious Organization
State Legislature	House District 23	State Legislature
State Legislature	House District 128	State Legislature
State Legislature	House District 143	State Legislature
State Senate	Senate District 6	State Senate

APPENDIX D: PLANNING TEAM

AGENCY	TITLE	STAKEHOLDER TYPE
State Senate	Senate District 11	State Senate
Sterling Municipal Library	Library Director	Community Organization
Swan Manor Assisted Living Facility	General Facility Representative	Residential Facilities / Vulnerable Populations
Texas A&M AgriLife Extension	District 9 County Coordinator	State Agency
Texas A&M Forest Service	Program Coordinator - Mitigation & Prevention	State Agency
Texas Commission on Environmental Quality (TCEQ), Region 12	Executive Assistant	State Agency
Texas Commission on Environmental Quality (TCEQ), Region 12	Regional Director	State Agency
Texas Department of Health and Human Services, Region 6	Regional Director	State Agency
Texas Department of Homeland Security	Media Representative	State Agency
Texas Department of Housing and Community Affair	Director of Single-Family and Homeless Program	State Agency
Texas Department of Housing and Community Affair	Manager of Single-Family Program	State Agency
Texas Department of Transportation (TXDOT)	District Engineer	State Agency
Texas Division of Emergency Management (TDEM), Region 4	Chambers County CLO	State Agency
Texas Division of Emergency Management (TDEM), Region 4	District 16 Chief	State Agency
Texas Division of Emergency Management (TDEM), Region 4	Regional Mitigation Coordinator	State Agency
Texas Division of Emergency Management (TDEM),	Recovery and Mitigation Section Chief	State Agency

APPENDIX D: PLANNING TEAM

AGENCY	TITLE	STAKEHOLDER TYPE
Region 4		
Texas Division of Emergency Management (TDEM), Region 4	Regional Mitigation Coordinator	State Agency
Texas State Soil & Water	Regional Office Program Supervisor	State Agency
Texas Water Development Board (TWDB)	Communications Representative	State Agency
Texas Windstorm Insurance Association	General Representative	State Agency
United Way	Disaster Recovery Committee Chair	Community Organization
U.S. Army Corps of Engineers / Texas Silver Jackets	Regional Representative for Fort Worth/Galveston Office	Federal Agency
U.S. Fish & Wildlife	Southwest Regional Representative	Federal Agency
The Waterford at Baytown	General Facility Representative	Residential Facilities / Vulnerable Populations



APPENDIX E
PUBLIC SURVEY RESULTS

APPENDIX E: PUBLIC SURVEY RESULTS

Overview 1
Public Survey Results 2

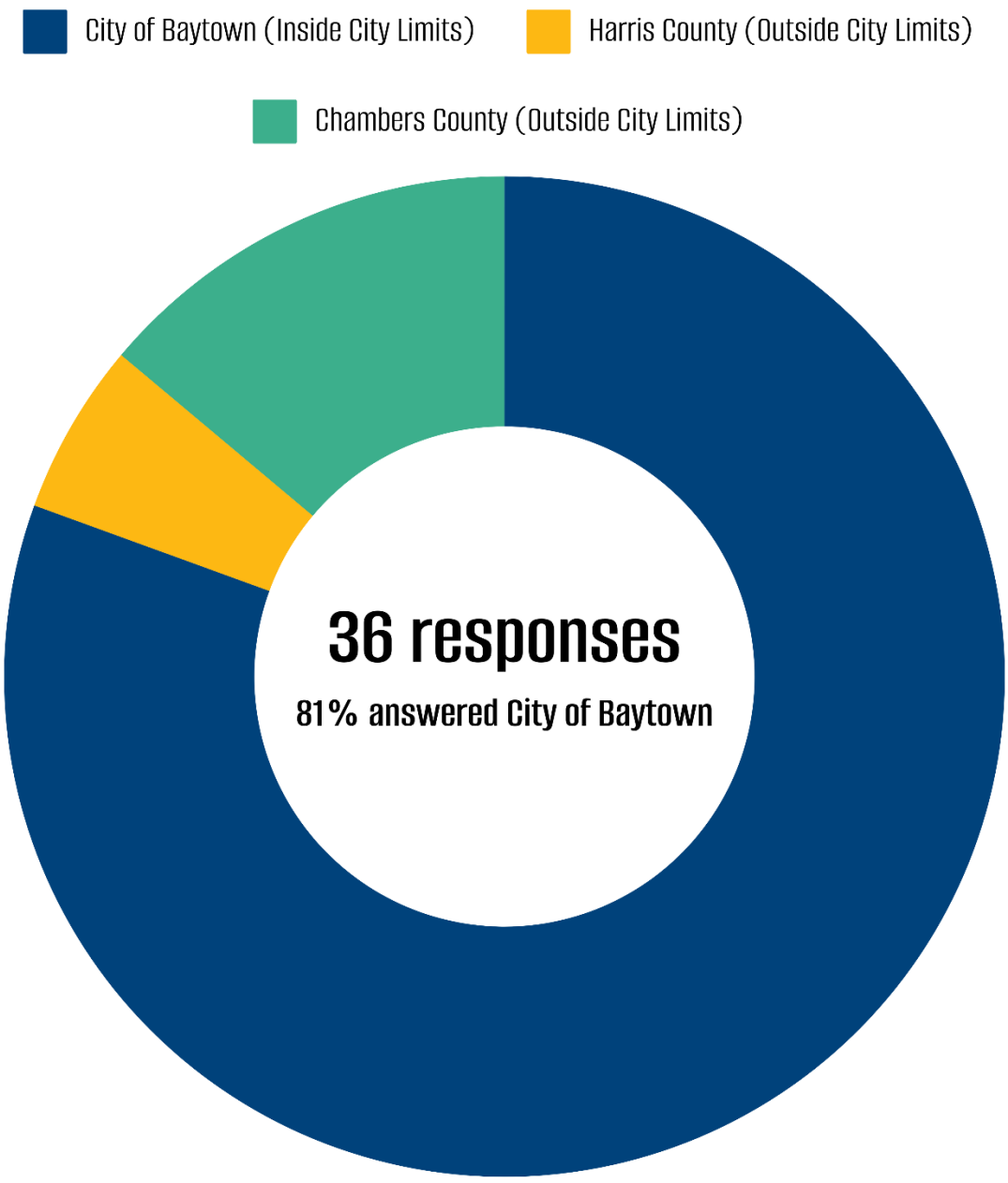
OVERVIEW

The City of Baytown prepared a public survey that requested public opinion on a wide range of questions relating to natural and human-caused hazards. The survey was made available through the city's website. This survey link was also distributed at public meetings and stakeholder events throughout the planning process.

A total of 36 surveys were collected, the results of the survey are analyzed in Appendix E. The purpose of the survey was twofold: 1) to solicit public input during the planning process, and 2) to help the jurisdictions identify any potential mitigation actions or problem areas.

All public survey results were discussed and shared with the Planning Team during the Mitigation Strategy Workshop. These results are also provided below. The survey results provide information regarding the public's experience with natural hazards, their perceived hazards of concern, recommended mitigation actions, and additional valuable insights. Overall, this survey enhances the mitigation planning process by ensuring the plan properly represents the community, is informed through local knowledge, and by promoting equity.

PUBLIC SURVEY RESULTS



APPENDIX E: PUBLIC SURVEY RESULTS

Have you ever experienced or been impacted by a disaster?



88.89%

Responded 'Yes'

Personal experiences shared in survey responses included:

"Flooded during Harvey and wind damage during Beryl and now can barely afford flood insurance or home insurance, and most companies don't want to insure us anymore too close to the water."

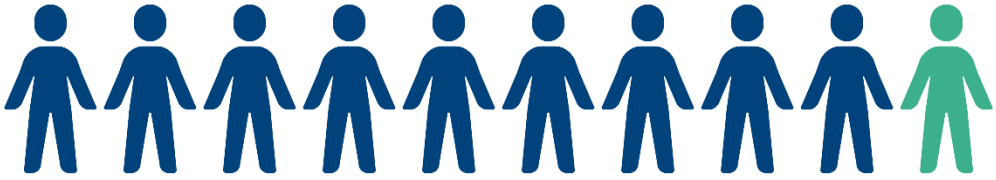
"Downed trees, flooding, long power outages, debris, etc."

"Tornadoes, power outages, hurricanes destroying fence and patio."

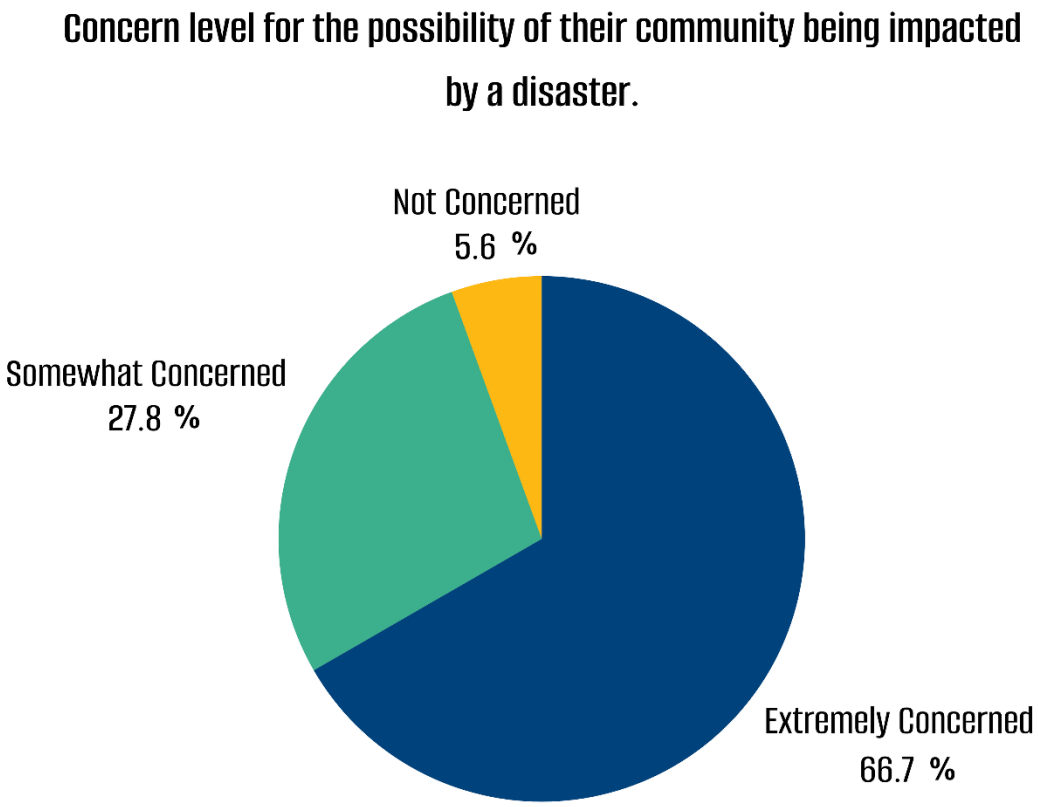
"Harvey, lost everything."

"Hurricanes Ike, Harvey, Beryl + the deep freeze / Texas Power Grid Failure."

87% of those who have been impacted by a disaster mentioned hurricanes in their explanations.

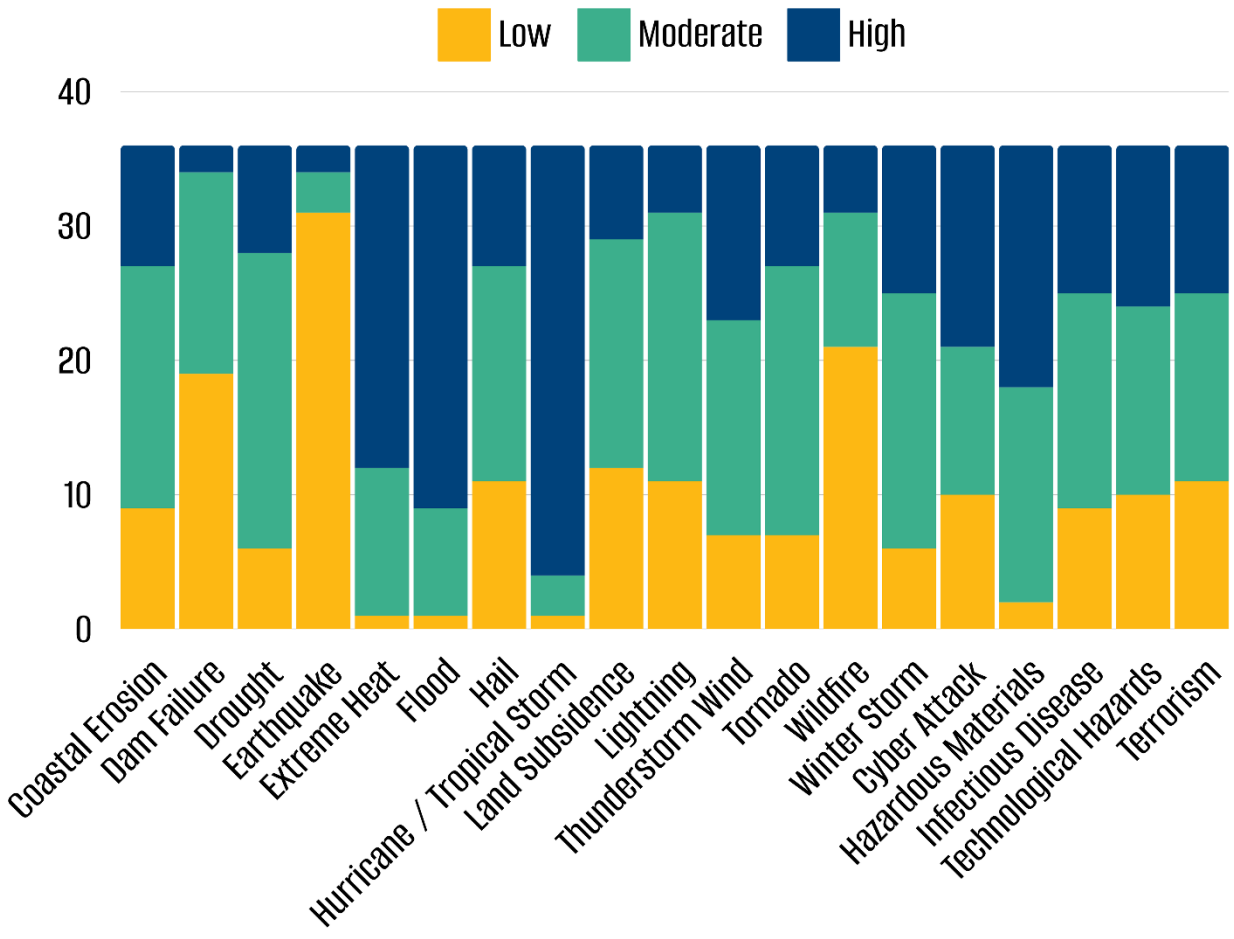


APPENDIX E: PUBLIC SURVEY RESULTS



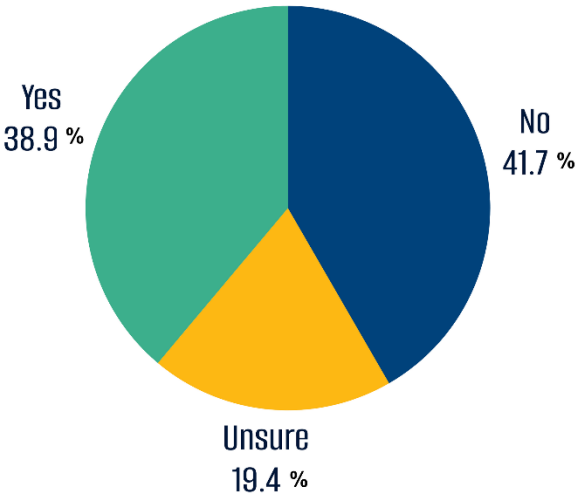
APPENDIX E: PUBLIC SURVEY RESULTS

With the consideration of frequency of occurrence and potential impact severity, please select the one hazard you think is the highest and second highest threat to your neighborhood:

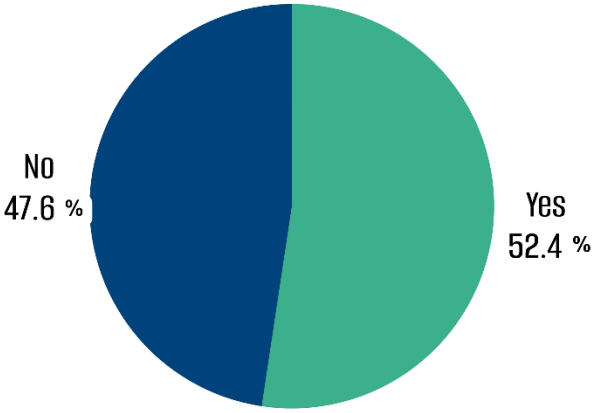


APPENDIX E: PUBLIC SURVEY RESULTS

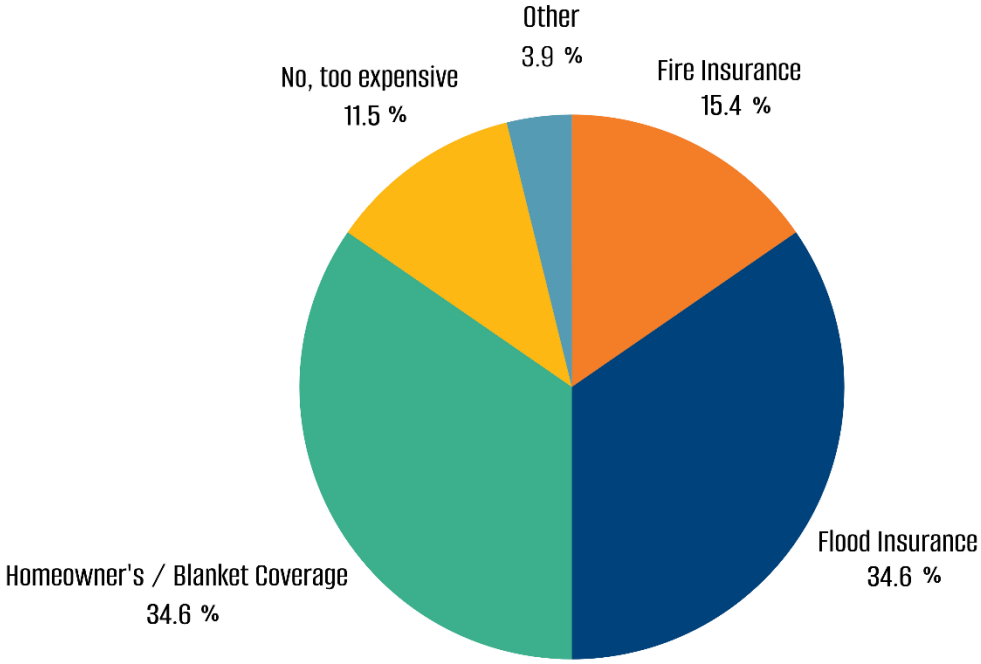
To your knowledge, is your home located in any high hazard risk zones?



Have you had any issues getting homeowners or renters insurance due to risks of hazardous events?



Do you have any hazard specific insurance? Why or why not?



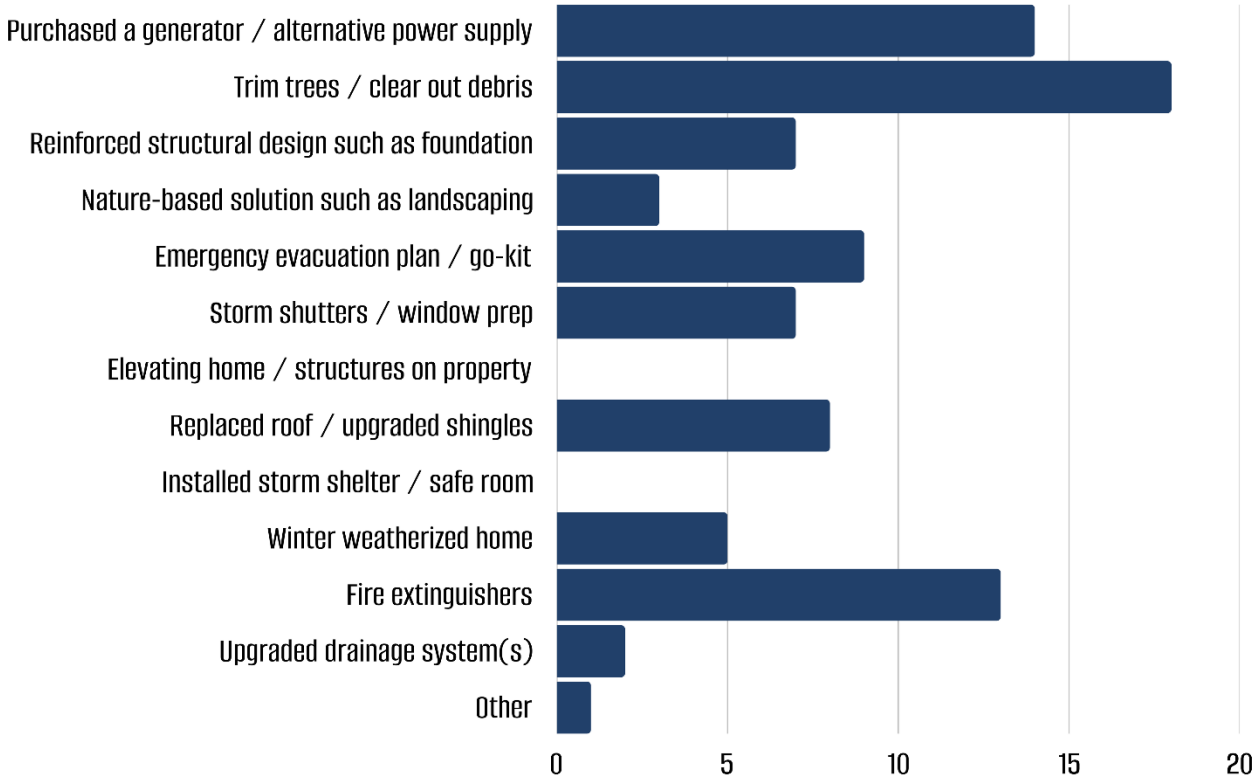
APPENDIX E: PUBLIC SURVEY RESULTS

Have you taken any actions to make your home or neighborhood more resistant to hazards?



66.67 %

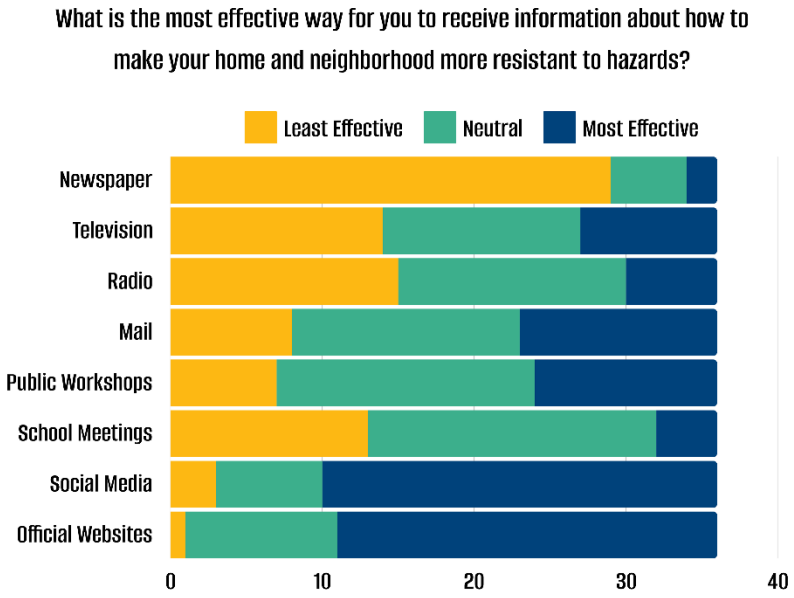
Responded 'Yes'





94.4 % of survey responders are interested in making their homes or neighborhoods more resistant to hazards.

APPENDIX E: PUBLIC SURVEY RESULTS



Effectiveness of communication methods for receiving information about how to make your home and neighborhood more resistant to hazards

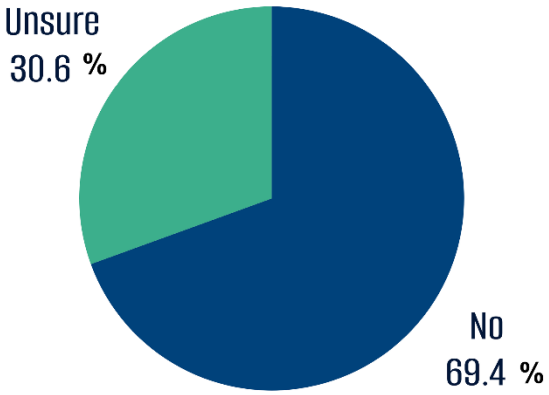


Additional communication methods recommended:

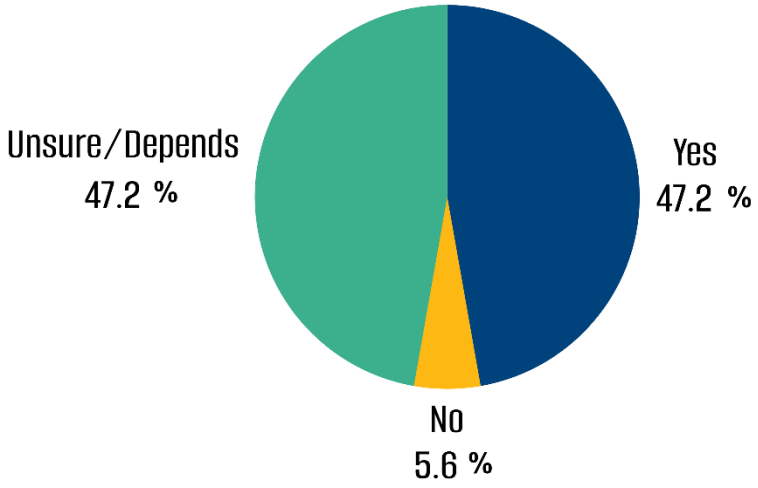


APPENDIX E: PUBLIC SURVEY RESULTS

Do you have any special access to functional needs (AFN) within your household that would require early warning or specialized response during disasters?

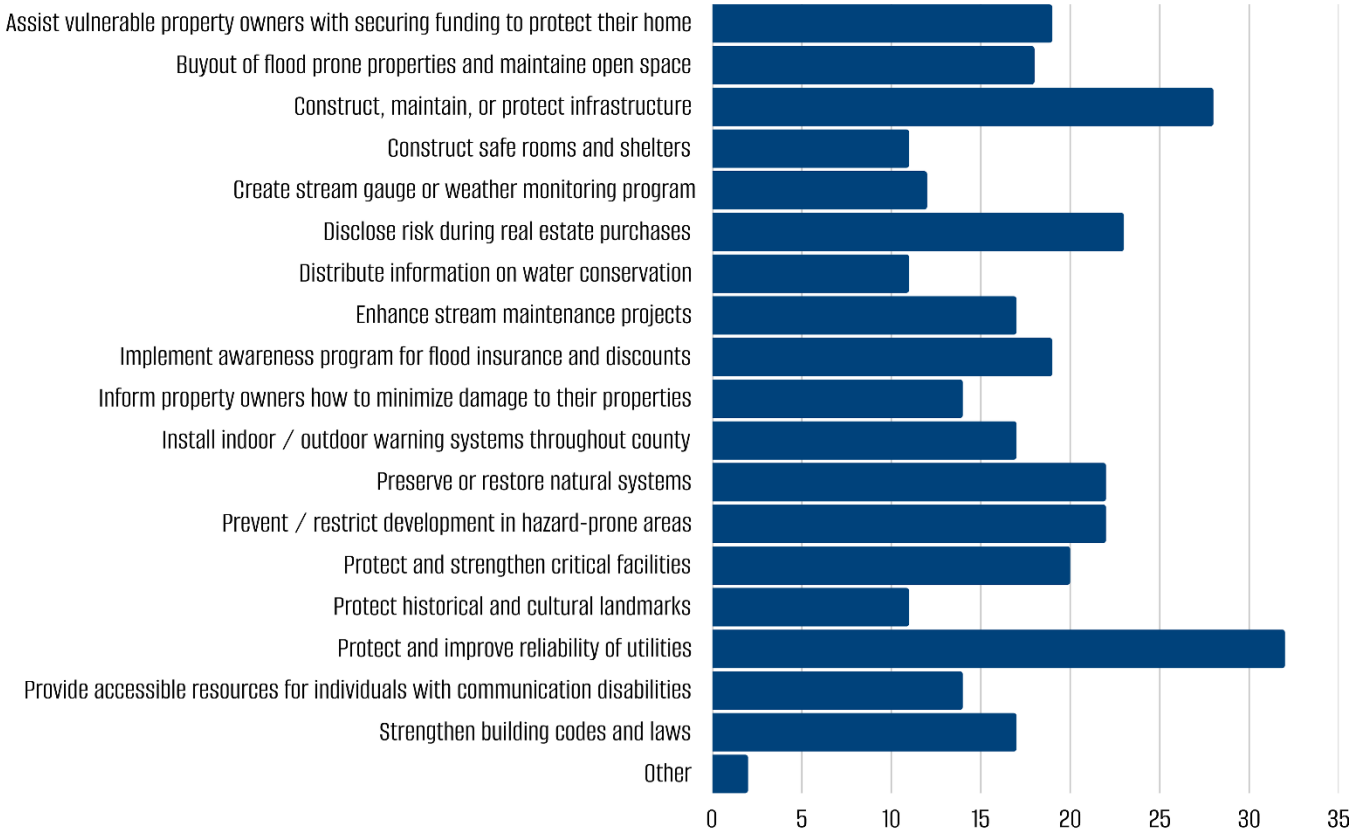


Would you support regulation (restrictions) on land uses within known high hazard areas?

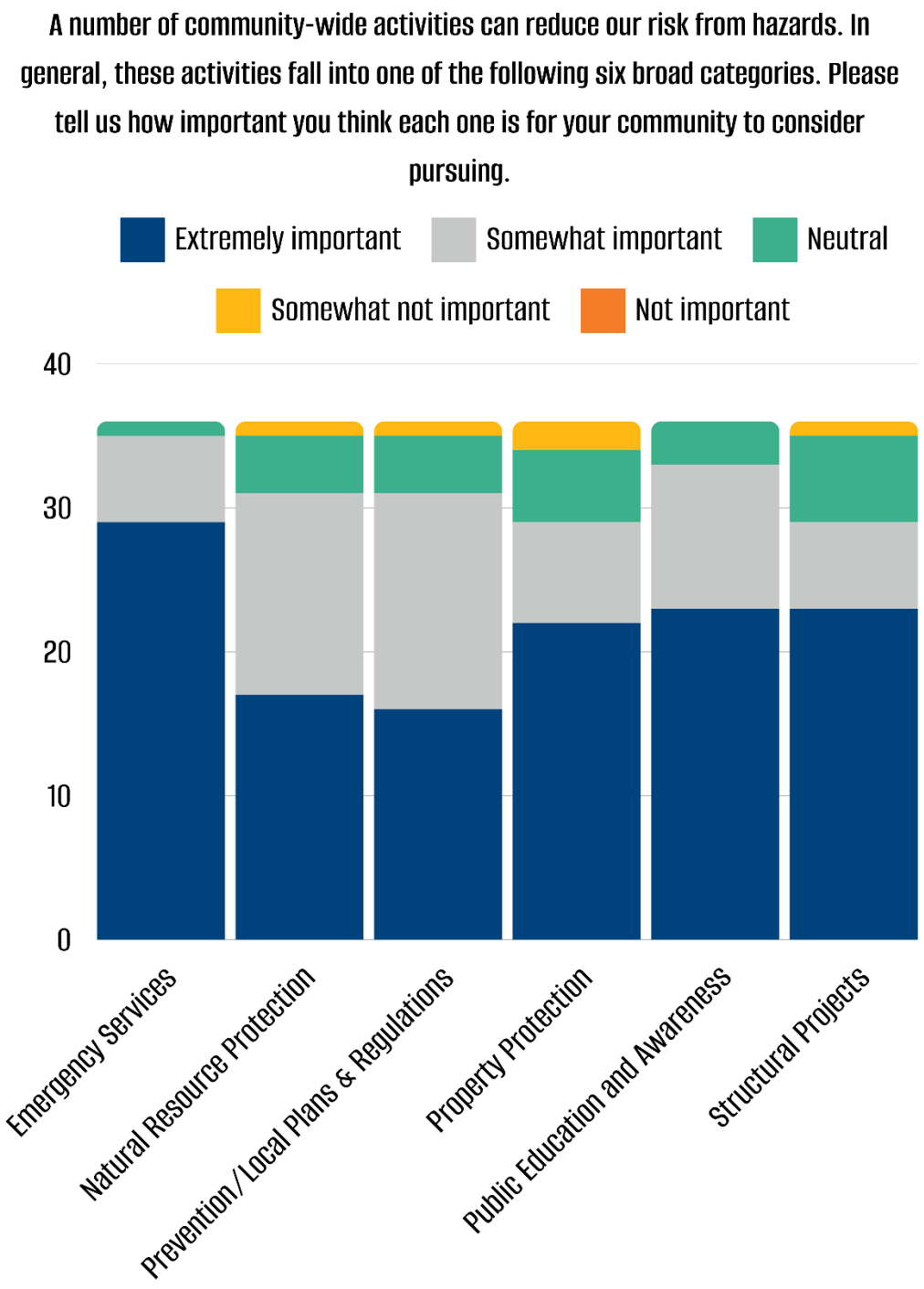


APPENDIX E: PUBLIC SURVEY RESULTS

In your opinion, please select steps your local government should prioritize to reduce or eliminate the risk of future hazard damages in your neighborhood.



APPENDIX E: PUBLIC SURVEY RESULTS



Emergency Services - Actions that protect people and property during and immediately after a hazard event. Examples include warning systems, evacuation planning, emergency response training, and protection of critical facilities or systems.

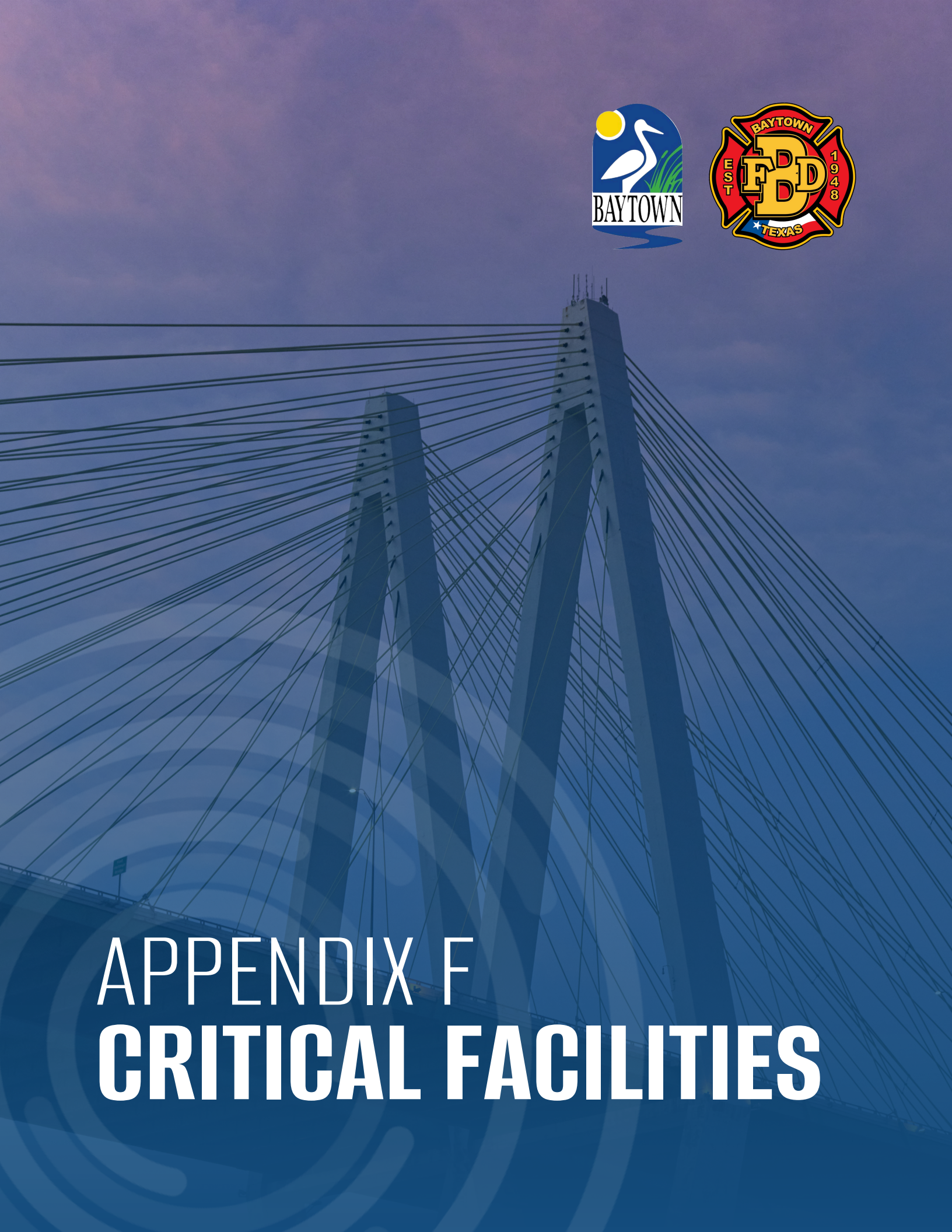
Natural Resource Protection - Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. Examples include floodplain protection, habitat preservation, slope stabilization, riparian buffers, and forest management.

Prevention / Local Plans & Regulations - Administrative or regulatory actions that influence the way land is developed and buildings are built. Examples include planning and zoning, building codes, open space preservation, and floodplain regulations.

Property Protection - Actions that involve the modification of existing buildings to protect them from a hazard or removal from the hazard area. Examples include acquisition, relocation, elevation, structural retrofits, and storm shutters.

Public Education and Awareness - Actions to inform citizens about hazards and techniques they can use to protect themselves and their property. Examples include outreach projects, school education programs, library materials, and demonstration events.

Structural Projects - Actions intended to lessen the impact of a hazard by modifying the natural progression of the hazard. Examples include dams, levees, seawalls detention / retention basins, channel modification, retaining walls, and storm sewers.



APPENDIX F
CRITICAL FACILITIES

APPENDIX F: CRITICAL FACILITIES

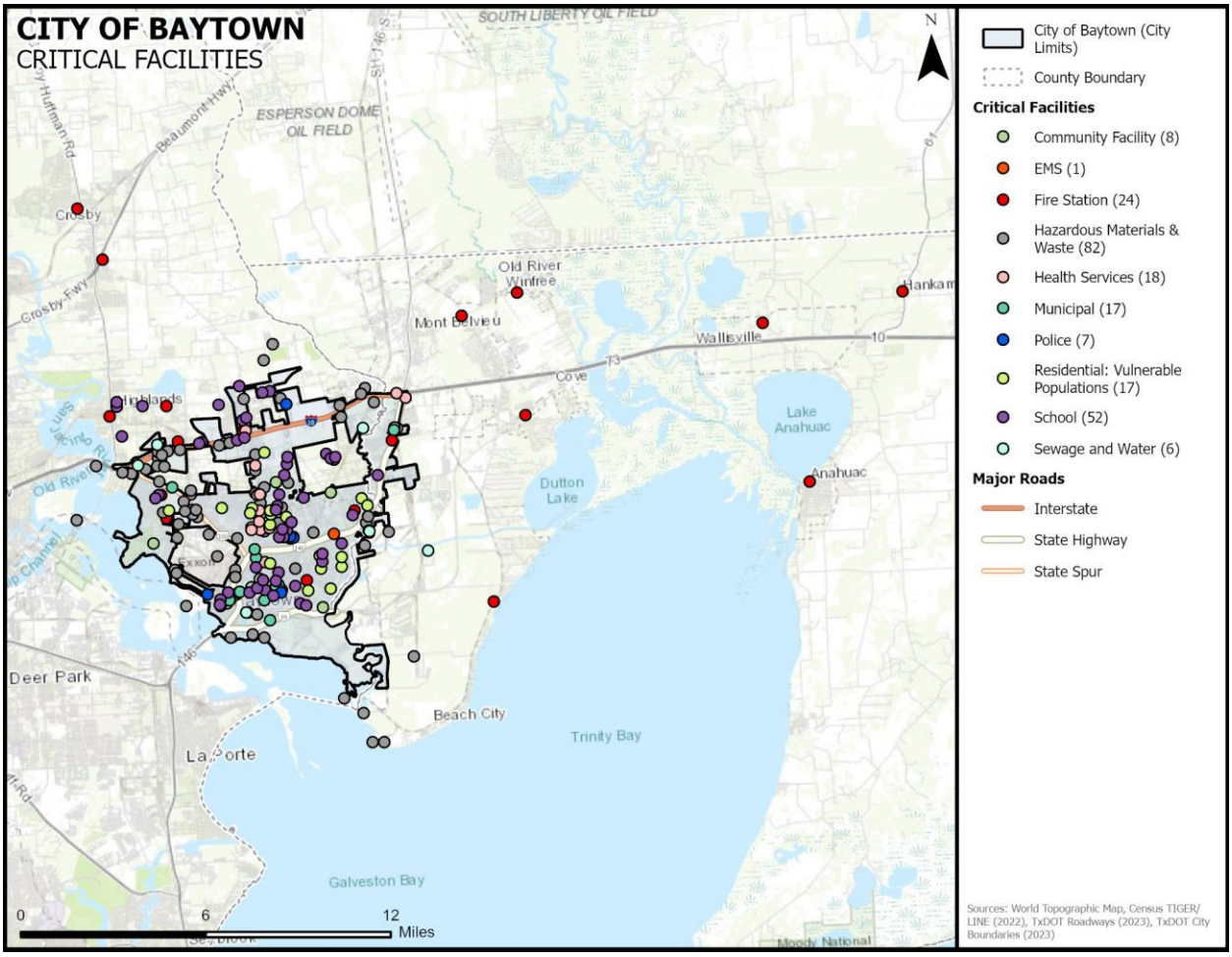
Overview 1
Critical Facilities 1

OVERVIEW

Appendix F is **For Official Use Only (FOUO)** and may be exempt from public release under FOIA. Figure F-1 locates all critical facilities that were included in the risk assessment. Mapped facilities were provided by Planning Team members. Table F-1 notes the critical facilities by type.

CRITICAL FACILITIES

Figure F-1. Critical Facilities in the City of Baytown

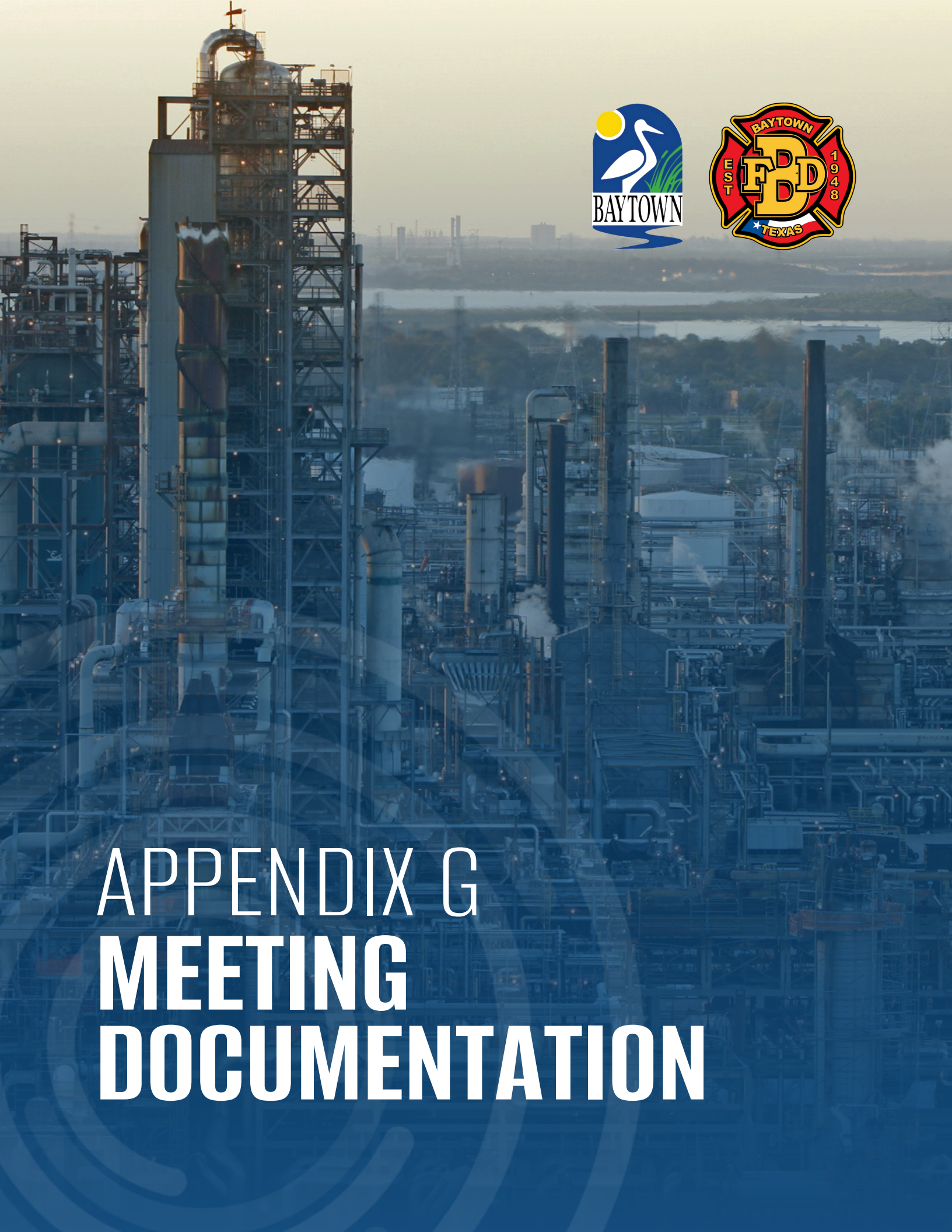


APPENDIX F: CRITICAL FACILITIES

Table F-1. Critical Facilities by Type in the City of Baytown

TYPE	NUMBER
Community Facility – Gathering Center	1
Community Facility – Library	1
Community Facility – Recreation / Park	6
EMS – Ambulance	1
Fire Station	24
Hazardous Materials & Waste	82[1]
Health Services – Action Behavior Center	4
Health Services – Dialysis Center	4
Health Services – Emergency Room	2
Health Services – Health Center / Medical Facility	4
Health Services – Hospice Care	3
Health Services – Hospital	1
Municipal	16
Municipal – EOC	1
Police	7
Residential: Vulnerable Populations	17
School – Early Childhood Education	1
School – Facility	10
School – Primary / Secondary	32
School – Specialized Private	5
School – University	4
Sewage and Water – Wastewater Treatment Plant	4
Sewage and Water – Water Distribution / Supply	2

[1] Facilities under this category include facility sites that manufacture, process, or otherwise handle hazardous materials as well as oil spill facilities. These types of facilities pose a risk if they were to be compromised due to a natural or other manmade hazard.



APPENDIX G
MEETING DOCUMENTATION

APPENDIX G: MEETING DOCUMENTATION

Workshop Documentation 1
Public Meeting Documentation 7
Public Notices 10

WORKSHOP DOCUMENTATION

Appendix G is **For Official Use Only (FOUO)** and may be exempt from public release under the Freedom of Information Act (FOIA).

The City of Baytown held a series of Planning Team workshops: a Kickoff Workshop on October 23, 2024, and a Risk Assessment Workshop and Mitigation Strategy Workshop on January 8, 2025. At each of these workshops members of the Planning Team were informed of the planning process, expressed opinions, and volunteered information. The Emergency Management Planning Committee attended the workshops and help additional meetings on November 13, 2024, and April 8, 2025. The City of Baytown hosted public meetings. The sign-in sheets for each workshop and public meeting are included below. For more details on the workshops and planning process, see Section 2.

Figure G-1. City of Baytown Kickoff Workshop, October 23, 2024

BAYTOWN

CITY OF BAYTOWN - HAZARD MITIGATION PLAN
KICK-OFF WORKSHOP
Baytown Emergency Operations Center
205 E. Wye Drive Baytown, Texas 77521
October 23, 2024 @ 2:00pm

H2O PARTNERS

Name	Jurisdiction	Title	Email	Phone
Stringer, John	Baytown	Chief of Police	john.stringer@baytown.org	832-203-9263
TERRY SAIN	BAYTOWN	RESIDENT	TERRY.SAIN@HOTMAIL.COM	(832)572-0077
Phillip Davis	Baytown	Risk Mgr	phillip.davis@baytown.org	281-420-5846
Mark Guzman	Baytown	Deputy EMC	Mark.guzman@baytown.org	281-422-1168
DAVID ACANDA	Baytown	EMC	david.alonia@baytown.org	281-422-1129
Rhonda Murphy	H2O Partners	Mitigation Planner	RMurphy@H2opartnersusa.com	512-571-2088
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259

APPENDIX G: MEETING DOCUMENTATION

CITY OF BAYTOWN - HAZARD MITIGATION PLAN
KICK-OFF WORKSHOP
Virtual Sign In
October 23, 2024 @ 2:00pm

Name	Jurisdiction	Title	Email	Phone
Planning Department – Baytown	Baytown	Planning Department	Russell.Davidson@baytown.org Ryan.Hvitlok@baytown.org	281-420-5394
Casey Cook	Baytown	Public Information & Education Coordinator	casey.cook@baytown.org	281-420-7116
Clifford Hatch	Baytown	Director – Parks and Recreation	clifford.hatch@baytown.org	281-420-6594
Cornell Gordon	Baytown	Planning and Construction Superintendent	Cornell.Gordon@baytown.org	281-420-6593
Juan Macias	Baytown	Assistant Director / City Engineer / Floodplain Manager	Juan.Macias@Baytown.org	281-420-7109
Kenny Dobson	Baytown	Fire Chief	kenneth.dobson@baytown.org	281-422-0044
Monica Cisneros	Baytown	Project Coordinator	monica.cisneros@baytown.org	281-422-1119
Sweta Patel	Baytown	CRS Coordinator	Sweta.Patel@baytown.org	281-420-7132
Zachary Start	Baytown	Chief Building Official	zachary.start@baytown.org	281-420-5370
Tricia Times	Not provided	Not provided	Not listed on City Directory	Not provided

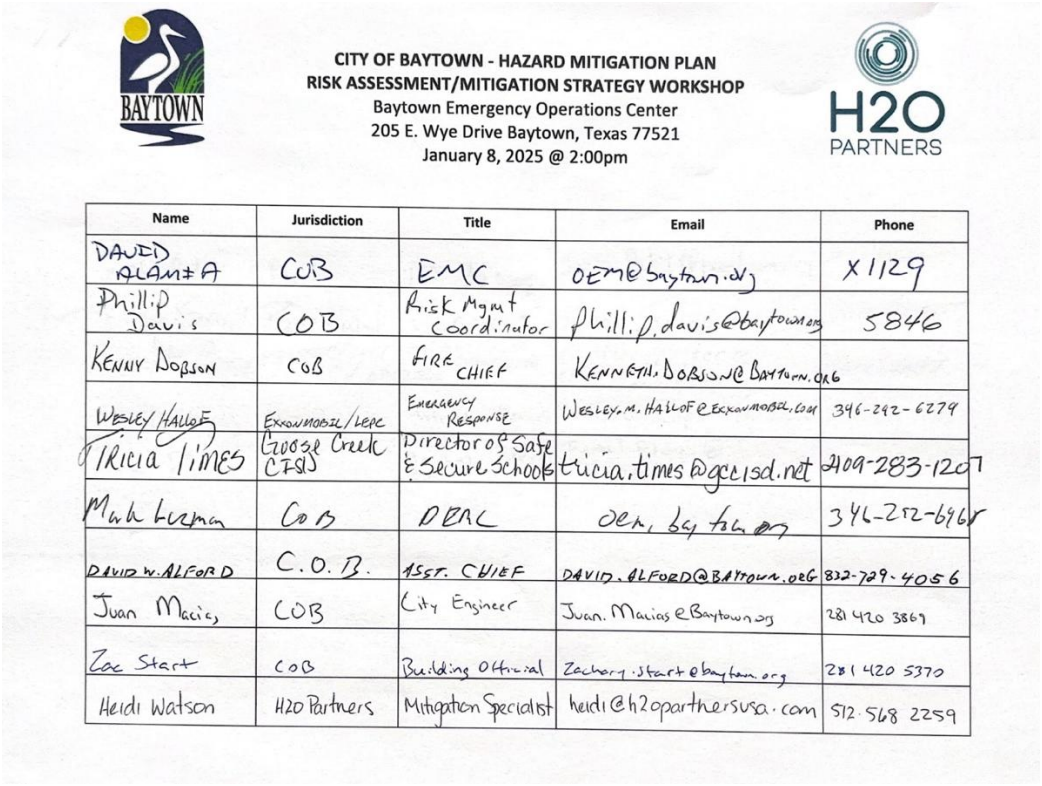
CITY OF BAYTOWN - HAZARD MITIGATION PLAN
KICK-OFF WORKSHOP
Virtual Sign In
October 23, 2024 @ 2:00pm

Name	Jurisdiction	Title	Email	Phone
Stevie-Ann O'Donnell	H2O Partners	Mitigation Outreach Coordinator	sodonnell@h2opartnersusa.com	631-921-2460
Krystian Murray	H2O Partners	Mitigation Specialist	kmurray@h2opartnersusa.com	512-827-1795
Will Parker	H2O Partners	Mitigation Specialist	wparker@h2opartnersusa.com	512-539-7016

APPENDIX G: MEETING DOCUMENTATION

Figure G-2. City of Baytown Risk Assessment and Mitigation Strategy Workshop, January 8, 2025

BAYTOWN

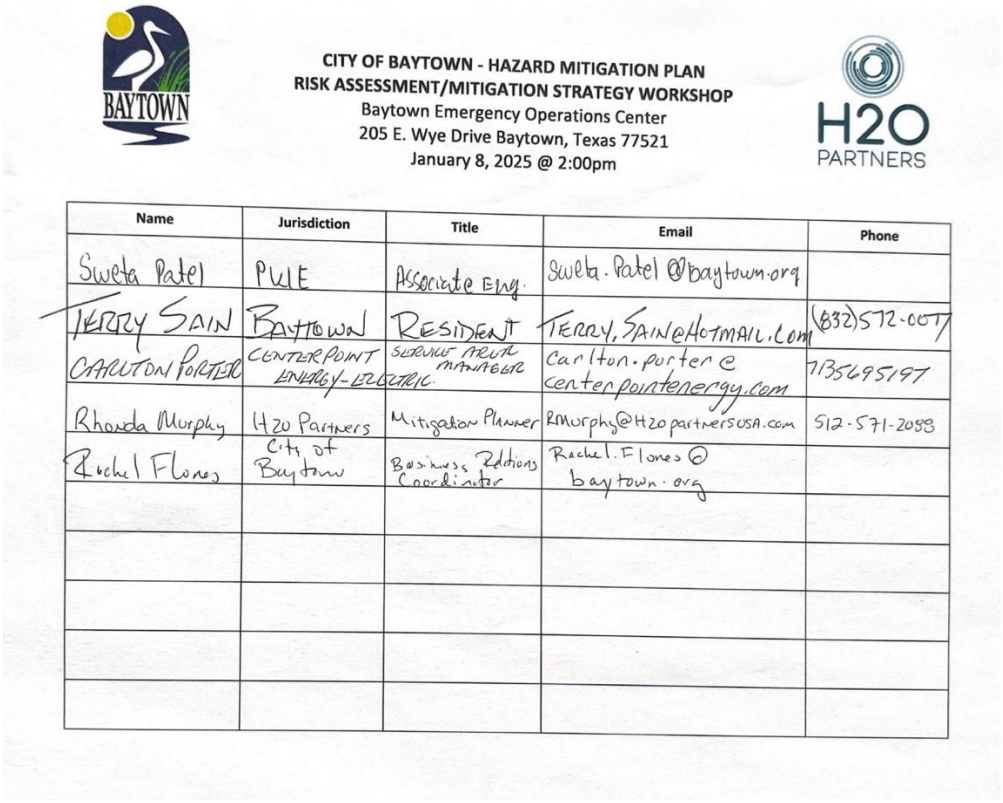


CITY OF BAYTOWN - HAZARD MITIGATION PLAN
RISK ASSESSMENT/MITIGATION STRATEGY WORKSHOP
Baytown Emergency Operations Center
205 E. Wye Drive Baytown, Texas 77521
January 8, 2025 @ 2:00pm

H2O PARTNERS

Name	Jurisdiction	Title	Email	Phone
DAVID ALAMEA	COB	EMC	OEM@baytown.org	X1129
Phillip Davis	COB	Risk Mgmt Coordinator	phillip.davis@baytown.org	5846
KENNY DOBSON	COB	FIRE CHIEF	KENNETH.DOBSON@BAYTOWN.ORG	
WESLEY HALLOF	EXXONMOBIL/LEPC	EMERGENCY RESPONSE	WESLEY.M.HALLOF@EXXONMOBIL.COM	346-292-6279
TRICIA TIMES	Goose Creek CISD	Director of Safe & Secure Schools	tricia.times@gccisd.net	2409-283-1207
Mark Luzman	COB	DERC	oem.baytown.org	346-252-6968
DAVID W. ALFORD	C.O.B.	ASST. CHIEF	DAVID.ALFORD@BAYTOWN.ORG	832-729-4056
Juan Macias	COB	City Engineer	Juan.Macias@Baytown.org	281 420 3869
Zac Start	COB	Building Official	Zachary.start@baytown.org	281 420 5370
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512 568 2259

BAYTOWN



CITY OF BAYTOWN - HAZARD MITIGATION PLAN
RISK ASSESSMENT/MITIGATION STRATEGY WORKSHOP
Baytown Emergency Operations Center
205 E. Wye Drive Baytown, Texas 77521
January 8, 2025 @ 2:00pm

H2O PARTNERS

Name	Jurisdiction	Title	Email	Phone
Sweta Patel	PWE	Associate Eng.	Sweta.Patel@baytown.org	
TERRY SAIN	BAYTOWN	RESIDENT	TERRY.SAIN@HOTMAIL.COM	(832)572-0077
CARLTON PORTER	CENTERPOINT ENERGY-ELECTRIC	SERVICE AREA MANAGER	carlton.porter@centerpointenergy.com	7135695197
Rhonda Murphy	H2O Partners	Mitigation Planner	RMurphy@H2opartnersUSA.com	512-571-2088
Rachel Flones	City of Baytown	Business Relations Coordinator	Rachel.Flones@baytown.org	

APPENDIX G: MEETING DOCUMENTATION

CITY OF BAYTOWN - HAZARD MITIGATION PLAN
RISK ASSESSMENT / MITIGATION STRATEGY WORKSHOP
Virtual Sign In
January 8, 2025 @ 2:00pm

Name	Jurisdiction	Title	Email	Phone
Cornell Gordon	City of Baytown	Parks Department Planning Superintendent	Cornell.Gordon@Baytown.org	281-42-6593
Clifford Hatch	City of Baytown	Parks Department Planning Director	clifford.hatch@baytown.org	281-420-6594
Frank Simoneaux	City of Baytown	PWE Director	Frank.Simoneaux@baytown.org	281-420-5300
Kevin Hilyard	City of Baytown	PWE Operations Superintendent	Kevin.Hilyard@baytown.org	281-420-6695
Laura Alvarado	City of Baytown	Councilmember – District 1	district.1@baytown.org	281-838-5888
Michael Leech	City of Baytown	PWE Assistant Director – Capital Projects	michael.leech@baytown.org	281-420-7109
Monica Sisneros	City of Baytown	PWE Project Coordinator	Monica.Cisneros@baytown.org	281-422-1119
Sterling Beaver	Not provided	Not provided	Not provided	Not provided
Kevin	Not provided	Not provided	Not provided	Not provided
Zac Stuart	City of Baytown	Planning & Development Chief Building Official	zachary.start@baytown.org	281-420-5370

CITY OF BAYTOWN - HAZARD MITIGATION PLAN
RISK ASSESSMENT / MITIGATION STRATEGY WORKSHOP
Virtual Sign In
January 8, 2025 @ 2:00pm

Name	Jurisdiction	Title	Email	Phone
Melissa Reabold	UWGBACC	CEO / NonProfit Representative	melissar@unitedwaygbacc.org	n/a
Stevie-Ann O'Donnell	H2O Partners Inc.	Mitigation Outreach Coordinator	sodonnell@h2opartnersusa.com	631-921-2460

APPENDIX G: MEETING DOCUMENTATION

Figure G-3. City of Baytown Emergency Management Planning Committee Meeting, November 13, 2024

Baytown Fire Department
Office of Emergency Management

Baytown Emergency Management Advisory Committee
& Local Hazard Mitigation Planning Team
EMAC Meeting 3
November 13, 2024
12:00pm – 01:00pm

NAME	TITLE/ POSITION	AGENCY/ORGANIZATION	SIGNATURE
David Alamia	Emergency Management Coordinator	Baytown Office of Emergency Management	
Mark Guzman	Deputy Emergency Management Coordinator	Baytown Office of Emergency Management	
Kenneth Dobson	Fire Chief	Baytown Fire Department	
Tony Gray	Health Director	Baytown Health	
Wesley Hallof	Emergency Preparedness Coordinator	ExxonMobil (Industry/LEPC Member)	VIRTUAL
Juan Macias	Assistant Director PWE Engineering/Floodplain	Baytown Public Works and Engineering	
Tricia Times	Safe and Secure Schools Director	Goose Creek CISD (Education Member)	
Melissa Reabold	Chief Executive Officer	United Way GBACC (VOAD/NGO Member)	VIRTUAL
Terry Sain	Former Council Member	Resident Member	
John Stringer	Police Chief	Baytown Police Department	
Kiska Boyd	Safety Officer	Methodist	
Zachary Start	Chief Building Official	CoB Planning + Dev	

Baytown Fire Department
Office of Emergency Management

Baytown Emergency Management Advisory Committee
& Local Hazard Mitigation Planning Team
EMAC Meeting 3
November 13, 2024
12:00pm – 01:00pm

NAME	TITLE/ POSITION	AGENCY/ORGANIZATION	SIGNATURE
Freddy Flores	Deputy Chief Building Offic	Planning & Development Svc.	
Tony Irby	Chairman	Baytown LEPC	VIRTUAL
Ryan Hvitlok	ASST. Director	PLNG & DEVELOPMENT	VIRTUAL
Melissa Reabold	CEO	United Way GBACC	VIRTUAL
Cornell Gordon	PLNG/Construction superintendent	Parks & REC	VIRTUAL
Rhonda Murphy	Consultant	H_2O PARTNERS	VIRTUAL
Wesley Hallof	EM PREP SPCLST	ExxonMobil	VIRTUAL

APPENDIX G: MEETING DOCUMENTATION

Figure G-4. City of Baytown Emergency Management Planning Committee Meeting, April 8, 2025

CITY OF BAYTOWN - HAZARD MITIGATION PLAN
EMERGENCY MANAGEMENT ADVISORY COMMITTEE &
LOCAL HAZARD MITIGATION PLANNING TEAM
EMAC MEETING #
April 8, 2025 @ Xpm

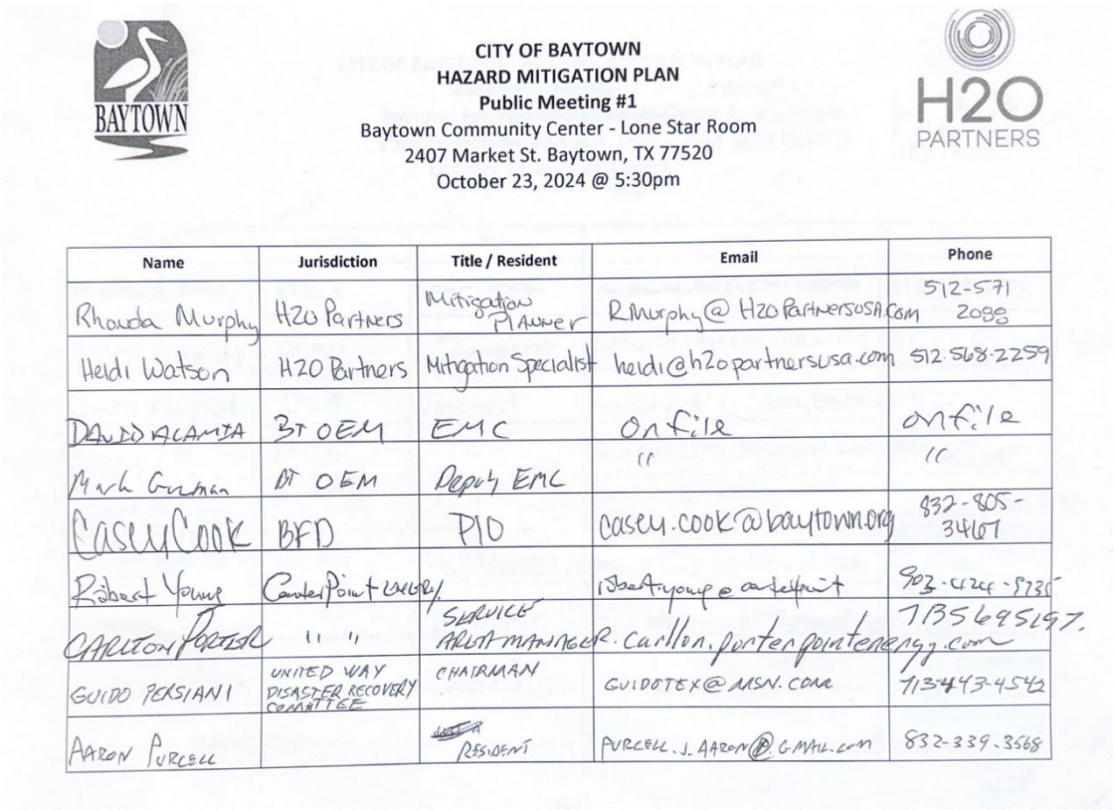
Name	Jurisdiction	Title	Email	Phone

APPENDIX G: MEETING DOCUMENTATION

PUBLIC MEETING DOCUMENTATION

As discussed in Section 2, public meetings were held in the City of Baytown. Documentation in the form of sign-in sheets for each of the meetings follows.

Figure G-5. Public Meeting, October 23, 2024



CITY OF BAYTOWN
HAZARD MITIGATION PLAN
Public Meeting #1
Baytown Community Center - Lone Star Room
2407 Market St. Baytown, TX 77520
October 23, 2024 @ 5:30pm

Name	Jurisdiction	Title / Resident	Email	Phone
Rhonda Murphy	H2O Partners	Mitigation Planner	RMurphy@H2OPartnersUSA.com	512-571 2088
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512.568.2259
DAVID ALAMIA	BT OEM	EMC	On file	on file
Mark Guzman	BT OEM	Deputy EMC	"	"
Casey Cook	BFD	PIO	casey.cook@baytown.org	832-805-3467
Robert Young	CenterPoint Energy		robert.young@centerpoint	903-424-9735
CARLTON PORTER	" "	SERVICE AREA MANAGER	carlton.porterpointenergy.com	7135695197.
GUIDO PERSIANI	UNITED WAY DISASTER RECOVERY COMMITTEE	CHAIRMAN	GUIDOTEX@MSN.COM	713-443-4542
AARON PURCELL		RESIDENT	PURCELL.J.AARON@GMAIL.com	832-339-3568

APPENDIX G: MEETING DOCUMENTATION

CITY OF BAYTOWN
HAZARD MITIGATION PLAN
Public Meeting #1
Baytown Community Center - Lone Star Room
2407 Market St. Baytown, TX 77520
October 23, 2024 @ 5:30pm

Name	Jurisdiction	Title	Email	Phone
LAWRENCE BELL	PCT. 3	Comm. INVOL.	LAWRENCE.BELL@HCTX.NET	713.274.3000
Malleli Hidalgo	PCT	community engagement	malleli@tejasbarrios.org	832-831-6183
Laura Alvarado	D 1	Council	district.1@baytown.org	
Jessica H	PCT2	C.	Jh20042017@gmail.com	832-359-9667
Dave Rogers	baytown sun	reporter	dave.rogers@baytownsun.com	409 651 8020
Wanda Alfred	PCT3	Resident	mswalfred@gmail.com	281 [illegible] 3937
Theresa Blackwood		RESIDENT	terri.blackwood323@gmail.com	832-877-6455
Phyllis Smith		Resident		

Figure G-6. Public Meeting, January 8, 2025

CITY OF BAYTOWN
HAZARD MITIGATION PLAN
Public Meeting #2
Baytown Community Center - Lone Star Room
2407 Market St. Baytown, TX 77520
January 8, 2025 @ 5:30pm

Name	Jurisdiction	Title / Resident	Email	Phone
Mark Zotti	TDEM	CLO - Chambers County	Mark.Zotti@tdem.texas.gov	832-778-6349
Mark Bezner	COB	DEMC	demc@baytown.org	346-292-6468
THERESA BLACKWOOD		RESIDENT	terriblackwood323@gmail.com	832-877-6455
Shawna Bossen	[illegible]	resident	dobsonclan2@gmail.com	
Yudith Niet		Bayou City Waterkeeper	yudith@bayoucitywaterkeeper.org	832-867-1250
MARY J LAREZ		Resident	hellomary.jlarez@gmail.com	
Laura Alvarado	COB	Resident/council	district.1@baytown.org	
Nathaniel Knox			NKnox@knoxgs.com	754-410-4753
Malcom Patterson		RESIDENT	patterson.malcom@yahoo.com	337 513 7987

APPENDIX G: MEETING DOCUMENTATION

CITY OF BAYTOWN
HAZARD MITIGATION PLAN
Public Meeting #2
Baytown Community Center - Lone Star Room
2407 Market St. Baytown, TX 77520
January 8, 2025 @ 5:30pm

Name	Jurisdiction	Title / Resident	Email	Phone
Rhonda Murphy	H2O Partners	Mitigation Planner	RMurphy@H2opartnersusa.com	512-571-2088
Heidi Watson	H2O Partners	Mitigation Specialist	heidi@h2opartnersusa.com	512-568-2259
DAVID ALANIZ	COB OEM	EMC	OEM@baytown.org	281-422-1129
Merry Holmes	TDEM	Mitigation Coor	Merryl.Holmes@tdem.texas.gov	281-794-4002
Lucy Salinas	TDEM	Mit. Coordinator	Lucilla.Salinas@tdem.Texas.gov	832-904-9816
Dave Rogers	Baytown Sun		dave.rogers@baytownsun.com	409-651-8620
Bricuida Alcaraz		Resident	Alcarazjune@gmail	7)351-9620
James Miller	BFD	Div. Chief	james.miller@baytontx.org	713-854-5258
Glen Spurgers	Citizen	Resident	glenspurgers@att.net	469-236-9078

CITY OF BAYTOWN
HAZARD MITIGATION PLAN
Public Meeting #2
Baytown Community Center - Lone Star Room
2407 Market St. Baytown, TX 77520
January 8, 2025 @ 5:30pm

Name	Jurisdiction	Title / Resident	Email	Phone
Charles Johnson	city	Mayor	Mayor@Baytown.org	

APPENDIX G: MEETING DOCUMENTATION

PUBLIC NOTICES

Public notices to announce the City of Baytown's participation in the Plan Update development process were posted on their website, through the local media, and/or posting the information on bulletin boards in public facilities.

Figure G-7. City of Baytown Public Notice, City Website

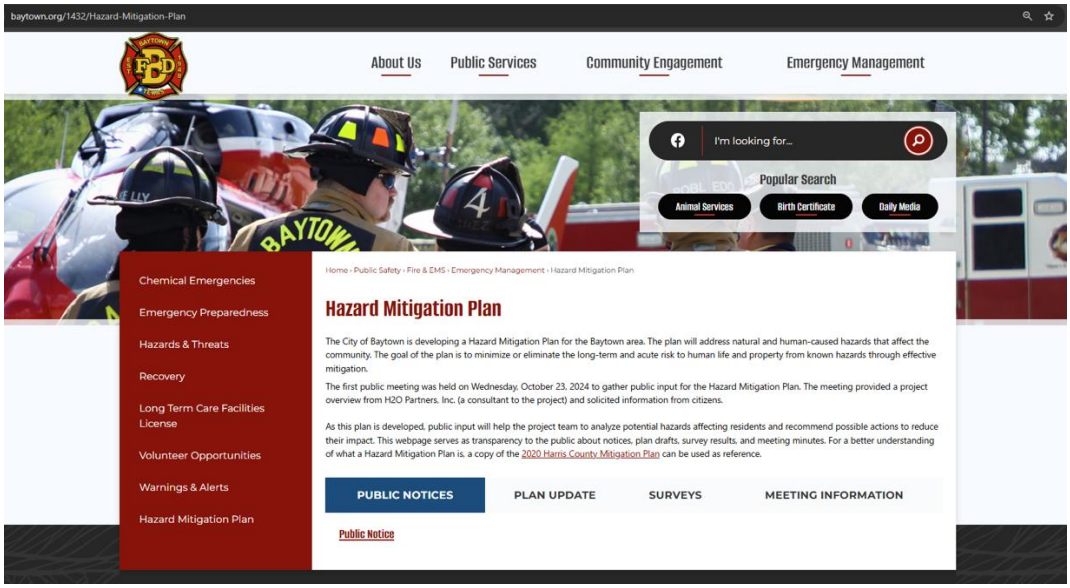


Figure G-8. City of Baytown Public Notice, City Facebook



APPENDIX G: MEETING DOCUMENTATION

Figure G-9. City of Baytown Public Notice, Fire Department Facebook



Figure G-10. City of Baytown Public Notice, Facebook Event Page

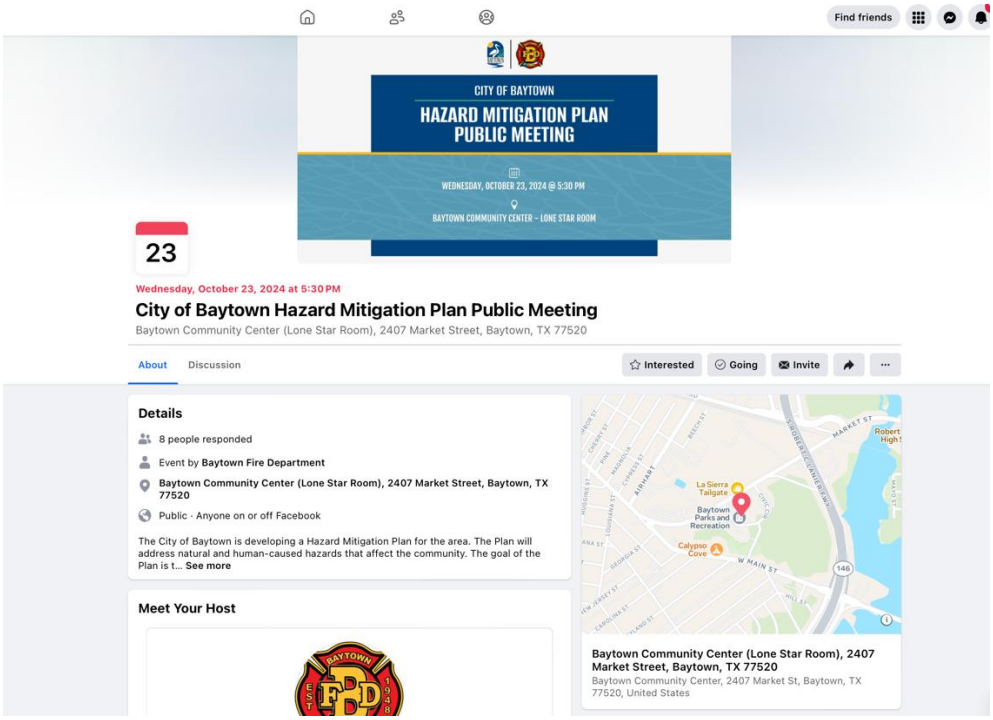


Figure G-11. City of Baytown Public Notice, Fire Department Instagram

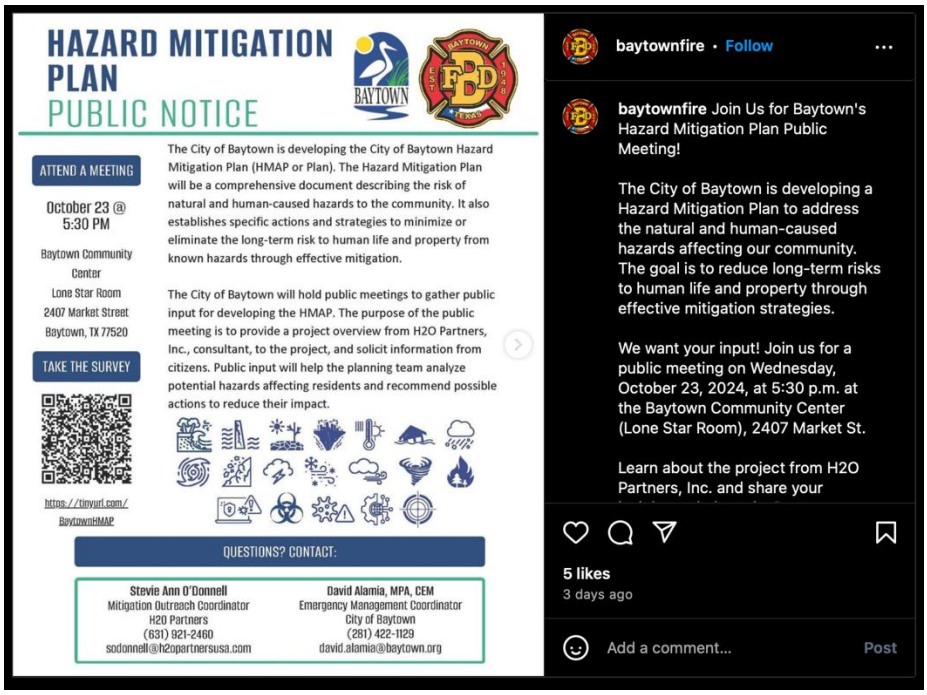


Figure G-12. City of Baytown Public Notice, State Senator Facebook



Figure G-13. City of Baytown Public Notice, Mass Text Alert

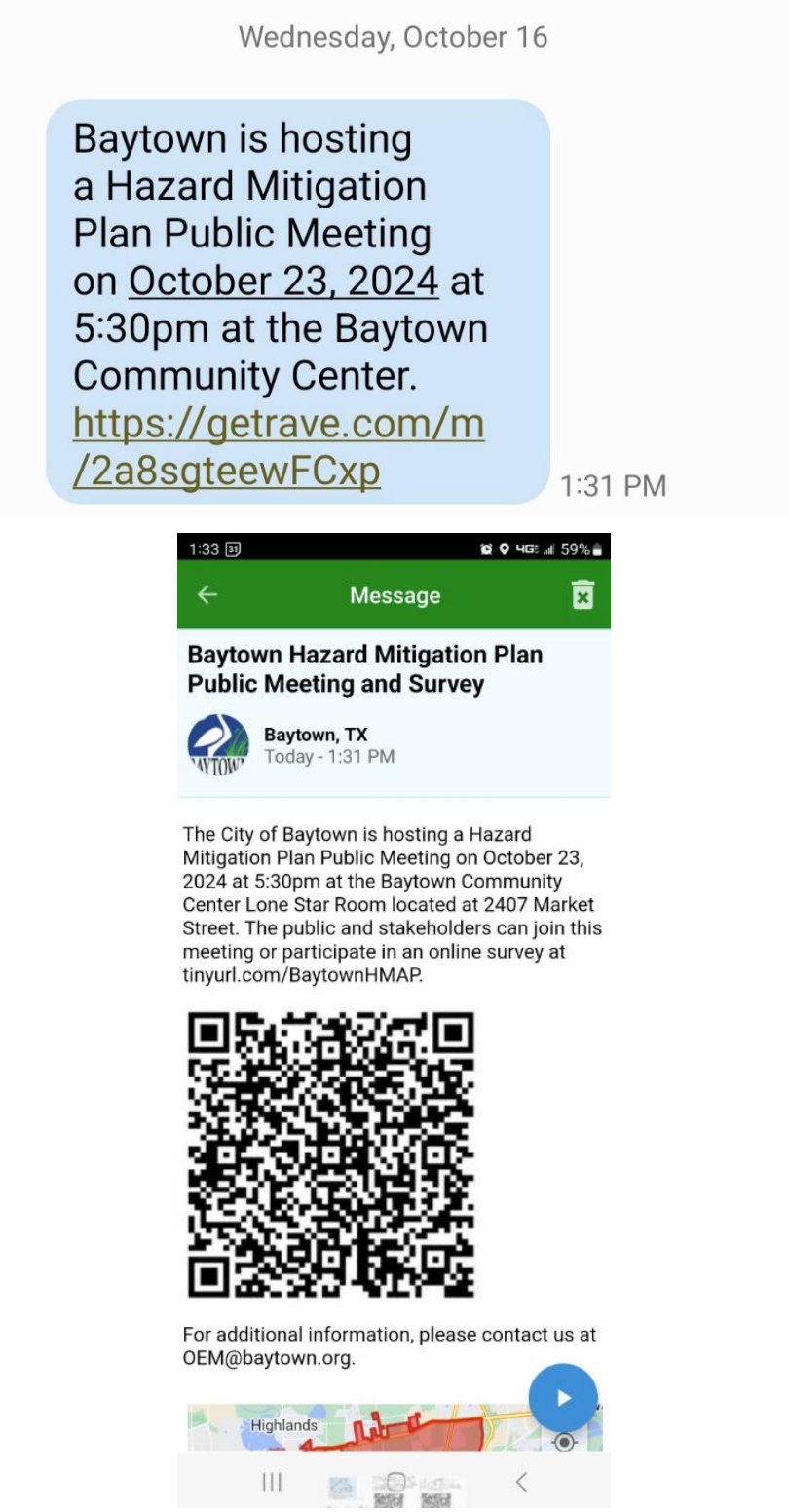
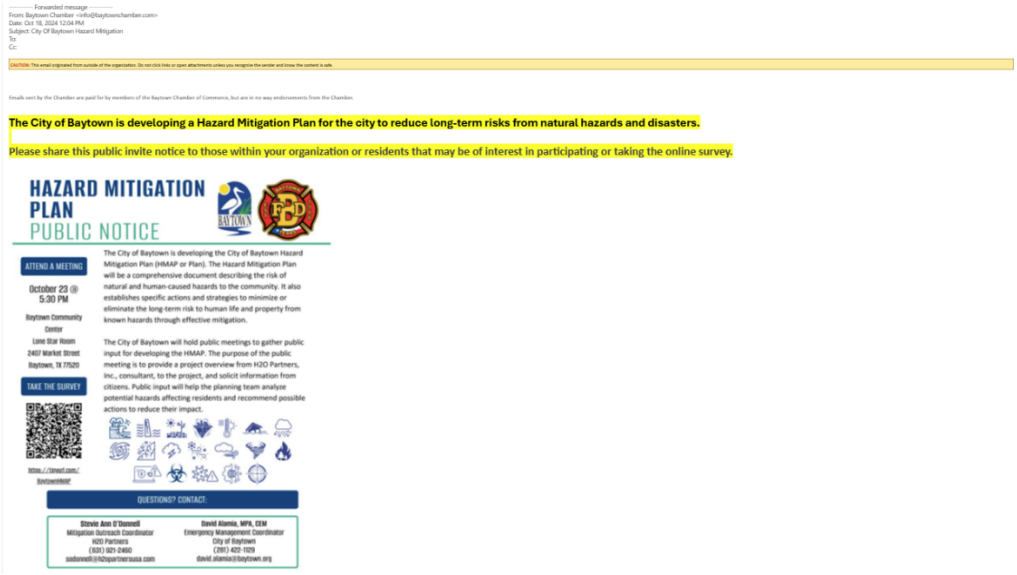


Figure G-14. City of Baytown Public Notice, Mass Email Alert



---------- Forwarded message ---------
From: Baytown Chamber <info@baytownchamber.com>
Date: Oct 18, 2024 12:04 PM
Subject: City Of Baytown Hazard Mitigation
To:
Cc:

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Emails sent by the Chamber are paid for by members of the Baytown Chamber of Commerce, but are in no way endorsements from the Chamber.

The City of Baytown is developing a Hazard Mitigation Plan for the city to reduce long-term risks from natural hazards and disasters.

Please share this public invite notice to those within your organization or residents that may be of interest in participating or taking the online survey.

HAZARD MITIGATION PLAN
PUBLIC NOTICE

ATTEND A MEETING

October 23 @ 5:30 PM

Baytown Community Center
Lone Star Room
2407 Market Street
Baytown, TX 77520

TAKE THE SURVEY

https://tinyurl.com/baytownHMAP

The City of Baytown is developing the City of Baytown Hazard Mitigation Plan (HMAP or Plan). The Hazard Mitigation Plan will be a comprehensive document describing the risk of natural and human-caused hazards to the community. It also establishes specific actions and strategies to minimize or eliminate the long-term risk to human life and property from known hazards through effective mitigation.

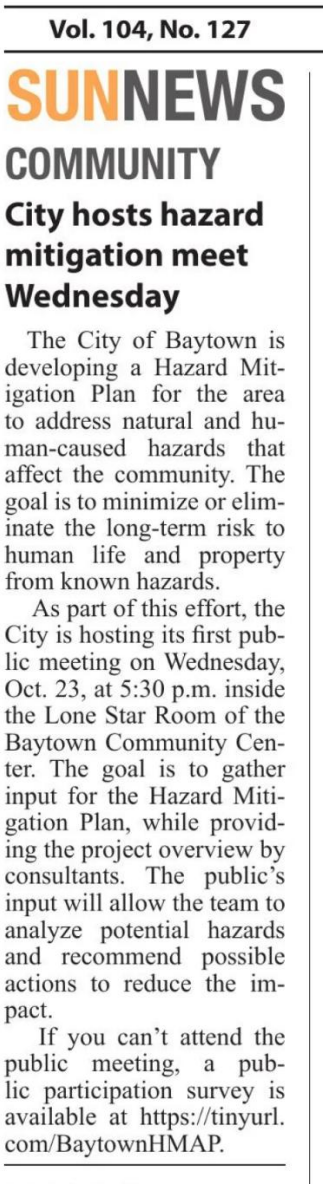
The City of Baytown will hold public meetings to gather public input for developing the HMAP. The purpose of the public meeting is to provide a project overview from H2O Partners, Inc., consultant, to the project, and solicit information from citizens. Public input will help the planning team analyze potential hazards affecting residents and recommend possible actions to reduce their impact.

QUESTIONS? CONTACT:

Stevie Ann O'Donnell
Mitigation Outreach Coordinator
H2O Partners
(928) 301-2460
sodonnell@h2opartnersusa.com

David Alamia, MPA, CEM
Emergency Management Coordinator
City of Baytown
(281) 422-1129
david.alamia@baytown.org

Figure G-15. City of Baytown Public Notice, Newspaper



Vol. 104, No. 127

SUNNEWS

COMMUNITY

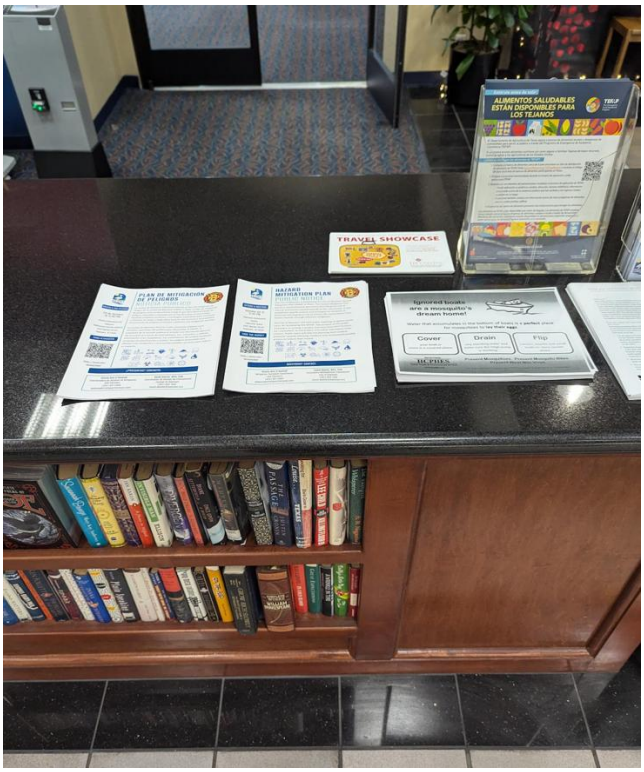
City hosts hazard mitigation meet Wednesday

The City of Baytown is developing a Hazard Mitigation Plan for the area to address natural and human-caused hazards that affect the community. The goal is to minimize or eliminate the long-term risk to human life and property from known hazards.

As part of this effort, the City is hosting its first public meeting on Wednesday, Oct. 23, at 5:30 p.m. inside the Lone Star Room of the Baytown Community Center. The goal is to gather input for the Hazard Mitigation Plan, while providing the project overview by consultants. The public's input will allow the team to analyze potential hazards and recommend possible actions to reduce the impact.

If you can't attend the public meeting, a public participation survey is available at https://tinyurl.com/BaytownHMAP.

Figure G-16. City of Baytown Public Notice, Library



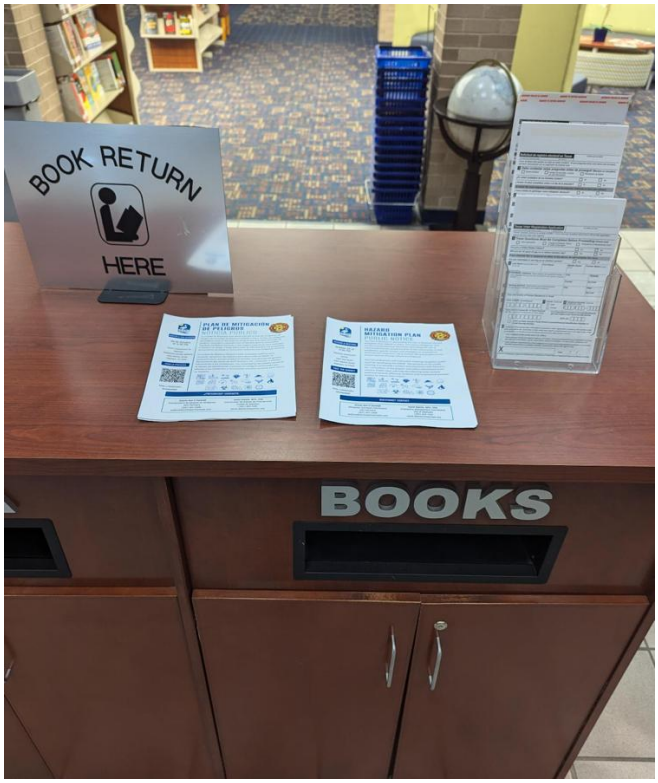


Figure G-17. City of Baytown Public Notice, City Clerk Office



Figure G-18. City of Baytown Public Notice, City Hall



APPENDIX G: MEETING DOCUMENTATION

Figure G-19. City of Baytown Public Notice, Public Works and Engineering Department



APPENDIX G: MEETING DOCUMENTATION

Figure G-20. City of Baytown Public Notice, City Website

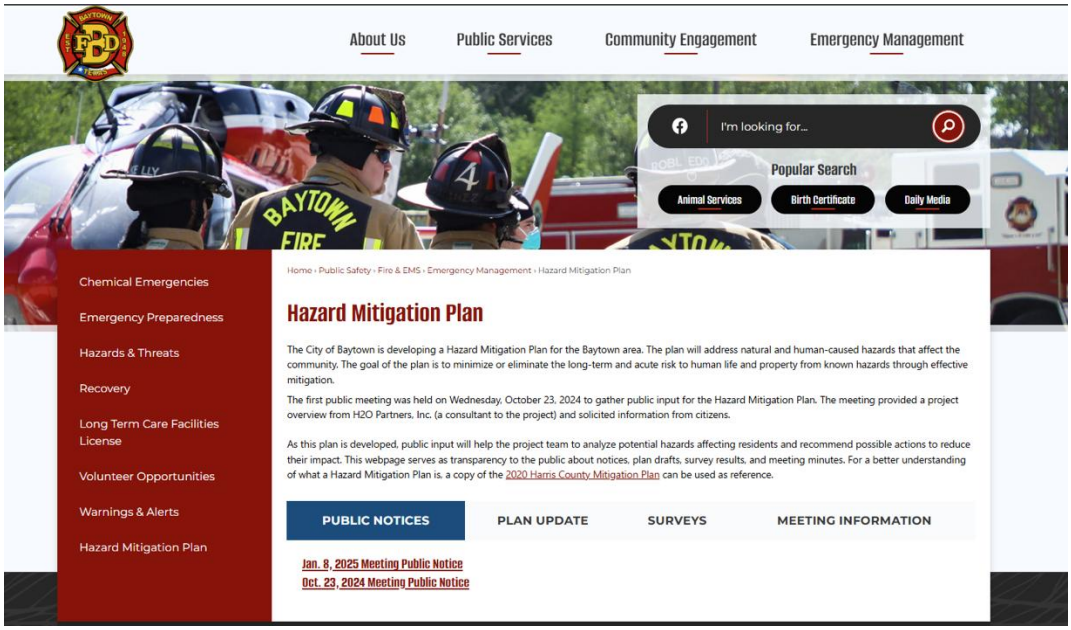


Figure G-21. City of Baytown Public Notice, City Facebook



APPENDIX G: MEETING DOCUMENTATION

Figure G-22. City of Baytown Public Notice, Fire Department Facebook

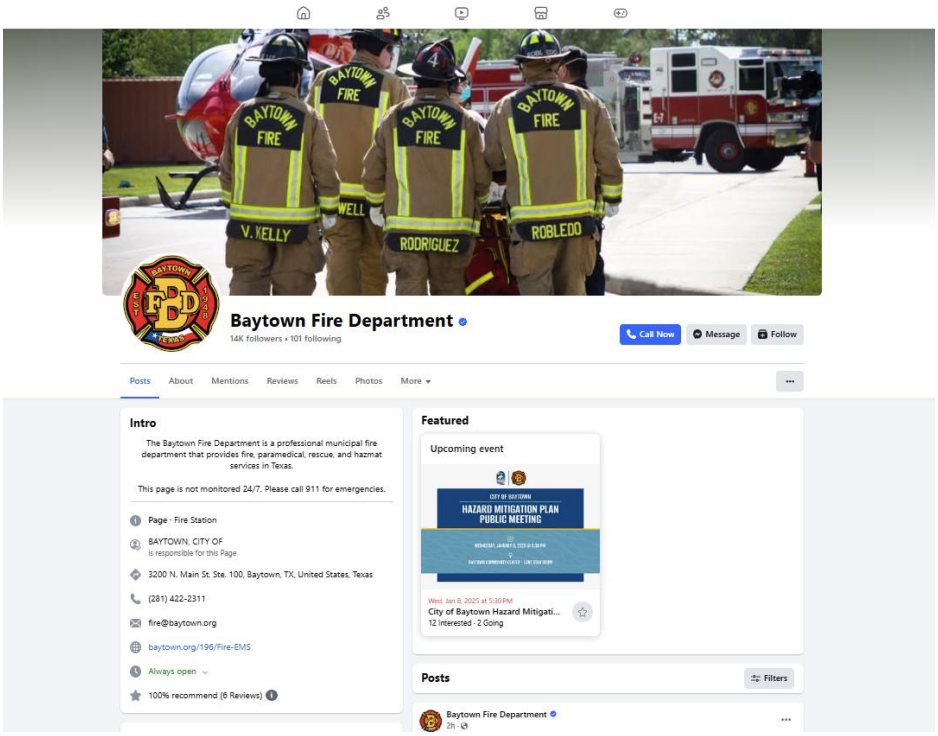
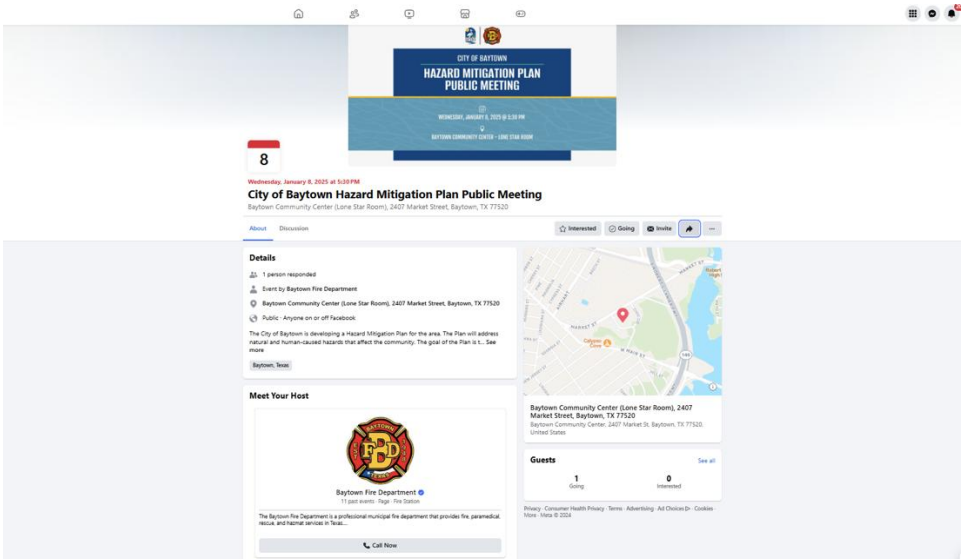


Figure G-23. City of Baytown Public Notice, Facebook Event Page



APPENDIX G: MEETING DOCUMENTATION

Figure G-24. City of Baytown Public Notice, Fire Department Instagram

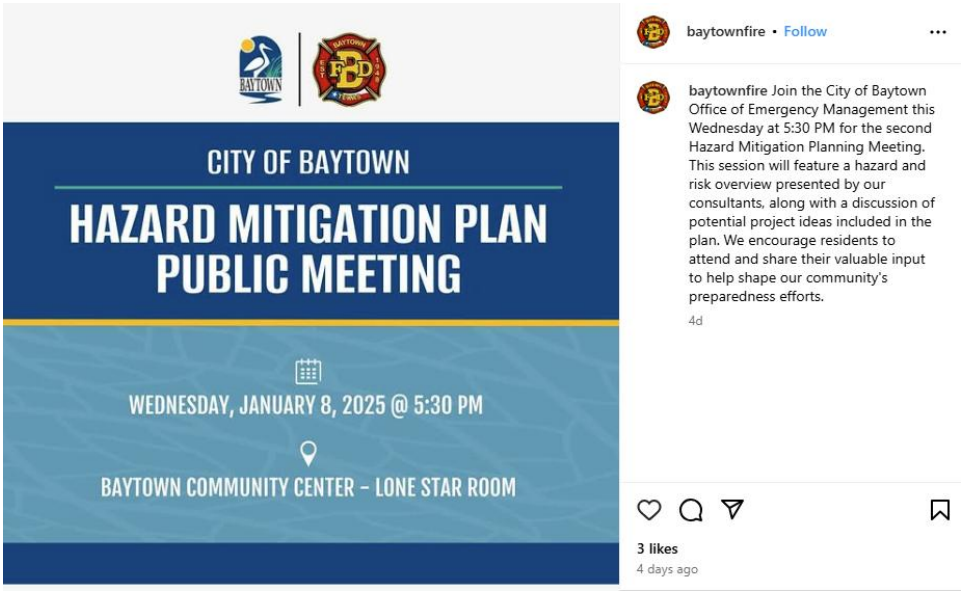
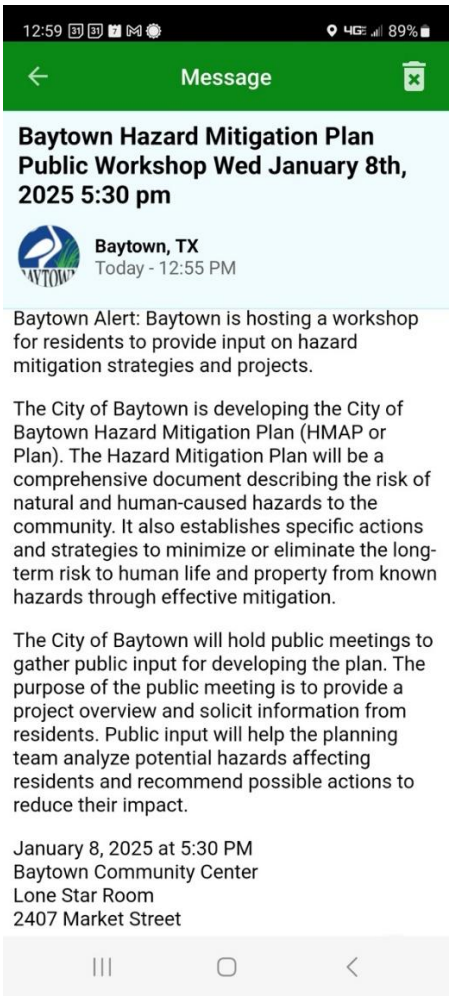
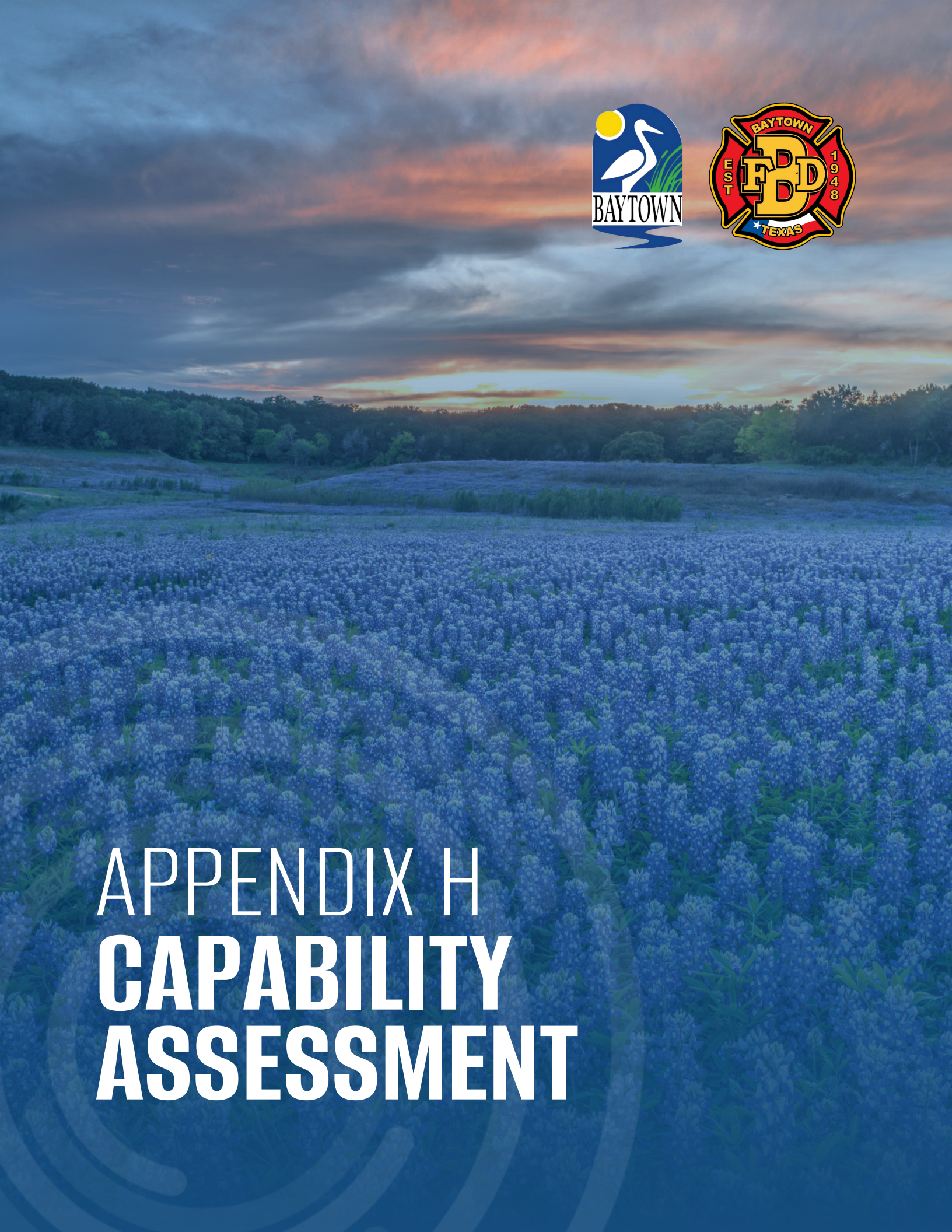


Figure G-25. City of Baytown Public Notice, Mass Text Alert





APPENDIX H
CAPABILITY ASSESSMENT

APPENDIX H: CAPABILITY ASSESSMENT

Overview 1
Community Capability Assessments.....2

OVERVIEW

A Community Capability Assessment is an integral component of the Hazard Mitigation Planning Process. It is an invaluable tool in assessing a community's existing planning and regulatory capabilities to support implementation of mitigation strategy objectives.

Beginning on Page 2, a completed Capability Assessment Checklist provides information on existing policies, plans, and regulations in place for Planning Team members at the local level or that may be provided by the County on an as-needed basis. ***Participation is denoted with an "x" on the Checklist.***

APPENDIX H: CAPABILITY ASSESSMENT

COMMUNITY CAPABILITY ASSESSMENTS

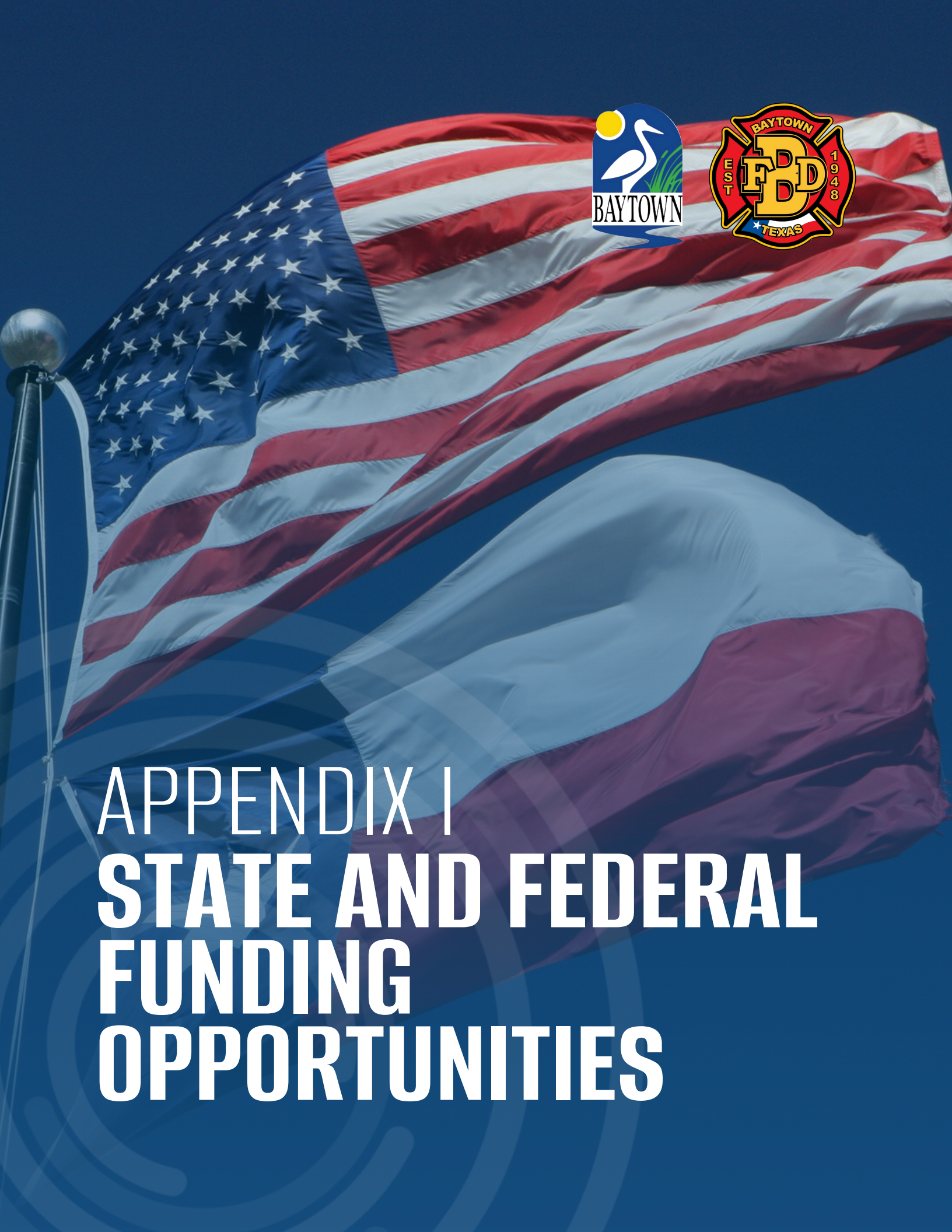
COMMUNITY CAPABILITY CHECKLIST	CITY OF BAYTOWN
PLANS	
Capital Improvements Plan	X
Climate Change Adaptation Plan	
Community Wildfire Protection Plan	X
Comprehensive Plan	X
Continuity of Operations Plan	X
Drought Contingency Plan/Protocol on Water Restrictions	X
Economic Development Plan	X
Emergency Management Action Plan	X
Emergency Operations Plan	X
Evacuation Plan	X
Extreme Heat Protocol	X
Flood Mitigation Plan	X
Hazard Mitigation Plan	X
Master Drainage Plan	X
Parks, Recreation, Trails and Open Space Master Plan	X
Regulatory Plan	x
Strategic Plan	X
Stormwater Management Plan / Ordinance	X
Transportation Plan	X

APPENDIX H: CAPABILITY ASSESSMENT

COMMUNITY CAPABILITY CHECKLIST	CITY OF BAYTOWN
POLICIES / ORDINANCES	
Building Codes	X
Fire Code	X
Floodplain Ordinance	X
Manufactured Home Restrictions	X
Stormwater Ordinance	X
Subdivision Regulations	X
Wildfire Ordinance	
Zoning Ordinance/Land Use Restrictions	X
PROGRAMS	
Carbon Capture Demonstration Projects Program	X
Cedar Bayou Initiative	X
Firewise Communities	
Floodplain Maps/Flood Insurance Studies	X
Historical Shoreline Movement	X
Hydrologic/Hydraulic Studies	X
Mutual Aid Agreement	X
National Flood Insurance Program Participant	X
NFIP Community Rating System Participant	X
Property Acquisition Program	X
Public Education/Awareness Programs	X

APPENDIX H: CAPABILITY ASSESSMENT

COMMUNITY CAPABILITY CHECKLIST	CITY OF BAYTOWN
Regional Groundwater Project	X
Shoreline Stabilization Project	X
Storm Drainage Systems Maintenance Program	X
Stream Maintenance Program	
StormReady Communities	X
Warning Systems/Services (reverse 911, outdoor warning sirens)	X
STAFF / DEPARTMENTS	
Building Code Official	X
Emergency Manager	X
Engineers	X
Environmental Conservation Specialist	
Floodplain Administrator	X
Geographic Information System (GIS) Coordinator	X
Personnel with Hazard Knowledge	X
Planners	X
Public Information Official	X
Resource Development/Grant Writer	X



APPENDIX I
STATE AND FEDERAL FUNDING OPPORTUNITIES

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

Overview 1

OVERVIEW

Texas utilizes state funds to improve statewide hazard mitigation capabilities and advance their hazard mitigation goals to help identify, understand, and manage various risks associated with natural hazards. State funds also provide funding for state facility and infrastructure upgrades, hazard mapping, mitigation planning, and other mitigation programmatic activities. Table I-1 describes a variety of loan and grant programs offered by state agencies for which mitigation activities may be eligible.

Table I-1. Summary of State Funded Mitigation Programs

AGENCY	FUNDING PROGRAM
Texas A&M Forest Service (TAMFS)	• Community Fire Protection Program • Community Wildfire Defense Grant • Fire-Adapted Communities Program (FAC) • Firewise USA Program • Forest Land Enhancement Program • Forest Legacy Program • Mitigation Project Support Fund Prescribed Fire Grants • Resilient Landscapes Program • Rural Fire Assistance Grant • State Fire Assistance for Mitigation (SFAM) - Mechanical Fuels Grants • State Fire Assistance for Mitigation (SFAM) - Vegetative Fuel Break Grant • Texas Longleaf Conservation Assistance Program • Urban Tree Canopy Project (UTC)
Texas Commission on Environmental Quality (TCEQ)	• Clean Water Act Section 319 Grants • High Hazard Potential Dam Program (HHPD) • Nonpoint Source Grant Program • U.S.-Mexico Border Water Infrastructure Program
Texas Department of Agriculture (TDA)	• Agricultural Management Assistance (AMA) • Agricultural Water Enhancement Program (AWEP) • Community Development Block Grant • Community Development Block Grant for Rural Texas • Conservation Innovation Grants (CIG) • Environmental Quality Incentives Program (EQUIP)

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

AGENCY	FUNDING PROGRAM
Texas Department of Housing and Community Affairs (TDHCA)	• Texas HOME Disaster Relief
Texas Department of State Health Services (TXDSHS)	• Hospital Preparedness Program (HPP) Cooperative Agreement • Public Health Emergency Preparedness (PHEP) Cooperative Agreement
Texas Department of Transportation (TXDOT)	• Bridge Preventative Maintenance Program • Emergency Relief (ER) Program • Highway Bridge Replacement and Rehabilitation Program • Safe Rest Stops Program • Transportation Enhancement Program
Texas Division of Emergency Management (TDEM)	• Building Resilient Infrastructure & Communities (BRIC) • Emergency Management Performance Grant (EMPG) • Fire Management Assistance Grants (FMAG) • Hazard Mitigation Planning Grants Program (HMGP) • Homeland Security Grant Program (HSGP) • Individual Assistance (IA) • National Earthquake Hazard Reduction Program (NEHRP) • Public Assistance (PA) Section 406 Funds
Texas Economic Development & Tourism (EDT)	• Economic Development Administration Grants and Investments
Texas General Land Office (TXGLO)	• Beach Grants • Beach Maintenance Reimbursement Fund • Coastal Erosion Planning and Response Act (CEPRA) • Coastal and Estuarine Land Conservation Program (CELCP) • Coastal Management Program (CMP) • Community Development Block Grant – Disaster Recovery (CDBG-DR) • Community Development Block Grant – Mitigation (CDBG-MIT) • Gulf of Mexico Energy Security Act (GOMESA) • Hazard Mitigation Grant Program Supplemental -LHMPP

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

AGENCY	FUNDING PROGRAM
Texas Parks and Wildlife Department (TPWD)	• Nation Resources Damage Assessment (NRDA) • National Wildlife Wetland Refuge System • North American Wetland Conservation Fund • Partners for Fish and Wildlife • Texas Farm and Ranch Lands Conservation Program (TFRLCP) • Wildlife Habitat Incentive Program (WHIP)
Texas State Soil and Water Conservation Board (TSSWCB)	• Clean Water Act Section 319 Grants • Nonpoint Source Grant Program
Texas Water Development Board (TWDB)	• Agricultural Water Conservation Grants • Agricultural Water Conservation Loans • Clean Water State Revolving Fund (SWSRF) • Community Assistance Program (CAP) • Drinking Water State Revolving Fund (DWSRF) • Economically Distressed Areas Program • Emergency Community Water Assistance Grants • Flood Infrastructure Fund (FIF) • Flood Mitigation Assistance (FMA) Program • Flood Mitigation Assistance (FMA) Swift Program • Flood Protection Planning Program • Groundwater Conservation District Loan Program • Planning Assistance to States • Regional Facility Planning Grant Program • Regional Water Planning Group Grants • Research and Planning Fund and Fund Development Program • Risk MAP Program • Rural Development Grants • Rural Water Assistance Fund • Silver Jackets • Small Flood Control Projects (USACE Section 205) • State Participation Program – Regional Water and Wastewater Facilities • State Water Implementation Fund for Texas (SWIFT) • State Water Resources Research Act Program • Texas Infrastructure Resiliency Fund (TIRF) • Texas Water Development Fund (DFund) • Water Research Grant Program • Water SMART - Drought Response Program

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

In addition to State funded programs, many local jurisdictions benefit from federal mitigation funding opportunities. FEMA'S Hazard Mitigation Assistance is a primary source for the implementation of mitigation projects throughout the Nation. Table I-2 described additional Federal, State, Local, and Non-Profit mitigation funding sources specifically within the State of Texas.

Table I-2. Federal, State, Local and Non-Profit Mitigation Funding Sources in Texas

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Agricultural Management Assistance (AMA)	Federal	USDA, NRCS	TDA	Provides financial and technical assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation methods into their farming operations.
Agricultural Water Enhancement Program (AWEP)	Federal	USDA, NRCS	TDA	Voluntary conservation initiative that provides financial and technical assistance to agricultural producers to implement water enhancement activities on agricultural land to conserve surface and ground water and improve water quality.
Agricultural Water Conservation Grants	State	TWDB	TWDB	Provided to state agencies and political subdivisions for projects that support the implementation of conservation of water management strategies identified in state and regional water plans. Yearly applications. Up to $1.2 million available annually. Grant categories vary from year to year.
Agricultural Water Conservation Loans	State	TWDB	TWDB	Agricultural water conservation loans to use either for improvements on facilities or as loan to individuals. Low-interest, fixed rates. Up to 10-year repayment terms. U.S. Iron and Steel requirements apply to certain projects. Eligible Loan applicants include political subdivisions.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
AmeriCorps - Corporation for National & Community Service (CNCS)	Federal	AmeriCorps	N/A	Provides funding for volunteers to serve communities, including disaster prevention. AmeriCorps/Vista has assisted local communities with wildfire mitigation projects.
American Recovery and Reinvestment Act (ARRA)	Federal	DOT Federal Transit Administration	TDA	Nicknamed the Recovery Act was a stimulus package enacted by the 111th U.S. Congress and signed into law by President Barack Obama in February 2009. Developed in response to the Great Recession, the primary objective of this federal statute was to save existing jobs and create new ones as soon as possible. Other objectives were to provide temporary relief programs for those most affected by the recession and invest in infrastructure, education, health, and renewable energy.
Assistance to Firefighters program - Fire Prevention & Safety (FP&S) Grants	Federal	FEMA, AFG		Fire Prevention & Safety (FP&S) Grants support projects that enhance the safety of the public and firefighters from fire and related hazards.
Beach Grants	Federal	EPA	TXGLO	EPA awards grants under authority of the BEACH Act to eligible states, territories, and tribes with beaches on ocean and Great Lakes coasts to develop and implement programs to monitor their beaches and notify the public when it is not safe to swim.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Beach Maintenance Reimbursement Fund	State	GLO	TXGLO	Allocates approximately $750,000 per year to help communities keep their beaches maintained. Applications are distributed to eligible participants in early fall and are due within a specified amount of time, no less than 30 days. Contracts are renewable annually.
Bridge Preventative Maintenance Program	State	TXDOT	TXDOT	A planned, cost-effective treatment that preserves, improves, or delays future deterioration of the condition of a bridge. To be eligible for the BMIP a bridge must have a condition rating of 5 or 6 for at least one of the following: deck, superstructure, substructure, culvert, or channel. Safety and improvement to the physical conditions of the State's on-system bridges are TxDOT's main goals in the prioritization of the bridges using BMIP funds. The Bridge Division develops an initial list each FY of eligible bridges in each district and distribute to the districts for the annual program call.
Building Resilient Infrastructure & Communities (BRIC)	Federal	FEMA	TDEM	Pre-disaster/annual cycle addressing all natural hazards, emphasis on infrastructure & lifelines.
Clean Water Act Section 319 Grants	Federal	EPA	TCEQ and TSSWCB	Provides grants for a wide variety of activities related to non-point source pollution runoff mitigation.
Clean Water State Revolving Fund (CWSRF)	Federal	EPA	TWDB	Providing low-cost financing for a wide range of wastewater, stormwater, reuse, and other pollution control projects.
Coastal Erosion Planning and Response Act (CEPRA)	State	GLO	TXGLO	Since 2000, the Texas General Land Office's Coastal Erosion Planning and Response Program has received more than $62 million in state funding and more than $62 million in matching funds,

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
CEPRA (continued)				completing more than 200 coastal erosion projects and studies. The application process for non-emergency project funding requests opens every even year in February and closes in early June of that same year.
Coastal and Estuarine Land Conservation Program (CELCP)	Federal	NOAA	TXGLO	When NOAA provides funding for CELCP, the GLO provides coastal communities an opportunity to apply for up to three projects per year, with federal grants for any single project not to exceed $3 million.
Coastal Management Program (CMP)	Federal	NOAA	TXGLO	Texas receives approximately $2 million annually in grants from National Oceanic and Atmospheric Administration (NOAA) and 90% of the funds are passed through to local governments and entities to address environmental needs and promote sustainable economic development along the coast. Projects must improve the management of the state's coastal resources and ensure long-term ecological and economic productivity. Section 306 administrative funds can be used for non-construction, coastal planning and education, and research. Section 306A improvement funds can be utilized for construction and land acquisition projects and preservation and restoration. CMP funding categories include Coastal Natural Hazards Response, Critical Areas Enhancement, Public Access, Water/Sediment Quantity and Quality Improvements, Waterfront Revitalization and Ecotourism Development, Permit Streamlining/ Assistance, Governmental Coordination and Local Government Planning Assistance.
Community Assistance Program (CAP)	Federal	FEMA, NFIP	TWDB	Product-oriented financial assistance program directly related to the flood loss reduction objectives of the NFIP.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Community Development Block Grant (CDBG)	Federal	HUD	TDA	The primary objective is to develop viable communities by providing decent housing and suitable living environments and expanding economic opportunities principally for persons of low- to moderate- income. Eligible applicants are non-entitlement cities under 50,000 in population and non-entitlement counties that have a non-metropolitan population under 200,000 and are not eligible for direct CDBG funding from HUD may apply for funding through any of the Texas CDBG programs.
Community Development Block Grant for Rural Texas	State	TDA	TDA	TDA administers the Community Development Block Grant for Rural Texas. The primary objective of the CDBG is to develop viable communities by providing decent housing and suitable living environments and expanding economic opportunities principally for persons of low- to moderate-income. Eligible applicants are non-entitlement cities under 50,000 in population and non-entitlement counties that have a non-metropolitan population under 200,000 and are not eligible for direct CDBG funding from HUD may apply for funding through any of the Texas CDBG programs.
Community Development Block Grant – Disaster Recovery (CDBG-DR)	Federal	HUD	TXGLO	Often following a disaster, the state may receive a CDBG-DR Supplement intended for mitigation and disaster recovery projects in the affected areas. Funding can be used to acquire properties in hazard prone areas. Since CDBG funds lose their federal identify they can also be used to supplement state or local match requirements on other funds such as FEMA HMA grants. Funding also supports public facilities including water and wastewater.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Community Development Block Grant – Mitigation (CDBG-MIT)	Federal	HUD	TXGLO	Eligible grantees to use this assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses. In February of 2018, Congress appropriated $12 billion dollars in Community Development Block Grant (CDBG) funds specifically for mitigation activities for qualifying disasters in 2015, 2016, and 2017. HUD was able to allocate an additional $3.9 billion, bringing the amount available for mitigation to nearly $16 billion.
Community Fire Protection Program	Federal	USDA	TAMFS	Mitigation delivered via USDA Forest Service and Private Forestry Coop Fire Program.
Community Wildfire Defense Grant	Federal	USFS	TAMFS	Offers financial assistance to at-risk local communities with planning for and mitigating against the risk of catastrophic wildfire. This program is authorized in Public Law 117-58, the Infrastructure Investment and Jobs Act. Two primary objectives: The development and revision of Community Wildfire Protection Plans (CWPP), and the implementation of projects described in a CWPP that is less than ten years old. Prioritizes at-risk communities that are in an area identified as having high or very high wildfire hazard potential, are low-income, and/or have been impacted by a severe disaster. No minimum federal funding limit for projects.
Conservation Innovation Grants (CIG)	Federal	USDA, NRCS	TDA	Voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Drinking Water State Revolving Fund (DWSRF)	Federal	EPA	TWDB	Makes funds available to drinking water systems to finance infrastructure improvements. The program also emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water.
Economic Development Administration Grants and Investments	Federal	U.S. DOC, EDA	EDT	Invests and provides grants for community construction projects, including mitigation activities.
Economically Distressed Areas Program	State	TWDB	TWDB	Provides financial assistance for projects serving economically distressed areas where water or sewer services do not exist, or systems do not meet minimum state standards. Eligible EDAP applicants include cities, counties, water districts, nonprofit water supply corporations, and all other political subdivisions. The city or county where the project is located must adopt and enforce Model Subdivision Rules for the regulation of subdivisions prior to application for financial assistance. Projects must also be in an economically distressed area where the median household income is not greater than 75 percent of the median state household income.
Emergency Community Water Assistance Grants	Federal	USDA	TWDB	$150,000 to $500,000 available to rural communities with populations over 10,000 people with a median household income less than $65,900. Aids communities who have experienced a decline in quantity or quality of drinking water as a result of an emergency including drought.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Emergency Management Performance Grant (EMPG)	Federal	FEMA	TDEM	The EMPG program provides a yearly allocation of funding to support state and local emergency management programs. This has included providing some funding for local mitigation plans, mitigation-oriented studies, and related activities.
Emergency Relief (ER) **Program**	Federal	US DOT - FHWA	TXDOT	Provides funds for roads and bridges on Federal-aid highways that are damaged as a direct result of a natural disaster or catastrophic failure from an external cause.
Emergency Watershed Protection (EWP)	Federal	USDA, NRCS	TWDB	Provides funding and technical assistance for emergency measures such as floodplain easements in impaired watersheds. Funding available through the Simplified Acquisition Procedures (SAP) ranges from $25K to $100K. Funded through contracts between project sponsors and the NRCS. There are no grants. The NRCS pays 75% of the costs.
Environmental Quality Incentives Program (EQUIP)	Federal	USDA, NRCS	TDA	Provides funding and technical assistance to farmers and ranchers to promote agricultural production and environmental quality as compatible goals.
Fire-Adapted Communities Program (FAC)	Federal	FEMA, USFA	TAMFS	Collaborates to identify its wildfire risk and works collectively on actionable steps to reduce its risk of loss. This work protects property and increases the safety of firefighters and residents.
Fire Management Assistance Grants (FMAG)	Federal	FEMA	TDEM	Provides fire suppression support to states when loss of life and property are imminent. Wildfire mitigation is also eligible under emergency protection if life is in imminent danger.

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Firewise USA Program	Federal	USDA, DOI, NASFF, NFPA	TAMFS	The national Firewise USA® recognition program provides a collaborative framework to help neighbors in a geographic area get organized, find direction, and take action to increase the ignition resistance of their homes and community and to reduce wildfire risks at the local level.
Flood Infrastructure Fund (FIF)	State	TWDB	TWDB	Enacted through Senate Bill 7 to address needs identified following the flood disasters of 2015, 2016, and 2017. Senate Bill 500 appropriated $793 million. The purpose is to provide loans and grants for flood activities and projects. Once the State Flood Plan is adopted, the account may only be used for projects included in the plan. The SWIFT Advisory Committee is the oversight entity.
Flood Mitigation Assistance Program (FMA)	Federal	FEMA	TWDB	Repetitive flood loss property reduction and projects that mitigate losses to NFIP insured properties.
Flood Protection Planning Program	State	TWDB	TWDB	Developed to evaluate solutions to flooding problems in the state of Texas. Planning activities eligible for this program may include:
Forest Land Enhancement Program	Federal	USDA, NRCS	TAMFS	Provides educational, technical, and financial assistance to help landowners implement sustainable forestry management objectives.
Forest Legacy Program	Federal	USFS	TAMFS	Program providing funding to protect private forest lands that are environmentally, economically, and socially critical. This program reduces development in the wildland-urban interface.
Hazard Mitigation Grant Program (HMGP)	Federal	FEMA	TDEM	Post-disaster multi-hazard mitigation funding for federally declared disasters. HMGP Post Fire funds are available for FMAG declarations.

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Hazard Mitigation Grant Program Supplemental – Local Hazard Mitigation Plan Program (LHMPP)	Federal	FEMA	TXGLO	Local Hazard Mitigation Plan Program (LHMPP) assists eligible entities by providing grants to develop or update local hazard mitigation plans, or to provide cost share for hazard mitigation planning activities funded through other federal sources. Community Development Block Grant Mitigation (CDBG-MIT) funds allocated by the United States Department of Housing and Urban Development (HUD) and administered by the Texas General Land Office (GLO) fund these planning activities, and the Hazard Mitigation Plan development and approval oversight is administered by the Federal Emergency Management Agency (FEMA) and administered by the Texas Division of Emergency Management (TDEM Grant awards will range from $20,000 – $100,000.
High Hazard Potential Dam Program (HHPD)	Federal	FEMA	TCEQ	Pre-disaster/annual cycle, for non-federal high hazard dams rated Unsatisfactory. Local match is 35% for each of the four grant periods.
Highway Bridge Replacement and Rehabilitation Program	Federal	FHWA	TXDOT	Provides funding to enable states to improve the condition of highway bridges through replacement, rehabilitation, and systematic preventive maintenance. Also includes the National Historic Covered Bridge Preservation Program.
Homeland Security Grant Program (HSGP)	Federal	DHS	TDEM	Homeland security activities identified in the state and local strategic plans. Funding supports threat & hazard and risk identification for natural, technological, and human-caused hazards. Some prevention activities may be considered mitigation.
Hospital Preparedness Program (HPP) Cooperative Agreement	Federal	HHS	TXDSHS	HPP is the primary source of federal funding for health care system preparedness and response and, in collaboration with public health, prepares health care delivery systems to save lives through the development of health care coalitions (HCCs).

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
				Under the direction of the HPP providers, the HCCs develop plans and provide training, and coordinate regional exercises.
Hydrologic Research Grants	Federal	NOAA		Up to $125,000 to conduct joint research and development on pressing surface water hydrology issues common to national, regional, local operational offices. Eligible applicants are federally recognized agencies of state or local governments, quasi-public institutions such as water supply or power companies, hydrologic consultants and companies involved in using and developing hydrologic forecasts.
Groundwater Conservation District Loan Program	State	TWDB	TWDB	Provides short-term loans to finance the start-up costs of Groundwater Conservation Districts. Funding is available for any Groundwater District or Authority with the authority to regulate the spacing of water wells, the production from water wells, or both. The program is authorized under Texas Water Code Chap. 36, Subchapter. L, and governed by TWDB rules in 31 Tex. Admin. Code Chap. 363, Subchapter. H.
Gulf of Mexico Energy Security Act (GOMESA)	Federal	DOI	TXGLO	GOMESA significantly enhances oil and gas leasing activities and creates revenue sharing provisions for the oil- and gas-producing states of Alabama, Louisiana, Mississippi, and Texas, and their coastal political subdivisions (CPSs). GOMESA funds are used for coastal conservation, restoration, and hurricane protection. The second phase of GOMESA revenue sharing began in Fiscal Year 2017 and expands the definition of qualified Outer Continental Shelf revenues to include receipts from Gulf of Mexico leases subject to withdrawal or moratoria restrictions. A revenue-sharing cap of $500 million per year for the four Gulf producing states, their CPSs and the Land and

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
				Water Conservation Fund applies from fiscal years 2016 through 2055.
Individual Assistance (IA)	Federal	FEMA	TDEM	Following a disaster, funds can be used to mitigate hazards when repairing individual and family homes.
In-Lieu Fee Program Mitigation Projects	Federal	USACE	Community Applicants	Restoration, establishment, enhancement, and/or preservation of aquatic resources through funds paid to a governmental or non-profit natural resources management entity to satisfy compensatory mitigation requirements for Department of the Army permits.
Mitigation Banks	Federal	USACE	Community Applicants	Mitigation Banks are sites approved by the Corps to sell compensatory mitigation credits for projects resulting in unavoidable impacts to waters of the U.S. When a permit is issued that requires compensatory mitigation, the permit will specify how many credits are required to be purchased at an approved mitigation bank.
National Earthquake Hazards Reduction Program (NEHRP)	Federal	FEMA	TDEM	Provides money to support enhanced earthquake risk assessments in local hazard mitigation plans and other earthquake hazard mitigation and preparedness activities.
Natural Resources Damage Assessment (NRDA)	Federal	EPA	TPWD	ERAs evaluate the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to physical stressors (e.g., cleanup activities) or chemical stressors (e.g., release of hazardous substances) at a site.
National Weather Service (NWS)	Federal	NOAA - NWS		NWS offers storm spotter training, along with weather and flooding safety guides. They can also sometimes provide funding to support severe weather signage in parks or other public places.

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
National Wildlife Wetland Refuge System	Federal	USFWS	TPWD	Provides funding for the acquisition of lands into the federal wildlife refuge system.
Nonpoint Source Grant Program	Federal	EPA	TCEQ, TSSWCB	The federal Clean Water Act (CWA) requires States to develop a program to protect the quality of water resources from the adverse effects of nonpoint source (NPS) water pollution. TCEQ and TSSWCB administer federal grants for activities that prevent or reduce nonpoint source pollution (NPS).
North American Wetland Conservation Fund	Federal	USFWS	TPWD	Provides funding for wetland conservation projects.
NRCS Conservation Programs	Federal	USDA, NRCS	Community Applicants	Provides funding through several programs for the conservation of natural resources.
Partners for Fish and Wildlife	Federal	USFWS	TPWD	Provides financial and technical assistance to landowners for wetland restoration projects in "Focus Areas" of the state.
Planning Assistance to States	Federal	USACE	TWDB	Aids states in planning for the development, utilization, and conservation of water and related land resources.
Pre-Disaster Mitigation Loan Program	Federal	SBA		Provides low-interest loans to small businesses for mitigation projects.
Prescribed Fire Grants	State	TAMFS	TAMFS	TAMFS's Mitigation & Prevention Department annually implements four prescribed fire grants intended to protect local communities and restore ecosystems. (1) SFAM Plains Prescribed Fire Grant – aids communities that have been or may be threatened by wildland fire by funding prescribed burning to reduce hazardous fuels

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Prescribed Fire Grants (continued)				in or around communities. Treatment areas will be located adjacent to priority communities in Texas that are at the highest risk for loss during a Southern Plains Wildfire Outbreak event. (2) The Community Protection Program Grant aids reducing the hazard of high-risk fuels on private lands through the use of prescribed burning. The treatment area will be within 10 miles of a National Forest boundary. The grant's goal is to protect high-risk communities and associated forest resources by reducing the risk of catastrophic wildfire on private and public lands. (3) The State Fire Assistance for Mitigation Central & East Texas Grant provides assistance to communities that have been or may be threatened by wildfire by funding prescribed burning to reduce hazardous fuels in and around communities. Treatment areas will be private property in the 43 Counties in Central and East Texas that have a Community Wildfire Protection Plan within the county. The goal is to protect high-risk communities and aid in ecosystem restoration by utilizing prescribed fire to consume excess vegetation before it contributes to catastrophic wildfire. Priority will be given to treatments sites that are within a CWPP, located near a Firewise community, located near homes based on Texas Wildfire Risk Assessment Portal and contain ecosystems that will benefit from prescribed fire. (4) Neches River and Cypress Basin Watershed Restoration Program - Prescribed Fire Grant provides assistance to landowners in utilizing prescribed fire for ecological improvement to

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Prescribed Fire Grants (continued)				the Neches River and Cypress Basin watersheds. This program will benefit the public and natural resources through improvement of water quality and quantity, control of invasive species and enhancement of wildlife habitat. Treatment areas will be private property in the Neches River and Cypress Basin Watersheds. Priority will be given to prescribed burn treatments that promote native ecosystem restoration, are in priority watershed protection zones and near public land.
Public Assistance (PA) **Section 406 Funds**	Federal	FEMA	TDEM	Following a disaster, funds can be used to mitigate hazards when repairing damages to a public structure or infrastructure. Wildfire mitigation is also eligible under emergency protection if life is in imminent danger.
Public Health Emergency Preparedness (PHEP) **Cooperative Agreement**	Federal	CDC	TXDSHS	Helps health departments build and strengthen their abilities to effectively respond to a range of public health threats, including infectious diseases, natural disasters, and biological, chemical, nuclear, and radiological events. Preparedness activities funded by the PHEP cooperative agreement specifically target the development of emergency-ready public health departments that are flexible and adaptable.
Regional Facility Planning Grant Program	State	TWDB	TWDB	TWDB grants to political subdivisions of the State of Texas for studies and analyses to evaluate and determine the most feasible alternatives to meet regional water supply and wastewater facility needs, estimate the costs associated with implementing feasible regional water supply and wastewater facility alternatives, and identify institutional arrangements to provide regional water supply and wastewater services for areas in Texas.

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Regional Water Planning Group Grants	State	TWDB	TWDB	Developed to guide and support planning of the state's water resources by administering and assisting in the development of the regional and state water plans. The department strives to improve the planning process each cycle by developing clear guidance for the program's stakeholders and utilizing best-available data, methodologies, and technical innovations.
Research and Planning Fund and Fund Development Program	State	TWDB	TWDB	Offers grants to eligible applicants for the development or revision of regional water plans. The proposed planning must be a plan, an amendment to an approved regional water plan developed by the regional water planning group for a regional water planning area pursuant to the Texas Water Code, §16.053 and Chapter 357, or other special studies approved by the TWDB which will enhance water planning efforts in the region. Activities eligible for funding are those related to the development, revision, or improvement of regional water plans including public meetings, hearings, and special studies.
Resilient Landscapes Program	Federal	USDA, USFS	TAMFS	The USFS is working with partners to restore healthy, resilient, fire-adapted ecosystems. Restoring ecosystems includes thinning crowded forests and using prescribed fire on two to three million acres each year, which can help prevent the buildup of flammable vegetation that feeds extreme wildfires.
Risk MAP Program	Federal	FEMA, NFIP	TWDB	Establishes or updates floodplain mapping and multi-hazard risk products.
Rural Development Grants	Federal	USDA-Rural Development	TWDB	Provides grants and loans for infrastructure and public safety development and enhancement in rural areas. Provides $100,000 or 75% of the total project, whichever is less.

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Rural Fire Assistance Grant	Federal	NIFC	TAMFS	Funds fire mitigation activities in rural communities.
Rural Utilities Service (RUS)	Federal	USDA-Rural Development		RUS administers programs that provide much-needed infrastructure or infrastructure improvements to rural communities. These include water and waste treatment, electric power, and telecommunications services.
Rural Water Assistance Fund	State	TWDB	TWDB	Designed to assist small rural utilities to obtain low-cost financing for water and wastewater projects. The RWAF offers tax-exempt equivalent interest rate loans with long-term finance options.
Safe Rest Stops Program	State	TXDOT	TXDOT	Texas has 21 major highways that serve as long distance travel corridors. Along each of these roadways, rest areas are an essential safety feature to reduce accidents caused by driver fatigue. These facilities give travelers a break from driving, and then return them to the road rested, refreshed and alert.
State Fire Assistance for Mitigation (SFAM) - Mechanical Fuels Grants	State	TAMFS	TAMFS	Provides financial assistance to reduce the hazard of high-risk fuels on private lands using hazardous fuel reduction. The grant's goal is protected high risk communities within the 32 high risk counties in Central Texas identified by Texas A&M Forest Service Mitigation and Prevention Department. Priority will be given to landowners that live with in the 32 high risk counties, are in a county or city that has an active Community Wildfire Protection plan or live with in a Firewise USA Site.
State Fire Assistance for Mitigation (SFAM) - Vegetative Fuel Break Grant	State	TAMFS	TAMFS	Provides financial assistance for the creation of vegetative fuel breaks on private lands in Texas. Vegetative fuel breaks are trees and shrubs systematically planted adjacent to fields, homesteads, or feedlots to reduce or redirect the wind. Projects will be in the Texas High Plains. The

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
				goal of the grant is to protect high-risk communities by reducing the risk of catastrophic wildfire on private and public lands. Grant recipients will be reimbursed up to $2,500 for actual costs associated with creating a green, vegetative fuel break, consisting of a minimum of 3 rows of trees and 400 feet in length.
Silver Jackets	Federal	USACE	TWDB	Can provide funding for flood related studies, public awareness, risk analysis, and flood response plans. Construction of small flood control projects.
Small Flood Control Projects (USACE Section 205)	Federal	USACE	TWDB	Authorizes use of USACE to do feasibility and construction of small flood control projects.
State Participation Program – Regional Water and Wastewater Facilities	State	TWDB	TWDB	The State Participation Program enables the TWDB to provide funding and assume a temporary ownership interest in a regional water, wastewater, or flood control project when the local sponsors are unable to assume debt for an optimally sized facility. The program is intended to encourage the optimum regional development of projects by funding excess capacity for future use where the benefits can be documented, and where such development is unaffordable without state participation. The goal is to allow for the "right sizing" of projects in consideration of future needs.
State Water Implementation Fund for Texas (SWIFT)	State	TWDB	TWDB	Passed by the Legislature and approved by Texas voters through a constitutional amendment, the SWIFT program helps communities develop and optimize water supplies at cost-effective rates. The program provides low-interest loans, extended repayment terms, deferral of loan repayments, and incremental repurchase terms for projects with state ownership aspects.

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
State Water Resources Research Act Program	Federal	USGS	TWDB	USGS in cooperation with the National Institutes for Water Resources supports an annual call for proposals to focus on water problems and issues that are of a regional or interstate nature or relate to a specific program priority identified by the Secretary of the Interior and the Institutes.
Texas Farm and Ranch Lands Conservation Program (TFRLCP)	State	TPWD	TPWD	Maintains and enhances the ecological and agricultural productivity of these lands through Agricultural Conservation Easements. The TFRLCP supports responsible stewardship and conservation of working lands, water, fish and wildlife, and agricultural production through: • Generating interest and awareness in easement programs and other options for conserving working lands. • Leveraging available monies to fund as many high-quality projects as possible. Highlighting the ecological and economic value of working lands and the opportunities to conserve working lands for the future.
Texas HOME Disaster Relief	Federal	TDHCA	TDHCA	The Texas HOME Disaster Relief Program is a long-term housing program designed to help eligible organizations serve income eligible households impacted by disasters. Funds are available to assist with federal or state declared disasters, or other natural or man-made disasters that may occur. The Department's practice is to maintain a HOME Disaster Relief Fund balance of $1 million whenever possible. These funds can be accessed to support impacted households not located in communities that receive HOME funds directly from the U.S. Department of Housing and Urban Development (HUD).

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Texas Longleaf Conservation Assistance Program	Federal	National Fish and Wildlife Foundation (NFWF)	TAMFS	Provides eligible landowners with financial and technical assistance for establishing, enhancing, and managing longleaf pine. Landowners with property within ten East Texas counties which include Angelina, Hardin, Jasper, Nacogdoches, Newton, Polk, San Augustine, Sabine, San Jacinto, Trinity, and Tyler are eligible to apply. Approved participants may receive up to 50% payment not to exceed a standard cap rate for implementing approved conservation practices. Approved conservation practices include prescribed burning, reforestation, site preparation, and forest stand improvement.
Texas Infrastructure Resiliency Fund (TIRF)	State	TWDB	TWDB	Enacted through Senate Bill 7 to address needs identified following the flood disasters of 2015, 2016, and 2017. Senate Bill 500 appropriated $685 million. Purpose is to provide loans, grants, and matching funds for flood projects through four separate accounts. Each account has different purposes. The oversight entity is the TIRF Advisory Board (SWIFT Advisory Committee and TDEM Director as non-voting member).
Texas Water Development Fund (DFund)	State	TWDB	TWDB	State funded loan program The DFund enables the Board to fund multiple eligible components in one loan to our borrowers, e.g., an application for funding of water and wastewater components can be processed in a single loan. Provide financial assistance for water supply projects, wastewater projects, and flood control projects (including structural and nonstructural flood protection improvements).

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NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
Transportation Enhancement Program	Federal	FHWA	TXDOT	Provides opportunities for non-traditional transportation related activities. Projects should go above and beyond standard transportation activities and be integrated into the surrounding environment in a sensitive and creative manner that contributes to the livelihood of the communities, promotes the quality of our environment, and enhances the aesthetics of our roadways. Projects undertaken with enhancement funds are eligible for reimbursement of up to 80 percent of allowable costs.
United States Geological Survey (USGS)	Federal	USGS		USGS issues competitive grants and cooperative agreements to support research in earthquake hazards, the physics of earthquakes, earthquake occurrence, and earthquake safety policy.
Urban Tree Canopy Project (UTC)	Federal	USDA, USFS	TAMFS	Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. In urban areas, the UTC provides an important stormwater management function by intercepting rainfall that would otherwise run off of paved surfaces and be transported into local waters though the storm drainage system, picking up various pollutants along the way. UTC also reduces the urban heat island effect, reduces heating/cooling costs, lowers air temperatures, reduces air pollution, increases property values, provides wildlife habitat, and provides aesthetic and community benefits such as improved quality of life.
U.S.-Mexico Border Water Infrastructure Program	Federal	EPA	TCEQ	Provides grant assistance to U.S. and Mexican communities located within 60 miles of the border for the development and construction of high-priority drinking water and wastewater facilities. The program furthers EPA's mission of protecting human health and the environment by providing

APPENDIX I: STATE AND FEDERAL FUNDING OPPORTUNITIES

NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
				critical resources for what is often an area's first drinking water and basic sanitation services.
Water Research Grant Program	State	TWDB	TWDB	TWDB funds a variety of water planning and water research studies and projects intended to assist and support regional water planning efforts or to answer regional water planning questions.
Water Conservation Field Services Program	Federal	HUD	Texas A&M AgriLife	Provides several grants related to safe housing initiatives.
Water2025 Challenge Grant Program for Western States	Federal	Bureau of Reclamation	TWDB	Up to $25,000 for projects that improve water use efficiency and improve water management practices.
Watershed Processes and Water Resources	Federal	Bureau of Reclamation	TWDB	Up to $250,000 for projects that can be completed within 24 months and that reduce conflicts through water conservation, efficiency, and markets.
Watershed Processes and Water Resources – National Research Initiative Standard Research (Part T)	Federal	USDA	TWDB	$100,000 available. Sponsors research that addresses two areas: (1) understanding fundamental watershed processes; and (2) developing appropriate technology and management practices for improving the effective use of water (consumptive and non-consumptive) and protecting or improving water quality for agriculture and forestry production.
WaterSMART – Drought Response Program	Federal	USDA	TWDB	$500,000 available. Innovative research in understanding fundamental processes that affect the quality and quantity of water resources at diverse spatial and temporal scales, ways on improving water resource management in agriculture, forested, and rangeland watersheds,

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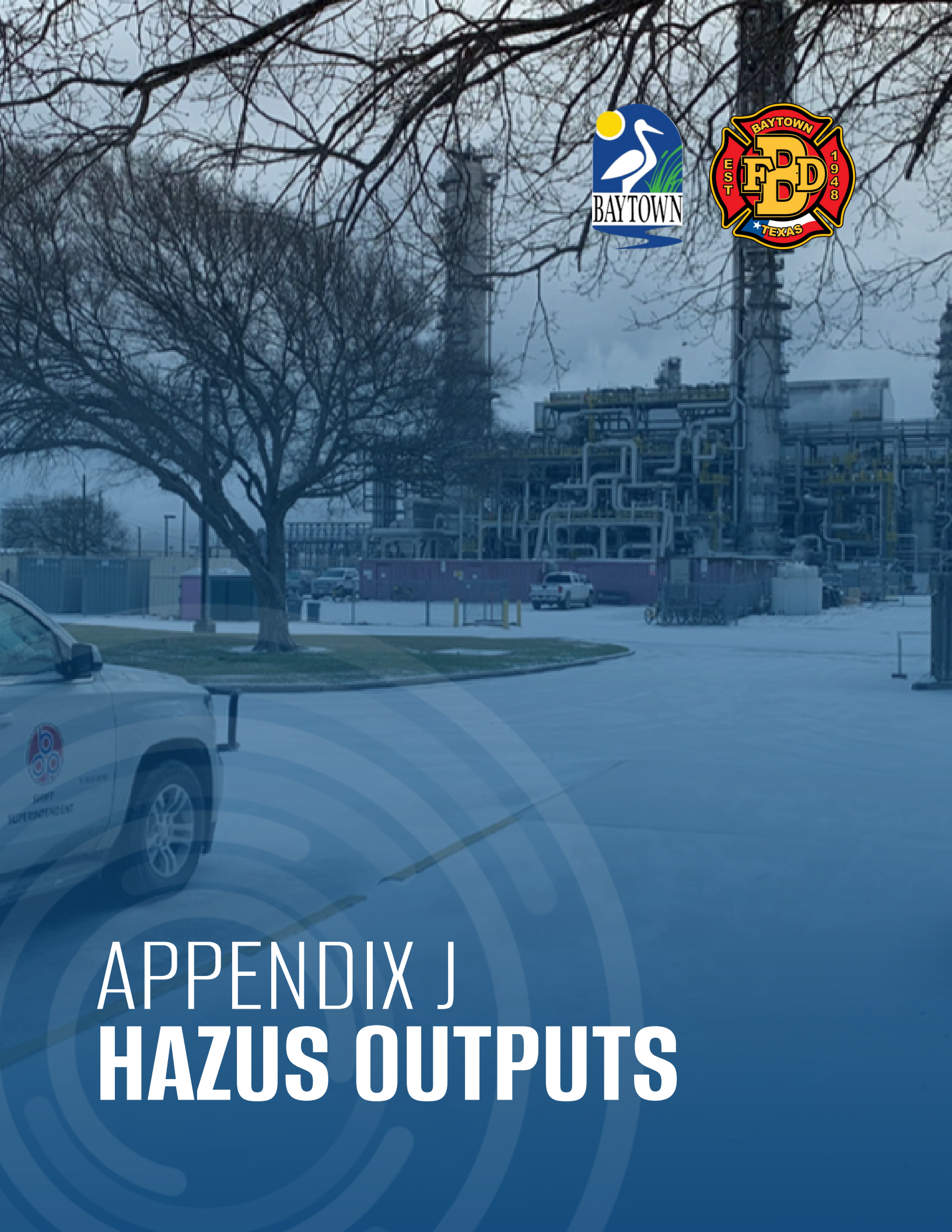
NAME	LEVEL	SOURCE AGENCY	MANAGING STATE AGENCY	PURPOSE OF FUNDING
				and developing appropriate technology to reach those goals.
Wildlife Habitat Incentive Program (WHIP)	Federal	USDA, NRCS	TPWD	Voluntary program for conservation-minded landowners who want to develop and improve wildlife habitat on agricultural land, nonindustrial private forest land, and tribal land.



APPENDIX J
HAZUS OUTPUTS

APPENDIX J: HAZUS OUTPUTS

Overview 1
Hazus Summary Output 1

OVERVIEW

Hazus is a nationally standardized risk modeling methodology that can be used to estimate potential damage, economic loss, and social impacts from earthquake, flood, tsunami and hurricane hazards. The flood model was utilized as an enhancement to the risk assessment for this plan. This model generates flood (riverine and coastal) hazard data using nationwide hydrological datasets, estimating the expected levels of damage to infrastructure and buildings. The model assumes a 100-year combined riverine and coastal flood scenario. A summary of the results is included in Tables J-1 through J-4.

HAZUS SUMMARY OUTPUT

Table J-1. Essential Facilities

Essential Facilities	Direct in City Limits		
	Total (Count)	Building Loss USD	Content Loss USD
Schools	30	0	0
Police Stations	2	0	0
Fire Stations	8	0	0
Emergency Operations Centers	1	0	0
Medical Care Facilities	2	0	0
Totals	**43**	**$ -**	**$ -**

Table J-2. Utility Systems

Utility Systems	Direct in City Limits	
	Total (Count)	Loss USD
Waste Water Facilities	18	99000719
Potable Water Facilities	0	0
Oil Facilities	2	35600
Natural Gas Facilities	0	0
Totals	**20**	**$ 99,036,319**

APPENDIX J: HAZUS OUTPUTS

Table J-3. Building Inventory

Aggregated Baseline Inventory (All Study Area)						
Building Damage	Total Buildings		Buildings w/ Substantial Damage		Undamaged Buildings	
	671		225		161	
Economic Loss*	Total Loss USD	Building Loss USD	Contents Loss USD	Inventory Loss USD	Income Loss USD	Wage Loss USD
	$ 1,291,635,000	$ 217,691,000	$ 340,020,000	$ 23,668,000	$ 89,079,000	$ 506,122,000
Shelter	Displaced Population		People Needing Shelter			
	4674		873			

Table J-4. Economic Loss by General Occupancy

Economic Loss by General Occupancy* (All Study Area)						
Occupancy Type	Total Loss USD	Building Loss USD	Contents Loss USD	Inventory Loss USD	Income Loss USD	Wage Loss USD
AGR	$ 6,972,000	$ 997,000	$ 2,164,000	$ 2,931,000	$ 512,000	$ 195,000
COM	$ 189,927,000	$ 24,620,000	$ 44,737,000	$ 5,000,000	$ 58,253,000	$ 33,077,000
EDU	$ 39,941,000	$ 1,829,000	$ 11,092,000	$ -	$ 7,036,000	$ 16,550,000
GOV	$ 601,890,000	$ 21,747,000	$ 91,291,000	$ -	$ 15,542,000	$ 440,205,000
IND	$ 170,320,000	$ 36,938,000	$ 104,022,000	$ 15,737,000	$ 3,132,000	$ 5,181,000
REL	$ 30,283,000	$ 1,602,000	$ 11,348,000	$ -	$ 4,363,000	$ 10,329,000
RES	$ 252,302,000	$ 129,958,000	$ 75,366,000	$ -	$ 241,000	$ 585,000